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An Observational Evaluation of Safety Resulting from Driver Distraction

Christina M. Dube
University of Massachusetts - Amherst, cmdube27@gmail.com

AN OBSERVATIONAL EVALUATION OF SAFETY RESULTING FROM DRIVER DISTRACTION

A Thesis Presented

by

CHRISTINA M. DUBE

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Approved as to style and content by:

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Michael A. Knodler, Chair

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Eleni Christofa, Member

____

Richard N. Palmer, Department Head

Department of Civil and Environmental Engineering

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ABSTRACT

"AN OBSERVATIONAL EVALUATION OF SAFETY RESULTING FROM DRIVER DISTRACTION"

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CHRISTINA DUBE, B.S., UNIVERSITY OF MASSACHUSETTS AMHERST

M.S.C.E., UNIVERSITY OF MASSACHUSETTS AMHERST

Directed by: Dr. Michael Knodler, Jr.

Distracted driving is a dangerous activity that continues to claim lives on roadways throughout the United States. A goal of this research was to collect distracted driving behavior data through observation in the field. A methodological approach was devised to keep data collection consistent across the observation periods. Analysis of the data provided information regarding trends in distraction type or driving behavior while engaging in a secondary activity. In combination with the observational portion of this research, another key component to understanding distracted driving was the crash report narrative key word search. By searching through the crash reports, it was determined which key words have high discriminating powers that indicate distraction was a key component to a crash. Additionally, the key word search demonstrated how accurately distraction related crashes are reported via the crash report form. This research contributed to the existing literature regarding distracted driving and also expanded the methods of research that are currently in use.

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CHAPTER 1

INTRODUCTION

Distracted driving can be defined as "any activity that could divert a person's attention away from the primary task of driving" (1). Distraction can be further broken down into three types of distractions: visual, manual, and cognitive (2). The use of a cell phone while operating a vehicle requires the driver to take at least one hand off of the steering wheel to hold the device. When using a phone to text message, the driver also needs to look at the phone screen or keypad and think about the message that he or she is reading or composing. Therefore, texting while driving incorporates all three types of distractions (visual, manual, and cognitive) within a single action and, as a result, decreases driving performance. In particular, distracted driving through the use of cell phones has become increasingly controversial in recent years in part due to the continual increase of the number of cell phones in use. In the United States in 2011, distracted driving was listed as a causal factor in 3,331 fatalities and 387,000 injuries, and in 2012 the death toll was similar with 3,328 fatalities and 421,000 injuries (1). Many states within the United States have passed laws that restrict cell phone use in an effort to decrease the fatalities and injuries associated with distracted driving on an annual basis. Some states have succeeded in making primary laws against talking or texting while driving, while many other states struggle to pass this regulation. There is concern related to these trends given the increased prevalence of cell phones within the market coupled with the added distraction that may be present from the increased functionality and reliance associated with smart phones.

Cell phones have many functions, but they mainly have two popular uses — cell phone conversations and sending electronic messages (also known as texting). Speaking on a phone requires the driver to mentally focus on both the conversation and the roadway as well as navigate the vehicle with either one or two hands. Texting while driving, however, has been classified as the most perilous aspect of distracted driving (1). The secondary activity of texting is extremely hazardous because in addition to mental distraction, the driver is physically taking his or her eyes off of the roadway in order to compose a message with only one hand on the steering wheel. Research has shown "increased driving performance degradation and proportionately less time spent focusing on the road while texting, relative to baseline driving" (3). There is a need for expanded research on distracted driving performance as related to the specifics of its prevalence within the driving environment.

CHAPTER 2

BACKGROUND

Given the importance of distracted driving within transportation, the topic has been the focus of many research efforts. There were several specific elements of the distracted driving literature that were relevant to the research within the scope of this thesis, including the following:

- Crash citation narrative search
- Distracted driving research through naturalistic and simulator studies
- Driver cell phone usage through direct observation at intersections
- Economic impact of distracted driving
- Driver attitudes regarding distracted driving
- Laws against phone use while driving in the United States

There are numerous methods for measuring and analyzing driver distraction, and the following literature review highlights results from several completed studies.

Crash Citation Narrative Search

In Massachusetts, a crash report form is completed by the responding police officer at the scene of the crash. This report form captures several pieces of crucial information regarding the vehicle, driver, and passenger information. The crash report form data is then collected and stored electronically in the UMass Safety Data Warehouse (4). The UMass Safety Data Warehouse is a state-of-the-art resource that compiles many different areas related to a crash for the state of Massachusetts, as shown in Figure 1. UMass Safety Data Warehouse (4). An example of how the UMass Safety Data Warehouse can be utilized for research was demonstrated through the work of Swansen et al. (5). Work zone crashes can be difficult to classify due to varying definitions of a work zone, and distracted driving crashes face a similar issue with the crash report forms. The research group for this work zone study formulated a list of predetermined key words, phrases, and word combinations such as arrow, arrow board, closure, cone, construction, etc. in order to search through the narrative sections of many crash reports (5). Since the listed words have varying association with work zone crashes, discriminating power was determined for each word. "For example, if three specific work-zone related words within a 20 percent discriminating power were discovered in the narrative, it was probable that approximately 60 percent of the narratives with those three words indicated work zone involvement" (5). Although this methodology should filter through the narratives and give more insight to the background information of work zone crashes, many crash reports have insignificant or missing narrative sections due to a lack in uniformity with the reporting process among police officers. "Unfortunately, not all crash reports contain narratives, but the results of the analysis suggest that when at least two of the 14 key words or phrases used in this analysis are found in a narrative, there is over a 50 percent chance that that crash is work zone related" (5). Using a similar methodology in this study, distracted driving crash reports will be analyzed through use of the electronic crash reports in the UMass Safety Data Warehouse. Similarly to work zones, distracted driving is a frequent factor in crashes, but it is not always accurately captured through the crash report forms.

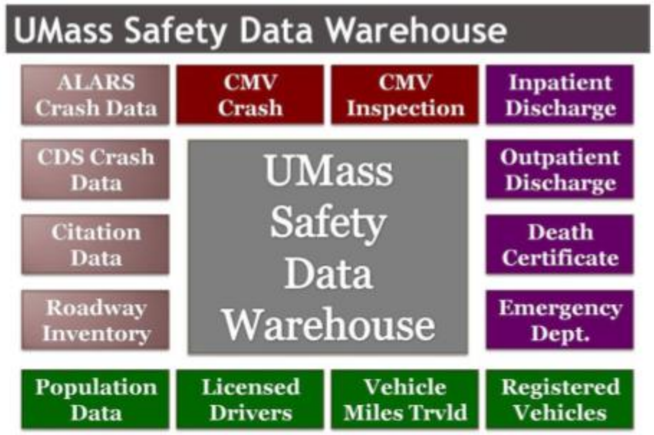

Figure 1. UMass Safety Data Warehouse (4).

<u>**Naturalistic Studies**</u>

Naturalistic research entails that the researchers insert various monitoring devices into vehicles for a specified period of time and collect the data at the end of the trial. These monitoring devices typically consist of the following: in-vehicle video cameras, accelerometers, Global Positioning Systems (GPS), forward radar, and devices that measure speed, braking, steering wheel position, etc. Additionally, the researchers also request access to the participants' cell phone data such as received messages, sent messages, and phone call durations. This data is available through the cell phone provider at the consent of the user. All of the variables are connected by time and date in order to analyze the data with respect to crucial events and driver behavior. Although the monitoring devices in the vehicles may seem intrusive enough to manipulate driver behavior, research has found that drivers typically are not drastically affected by this change.

It is important to first analyze the difference between distracted and non-distracted driving behaviors in order to emphasize how dangerous distracted behavior can be. In order to distinguish the dangers of distracted driving versus non-distracted driving behaviors, researchers from Monash University Accident Research Center in Australia conducted a naturalistic study to determine the amount of errors made by both types of drivers (6). This road test used a vehicle that was equipped with instruments that could collect data with regards to vehicle and eye movement. Many of the above-mentioned vehicle monitoring devices were implemented in this study. The drivers' behaviors were categorized and organized according to a predetermined list that accounted for a variety of errors such as lane departure, traveling over the speed limit, etc. The results from this study showed that distracted drivers made more errors than non-distracted drivers, and this goes along with the existing literature on distracted driving. They stated, "Drivers made a total of 268 errors when distracted and 182 errors when driving undistracted. All drivers committed to driving errors on each drive, with the average number of errors made per driver higher when distracted (11.7) compared to when not distracted (7.9)… drivers were 48% more likely to make an error when distracted…" (6). Since humans are not perfect by nature, it is acceptable that this study found that there was human error without distraction; however, with added distraction, the drivers performed significantly worse than non-distracted drivers. This naturalistic study is important because it proves a commonly stated idea that driving performance declines with distractions.

One of the most popular naturalistic studies was conducted by Virginia Tech Transportation Institute (VTTI), and their results were published in the paper titled "The 100-Car Naturalistic Driving Study" (7). This was the first large-scale naturalistic study with the purpose of collecting pre-crash and near-crash driving data, and determining the cause of these crash or near-crash events. The research monitored three types of dangerous situations with respect to driver inattention—crash, near-crash, and incident. Many aspects of driver distraction were accounted for in the analysis of the participants' behaviors, but the use of hand-held wireless devices, in particular, was "associated with the highest frequency of distraction-related events for both incidents and near-crashes" (7).

The monitoring devices within the vehicle allow for researchers to capture variables that may be difficult to obtain data for otherwise. For example, through the use of in-vehicle video footage, naturalistic studies can capture detailed variables such as the position of the cell phone during usage in relation to the steering wheel. It was determined that participants typically held the cell phone at three distinguished levels (low, medium, and high) while driving (8). These levels are shown as Figure 2.

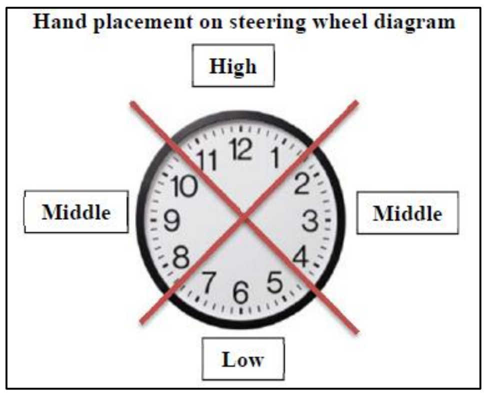

Figure 2. Hand Placement on Steering Wheel Diagram (8).

This naturalistic study monitored the distracted behavior of 204 drivers over the course of 31 days using hand-held (HH), portable hands-free (PHF), and integrated hands-free (IHF) devices. Once the data was collected and analyzed, it was determined that the largest TEORT, total eyes off the road time, occurred during the use of hand-held devices while texting. An average of 23.3 seconds was spent looking off the road while sending a text, and 8.2 seconds were spent looking at the phone while browsing or reading (8). Like many of the other naturalistic studies, the cell phone records were analyzed in coordination with the in-vehicle cameras and other instrumentation devices in order to produce results. The complete table of tasks and associated average total eyes off the road times can be found in Figure 3. The column labeled "N" shown the population of drivers who completed the associated task.

Subtask	Mean TEORT (s)	Standard Error	N
HH: Text	23.3^{A}	1.7	207
HH: Browse/Read	$8.2^{B,D}$	0.5	286
HH: Dial	7.8^{B}	0.3	405
PHF: Locate/Put On	$2.7^{B,C,D}$	0.9	15
IHF: Begin/Answer	$2.5^{C,D}$	0.4	120
HH: Locate/Answer	$1.3^{C,D}$	0.1	746
HH: End Task	$1.3^{C,D}$	0.1	813
IHF: End Task	$1.3^{C,D}$	0.1	154
PHF: End Task	$0.5^{C,D}$	0.1	33
PHF: Begin/Answer	$0.5^{C,D}$	0.2	13

Tukey-Kramer significant differences denoted by capital letters.

Figure 3. Average Total Eyes off the Road Times (8).

<u>Simulator Research</u>

Driver simulator technology is another popular research method for distracted driving. Through use of a simulator, the researcher is able to also incorporate eyewear technology in order to track the visual focus of the participants in the study. It is also easier for the researcher to manipulate the variables due to the nature of the controlled simulator setting. There are some disadvantages, however, when using a simulator; these issues are participant recruitment, motion sickness, realistic quality of the simulated scenario, etc. Researchers have been able to overcome most of these downfalls with the simulator and produce results that mimic those found in naturalistic studies.

An example of a fruitful research study through the use of a driving simulator was shown through the experiments of Ranney et al. (3). Several measurements were taken during the research such as the task duration, text entry accuracy, and glance frequency. Secondary tasks such as contact, destination entry, dialing, radio tuning, and text messaging were recorded and broken up into age groups. In order to complete the phone tasks, the participants were required to own a smartphone in order to participate in the study. A crucial aspect to simulator research is acquiring large sample sizes for a broad range of ages, and this study was able to successfully recruit the necessary sample size. The results from this specific research can be found in Figure 4, and the group concluded, "generally, the text message task had the longest durations, followed closely by destination entry…effects of driver age are most evident for text messaging" (3). With respect to what they called the glance frequency, or total eyes off the road time, "the analyses are consistent in revealing that text messaging required significantly more long glances than any of the other secondary tasks… and text messaging trials required more than 20 seconds of time looking away from the forward roadway view for all age groups" (3). In order to calculate the time spent looking off the roadway, the researchers used eye tracking devices as well as video footage to ensure similar results.

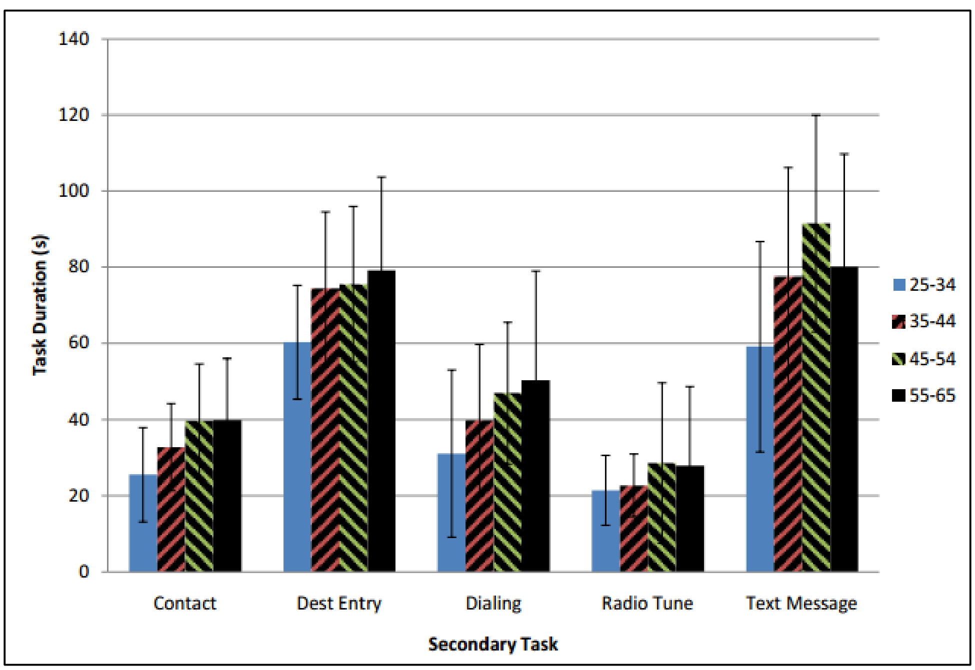

Figure 4. Duration of a Secondary Task (3).

Another simulator research study conducted by Boyle et al. (2) examined total eyes off the road time in a similar manner to the naturalistic study conducted by Fitch et al. (8). This was done in support of the NHTSA Visual-Manual Driver Distraction Guidelines through the use of eye wear in order to track visual movements during the simulation period. The NHTSA determined in a prior distracted driving simulator study that "if each word consisted of 5 characters, then a message of 120 characters would produce the 12-second maximum off-road glance duration" (2). Therefore, 12 seconds was determined to be the maximum allowable cumulative glance duration, or TEORT, for this study; at least 85% of the participants were required to fall below this threshold. For the purpose of comparison, participants were asked to perform numerous text entry and text reading tasks at three different levels of length—short, medium, and long. The results of this experiment are shown in Figure 5. For every task, for both text entry and text reading, the 85^{th} percentile fell below the 12 second maximum, except for the long text entry task. The researchers concluded that for this task, more than 50 percent of the participants' performances did not conform to the 12 second limit (2). The graphs demonstrate that as the length of the text entry or reading increases, the total eyes off the road time also increases. This is a cause and effect relationship that could be assumed by many, but it was proven and confirmed through research.

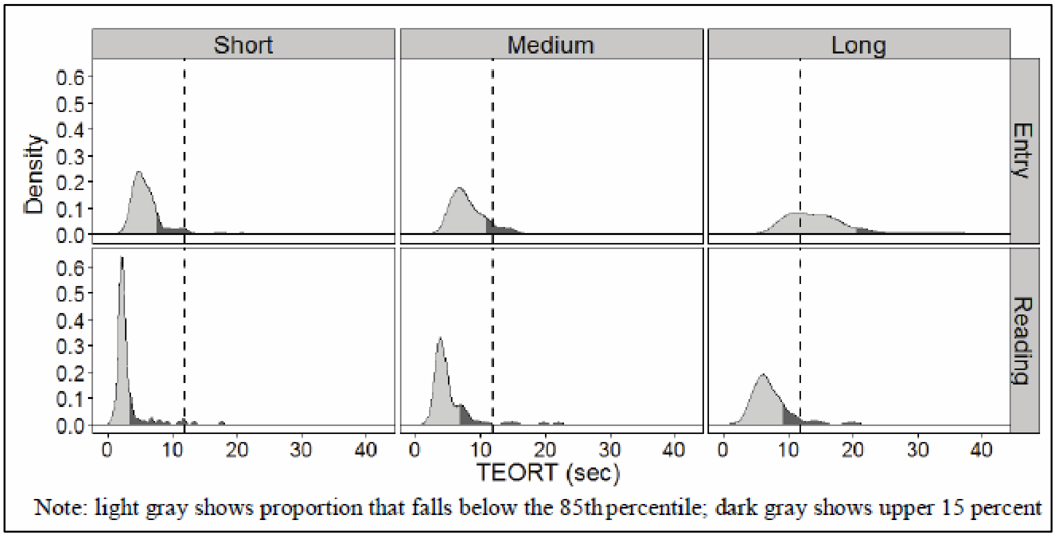

Figure 5. Density Graphs for Task Entry Type and TEORT (2).

Driver Usage through Direct Observation

The National Highway Traffic Safety Administration (NHTSA) developed a protocol for cell phone usage observations, but this standardized method had limitations (9). The observations could only be conducted during daylight and at controlled intersections. Three types of electronic device usages were also defined to be a driver holding a phone to the ear, a driver speaking while wearing a visible headseat, and a driver visibily manipulating a handheld device. By conducting these observations at a controlled intersection, the observer would be given enough time to collect driver behavior data while stopped in traffic. Due to the daylight limitation, there would also be ample lighting to accurately see the drivers' actions.

This method was used for research conducted by the University of Massachusetts Traffic Safety Research Program (UMassSafe) in 2012. It was completed as a component of the annual seat belt observation study for the state of Massachusetts. This study was composed of 145 observation sites, one observer, and one recorder (10). The following data was collected from each driver stopped at an intersection: cell phone use, seatbelt use, gender, age, race, vehicle type, state of license plate, and presence of a passenger. In accordance with the NHTSA protocol, data was only collected during daylight from 7:00 A.M. to 7:00 P.M. during the month of June 2012 (10). A point of interest in this study is the relation of cell phone usage to whether or not a passenger was present. The results indicate that drivers without passengers had a cell phone usage rate of 8.6 percent, and if a passenger was present, the rate dropped to 1.9 percent. This could happen because the driver might ask to have the passenger complete the cell phone task while the driver focuses on the road, or the driver refrains from using a cell phone so that the passenger's life is not endangered.

Economic Impact of Distracted Driving

Minimizing distracted driving could also improve aspects other than traffic safety. Distracted driving incorporates a broad range of economic impacts including the cost of crashes, decreased fuel efficiency, cost of ad campaigns, and law enforcement. This is by far the most researched aspect of sustainability with respect to distracted driving. The National Safety Council's website states, "A Harvard risk analysis study estimated the annual cost of crashes caused by cell phone use to be $43 billion" (11). The behavior of a distracted driver typically consists of sudden stopping due to inattention to the traffic conditions ahead. This has an effect on the fuel efficiency of the vehicle and does not promote "green driving." Two aspects of "green driving" that distracted driving disregards are the following: use engine braking for smooth deceleration and avoid sharp braking (12). By not incorporating these fuel efficient driving habits, the distracted driver will likely spend more money on gasoline than an attentive driver who embraces these two along with many other "green driving" strategies.

Efforts have been made in the past few years to convey the message to the public that distracted driving is a dangerous activity. These ad campaigns cost companies money to create and air on national television and radio airwaves. The hope is that the cost of these ads will be outweighed by the lives and money saved through reduction in distracted driving crashes. Additionally, it could be expensive for the state governments to pay the law enforcement to patrol various areas for cell phone use while driving. Only a handful of states within the United States have primary laws that restrict cell phone use, so this is also a difficult item to address for the police. These are some general assumptions because cost data for the campaign strategies and enforcement are not readily available in literature or on-line sources. On the other side of this situation, if a driver is caught using a cell phone in a state that has a primary law, the driver will be forced to pay a fine and potentially have increased insurance rates as a penalty for disobedience. For example, in New York, drivers can face up to a $150 fine and 3 points on their driving record (13).

Additionally, distracted driving has strong effects on quality of life and overall human well-being. Drivers who are distracted are at a greater risk of a crash that can result in an injury or fatality. A particular age group in question is the young adults and novice drivers. The NHTSA states, "For drivers 15-19 years old involved in fatal crashes, 21 percent of the distracted drivers were distracted by the use of cell phones" (1). Distracted driving does not just affect the person who is partaking in the activity, but it also affects the surrounding drivers, bicyclists, and pedestrians; they become endangered because the driver could potentially crash into one or more of these previously mentioned parties. As injuries and fatalities increase due to distracted driving, the roadway environment is becoming a dangerous place for all types of users.

Driver Attitudes Regarding Distracted Driving

NHTSA conducted an evaluation of drivers with varying ages and their opinions on how their driving performance is affected when using a cell phone to talk, text, or e-mail (14). The information was categorized by gender and age group, and the individuals were allowed to give multiple responses. The findings from this self-reported driver performance survey were summarized in two separate tables; Table 1 presents responses to driving performance while talking on the phone, and Table 2 refers specifically to sending or reading text messages or e-mail while driving.

Table 1. Self-Evaluated Driving Performance While Talking on a Phone (14).

How Talking on a Phone Affects Driving, by Sex and Age, Percentage (Multiple Responses)

Effects	Sex		Age Group					
	Male	Female	18–20	21–24	25–34	35–44	45–64	65+
No difference	55.1	52.4	60.8	63.0	57.3	51.9	50.5	50.9
Drive slower	19.3	21.3	14.4	14.8	23.1	20.1	21.0	17.2
Drive faster	0.6	1.5	1.9	3.1	2.7	0.5	0.1	0.4
Change lanes less frequently	1.4	1.6	4.3	0.8	1.4	2.4	1.1	0.9
Drift out of lane/roadway	1.3	0.2	0.0	2.3	0.9	0.5	0.6	0.4
(N)	(1,896	(1,919)	(209)	(257)	(873)	(593)	(1,596	(233)

Table 2. Self-Evaluated Driving Performance While Texting or E-mailing (14).

How Texting/E-Mailing Affects Driving, by Sex and Age, Percentage (Multiple Responses)

Effects	Sex		Age Group					
	Male	Female	18–20	21–24	25–34	35–44	45–64	65+*
No difference	24.2	25.8	19.6	27.0	29.5	19.6	24.1	n/a
Drive slower	36.4	25.3	37.1	30.2	26.9	31.3	34.6	n/a
Drift out of lane/roadway	8.2	5.8	9.3	15.1	5.3	2.7	4.4	n/a
Change lanes more frequently	2.4	2.1	7.2	0.8	2.6	0.9	0.0	n/a
(N)	(376)	(329)	(97)	(126)	(227)	(112)	(136)	*

*sample is too small for respondents 65 and older.

An evident issue is the use of cell phones with younger drivers. In particular, texting or e-mailing while driving is a more prevalent issue in crashes than talking on the phone. Another survey asked whether the individuals were using a cell phone at the time of the crash or near-crash (14). Those who responded in the 18-20 years old category had the highest rated responses for sending a text or e-mail at the time of the crash or near-crash event. The results are shown in Figure 6. Not only do these individuals have only a few years of driving experience, but they are also choosing to engage in secondary activities while driving.

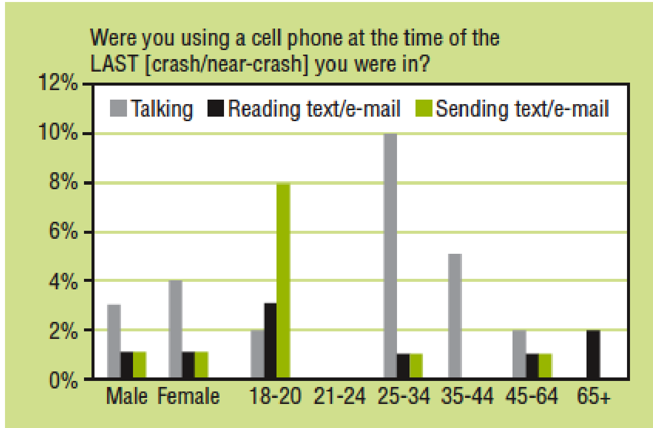

Figure 6. Cell Phone Use at the Time of the Last Crash or Near-Crash Event (14).

A survey conducted by the AAA Foundation for Traffic Safety in 2012 asked drivers how often or regularly they engaged in certain activities while driving in the past 30 days (15). Some of the activities involving distracted driving were listed as the following: read text message or email while driving, typed or sent text message or email while driving, checked social media while driving, or used internet while driving (15). Other driver activities recorded included drunk driving, drowsy driving, seatbelt usage, speeding, or running a red light. When comparing the percentages of people who reported engaging in distracted driving rather than the other possible categories, there was a considerable percentage of people who regularly engage in secondary activities while driving. The data from this survey is depicted in a tabular format in Figure 7.

	Frequency of Talking on Cell Phone While Driving (Past 30 days)		
	Never (n=1,057)	Once / Rarely (n=1,248)	Fairly Often / Regularly (n=985)
	% Reporting Action or Behavior		
Drove 15 mph over speed limit on freeway (past 30 days)	31	52	65
Read text message or email while driving (Past 30 days)	4	34	65
Typed or sent text message or email while driving (Past 30 days)	3	24	53
Ran red light when could have stopped safely (Past 30 days)	25	42	47
Drove while so tired that had hard time keeping eyes open (Past 30 days)	14	31	44
Drove 10 mph over speed limit on residential street (Past 30 days)	30	50	60
Drove without wearing seatbelt (Past 30 days)	16	22	29
Checked social media while driving (Past 30 days)	1	9	23
Used internet while driving (Past 30 days)	1	10	25
Drove when thought alcohol level might have been close to or over legal limit (Past year)	6	16	19
Involved in crash (Past 2 years)	8	14	14

Figure 7. Self-Reported Driver Behavior in Relation to Cell Phone Use during the Past 30 Days (15).

Laws

The policies and laws for cell phone use while driving vary from state to state. According to the Governors Highway Safety Association as of May 2014, no states have banned cell phone use for all drivers, but there are 37 states and the District of Columbia that have banned all cell phone use by novice drivers (16). As for text messaging while driving, 43 states, the District of Columbia, Puerto Rico, Guam, and the United States Virgin Islands have text messaging bans for all drivers, and all but 5 of these areas have primary enforcement for the ban (16). States may have bans for hand-held devices, text messaging, and young driver use of cell phone. These three types of laws against cell phone use according to each state are depicted in Figure 8, Figure 9, and Figure 10. Figure 8 and Figure 9 show bans for hand-held device use and text messaging; the bans by state are categorized as all drivers, partial (typically targeting specific age groups or conditions), and no ban.

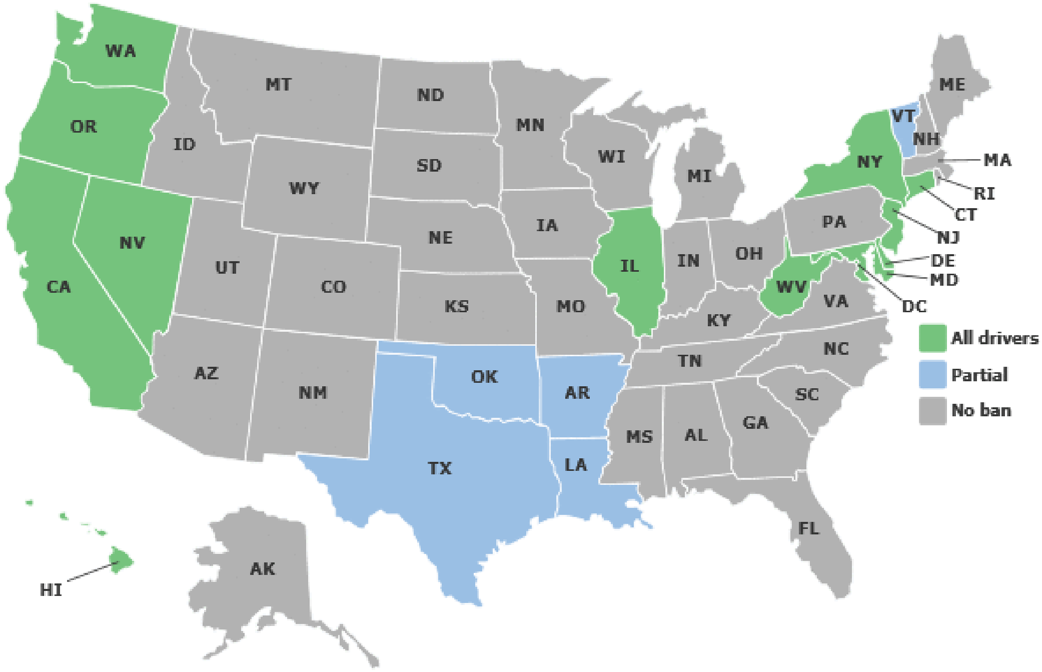

Figure 8. Hand-Held Device Ban in the United States (16).

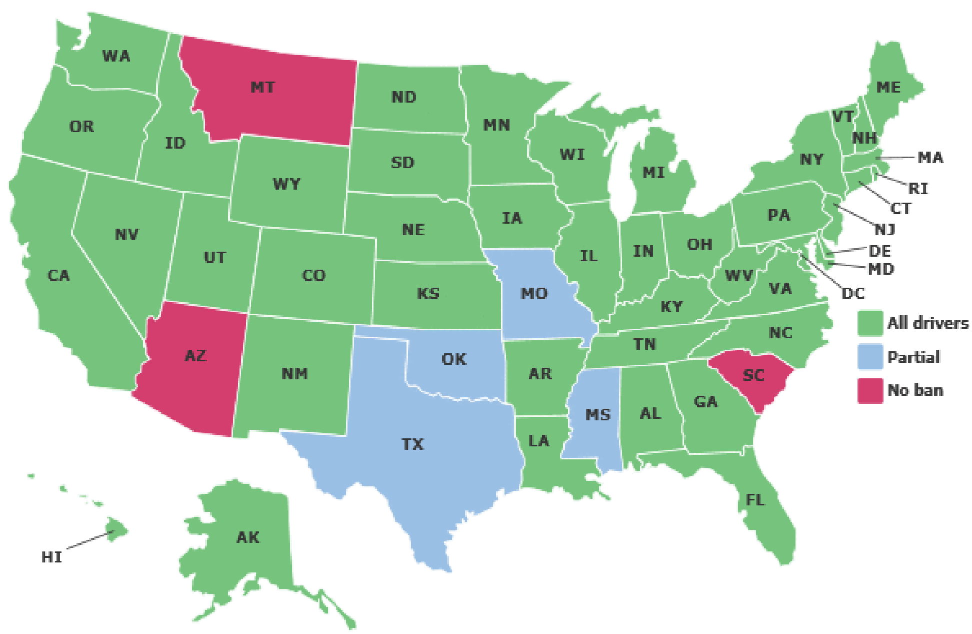

Figure 9. Text Messaging Ban in the United States (16).

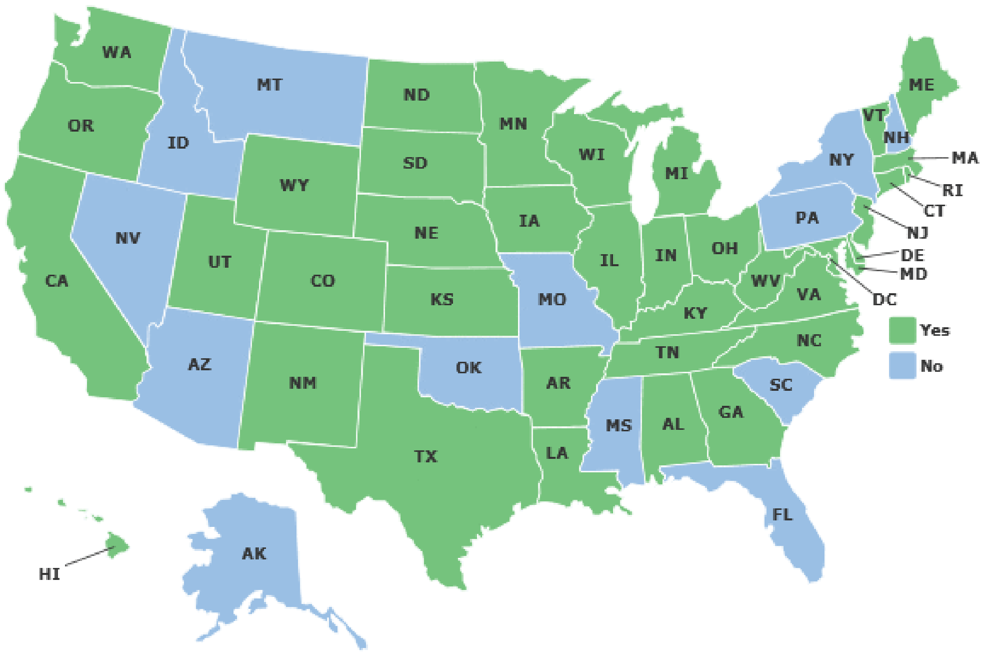

Figure 10. Young Driver All Cell Phone Use Ban in the United States (16).

On September 30, 2010, Massachusetts enacted the Safe Driving Law that put a ban on texting and limited cell phone use while driving (18). The limited cell phone use portion of this law mainly affected junior operators, and it restricted all cell phone use while driving for these individuals. For a first offense, the perpetrator pays a $100 fine, 60-day license suspension, and needs to complete an additional course (19). A second offense is a $250 fine and a 180-day suspension, and a third or subsequent offense is a $500 fine and 1-year suspension (19). All drivers in the state of Massachusetts are prohibited from texting while driving, and this applies to a vehicle that is in motion or stopped in traffic. A first offense has a fine of $100, a second offense has a fine of $250, and a third or subsequent offense has a fine of $500 (19).

CHAPTER 3

RESEARCH APPROACH

Research objectives, hypotheses, and a series of tasks are proposed in response to the following problem statement.

Problem Statement

Although laws have been passed in many states that prohibit distracted driving behaviors, people disregard these rulings and continue to use various devices while driving. By observing random drivers who may or may not be distracted, this research attempted to find commonalities among drivers and further understand driver behavior while distracted. This type of mobile observation had the ability to shed light on natural driving behaviors without driver manipulation. There was a need for information regarding driver behavior while distracted and distraction through use of mobile observations. By analyzing distracted driving behavior, transportation engineers can incorporate various elements into the roadway design in an effort to enhance traffic safety.

Additionally, there was a need for an expanded analysis of the typical approach to interpreting the role of distraction from typical crash analyses, distracted driving crash report analysis and identification of key words that may indicate a crash caused by driver distraction. After completing a thorough analysis, it was possible to determine if there are any commonalities in the crashes involving distracted driving.

Research Objectives

The overarching goal of this thesis research was to expand current research and understand driver distraction. Within the framework of this overarching goal, research objectives were developed as outlined in the following section.

Objective 1: Identify attributes of observed distracted driving behaviors and determine which behaviors are more common or detrimental to the drivers' ability to operate a motor vehicle. Completion of the research objective led to an improved understanding of the behaviors that currently exist on the roadway and the behaviors that have potential to lead to a crash.

Objective 2: Understand the role and impact of distraction on crashes. Common elements were found in the crash reports with the key words that indicate distraction was a factor in the crash. In combination with Objective 1, it was possible to link crash narrative reports with similar observed driver behaviors, and there was a better understanding of the events that may take place leading up to the time of a distracted driving related crash.

Research Hypotheses

The following research hypotheses have been developed based on the research objectives and from the findings in previous studies:

Hypothesis 1: The number of drivers engaging in distracted driving has decreased and the number of distracted driving crashes has been reduced since the existence of the Massachusetts Safe Driving Law due to an increase in awareness of the dangers of distracted driving.

Hypothesis 2: There are crashes that are categorized as non-distracted, but the narrative portion of the crash report provides evidence of a distracted driving related crash. Distracted driving crashes contain narratives that provide insight to the crash event.

Hypothesis 3: There are definite hot spot locations for distracted driving crashes in Massachusetts. In particular, it is expected that more hot spots will appear on high-speed roadways and near large cities as opposed to local roads.

Task 1: Perform Literature Review

A comprehensive literature review was conducted in order to understand past and current distracted driving research. Data collection methods and results from previous research efforts were a key part of this project. There were many distracted driving studies conducted through use of naturalistic instrumentation and driving simulators, but it appeared that no one had published data collected through mobile field observation. This task was initialized and continued through the thesis process.

Task 2: Field Observations

Although states have passed laws against cell phone use while driving and awareness campaigns have been aired on television, radio, and in print, drivers continue to engage in secondary activities while driving. By completing a mobile observation on a high speed roadway, the drivers who were engaging in secondary activities were observed for a short span of time. The aim was to observe distracted drivers in their "natural habitat" as they made the decision to use a cell phone collect data regarding their driving behavior.

Before the data collection team was assembled and sent out into the field to observe drivers, several items were addressed. It was important to determine which variables were to be observed and what their level of importance was to the research. A field observation procedure and protocol was then determined so that the manner in which the team performed the observations remained constant. The aim of both of these subtasks was to improve the data quality from the field work so that the results maintained a high level of validity.

Task 2A: Determine Variables and Variable Levels for Field Observations

A list of vehicle, driver, and distraction information of the observed vehicles were recorded by the research team for analysis. Basic information about the location of observation such as time of day the observations began and ended, roadway type, number of travel lanes, and speed limit for the given observation area were recorded. If the observation was taken while a vehicle was not at free flow speed (i.e. stopped at an intersection or stopped due to congestion) it was noted by the observer. As shown in Table 3, several variables of interest were determined for the data collection process. The major observation emphasis areas were the following: vehicle type, travel lane positioning, vehicle action, vehicle speed, driver information, and passenger information. The first four boxes described vehicle information, and the fifth box examined the driver's gender, approximate age range, distraction type, and the steering wheel holding position during the distraction. It was important that vehicles with an attentive driver were also be recorded for comparison to distracted drivers. The passenger information of a vehicle was collected for the purpose of determining whether or not the presence of a passenger likely increased or decreased the chance of a driver to operate a vehicle while distracted.

Table 3. Proposed Variables and Variable Levels for Field Observation Data Collection

VEHICLE	TRAVEL LANE	ACTION	VEHICLE SPEED	DRIVER				PASSENGER			
Passenger	Left Lane	Passing		Male	Age 18-19	**Distraction:**	**Holding Position:**	Adult	1 Child	Seated Front	**Action:**
SUV	Right Lane	Non-passing	_______ mph	Female	Age 20-39	Cell Talk	12:00	Elder	2 Children	Seated Back	Alert
Pick-Up	Other	Other		Unknown	Age 40-60	Cell Touch	3:00 / 9:00	Teen	3 Children		Cell Use
Mini-Van			Unknown		Age 60+	iPad/Tablet	6:00	Child			Sleeping
Commercial					Unknown	Other	Other	Unknown			Other
						No Distraction					

The layout of the data collection sheet allowed the observer to collect information quickly because it eliminated the need to write notes about each driver, and he or she simply circled or highlighted the information that was applicable to the vehicle under observation. A large number of driver observations were recorded so that the data classified as a large sample size, and the appropriate statistical analyses for the data were completed.

Task 2B: Develop Field Observation Procedure and Protocol

In order to collect the variables mentioned previously, it was important to generate a standardized method for observation so that the data was recorded consistently across observations. The observation team consisted of a vehicle, a driver, and one or more research assistants. The driver only had two tasks—obey the speed limits and the rules of the road; he or she drove safely and carefully with the flow of vehicles on the roadway. Although this might have decreased the number of observed vehicles on a given run, it ensured that the vehicle was operating at the appropriate and regulated speed and reduce the probability of capturing the same vehicle data twice.

The individuals, or "observers", accompanied the driver and had the responsibility of capturing observed driving data as the vehicle was in motion from nearby vehicles. The primary method of data collection was direct observations recorded to the pre-made data collection sheet with the list of variables and categories for each observed vehicle (refer to Table 3). If there was an observation that did not have a corresponding option on the data collection sheet, the observer wrote a detailed note and circled the option titled "other". As part of this task, additional methodologies for accurately capturing the field data were explored, including, but not limited to, video cameras or voice recorders which might have allowed for cross-check of the collected information for errors at a later time. At no time were video of the drivers of vehicles included within the captured data.

Task 3: Crash Reports

Crash reports are a useful tool for investigating the events leading up to a crash. There were several available options for crash report analysis, and this task included the following subtasks: crash report narrative search, determination of crash hot spots, and crash analysis before and after the Massachusetts Safe Driving Law.

Task 3A: Crash Report Narrative Search

Using the UMass Safety Data Warehouse, crash reports that were classified directly as distracted driving related were identified. However, some reports might have been incorrectly identified as distraction related event and others might have been incorrectly identified as non-distracted. For this reason, a necessary subtask was to complete a crash report narrative search to identify the crashes that were a false positive or a false negative. In order to complete this subtask, a list of key words or phrases were determined in order to run a comprehensive crash report narrative search. The narratives might have indicated distracted driving related crashes that were not originally classified as such. The list of key words for the search included, but was not limited to, the following: cell, phone, text, texting, distracted, and call. Other key words related to distraction but not specifically related to cell phone use were incorporated. A thorough analysis was necessary in order to determine which narratives contained enough written information to declare that a crash did or did not involve driver distraction. After examining the distraction related crash reports, it was possible to find crash hot spots or commonalities among the crash reports and scenarios.

Task 3B: Determination of Crash Hot Spots

Once the crash reports that involved distracted driving were established, it was then possible to map these events and determine hot spot locations or segments within Massachusetts. This was done using GIS software and Microsoft Excel. With the determination of these locations or regions, it would be possible to encourage increased police monitoring or institute a change in the current roadway design in order to improve traffic safety.

Task 3C: Crash Analysis Before and After Massachusetts Safe Driving Law

There was crash data available from before the Massachusetts Safe Driving Law was established in September of 2010 and after this date. Therefore, the crash reports from before and after this date were analyzed statistically to determine the trends that appeared after the Massachusetts Safe Driving Law was in place. Crash rates and frequencies were also statistically analyzed for both time periods.

Task 4: Field Observation Data Analysis

After each mobile field observation trial, a preliminary analysis of data was completed in order to evaluate the collection procedure and results. In the event that certain variables were difficult to obtain or were found to be insignificant, the variables were modified or disregarded for the future trials. Since one of the research goals was to compare distracted and non-distracted driving behavior, it was crucial that both categories had a large enough sample size for analysis. Additionally, collected data that coincided with the information collected from the state-wide Massachusetts seatbelt study (i.e. presence of passenger, cell phone usage rate, etc.) was compared. Another portion of this task consisted of making a connection between the collected field data and the crash reports. The observed behaviors were a crucial element when determining the possible events that might have led to a distraction related crash. The appropriate statistical analyses were explored and the most appropriate method was selected.

Task 5: Documentation of Findings

Once the above tasks were completed, the research results were presented in the form of a Master's Thesis. This thesis was created in accordance with the University of Massachusetts at Amherst guidelines and policies (20).

Timeline

Table 4 presents a proposed timeline for the completion of this Master's Thesis. As shown there was a considerable amount of overlap between tasks. The timeline was a rough estimate of when each task was started and completed and was subject to change.

Table 4. Research Thesis Timeline

		Month						
Task	**Task**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
1	Literature Review	■	■	■	■	■	■	■
2A	Determine Collection Variables	■	■	■				
2B	Procedure & Protocol		■	■	■			
3A	Crash Report Narrative Search		■	■	■	■	■	
3B	Determination of Crash Hot Spots				■	■	■	
3C	Crash Analysis Before/After SDL				■	■	■	
4	Field Observation Data Analysis					■	■	■
5	Documentation of Findings					■	■	■

Contributions to the Literature

Completion of the proposed thesis provided significant contributions to the existing literature. The mobile field observation provided information regarding how drivers naturally behave on the roadway without being consciously monitored. This type of research was not completed before, and the results were the first of its kind. To date, there were no published reports of a distracted driving mobile field observation study such as this. The crash report analysis provided information regarding numerous distracted driving crash events, and in combination with the field data, it was possible to compare the direct field observations and distraction rates to the distracted crash locations on various roadways with a large number of observations. These findings may cause highway engineers to re-evaluate roadways with crash hot spots and determine if guardrails, roadside vegetation, or signage should be added or modified so that the frequency or severity of distracted crashes may be reduced. This information could also be useful for law enforcement location identification. The crash report analysis could establish a systematic approach to help others access distracted driving related crash reports outside of Massachusetts. Additionally, there may be commonalities in distracted driving behaviors from the field observations that can help police identify when a driver surrounding them on the highway may be engaging in secondary activities.

CHAPTER 4

RESULTS

The results from the various project tasks and analyses of the data that were completed in response to the stated goal of expanding current research and understanding of driver distraction are presented in the sections below in a format consistent with the methodology. More specifically, results are presented for the field observations, crash report analyses, and narrative search analyses, respectively.

Field Observations Results

The motivation of the mobile distraction observation task was directly rooted in the desire to evaluate firsthand the prevalence and role of distraction from vehicles within the traffic stream. Many of the direct observation studies completed to date are limited to solely intersection locations with varying degrees of vehicle movement. To that end, a mobile distraction observation study was carried out as outlined previously in the methodology section. Both qualitative and quantitative observations were made on a selected sample of roadways with diverse characteristics across Massachusetts. The selected roadways varied across several key independent variables, including number of lanes, shoulder width, speed limits, and traffic conditions. To capture observation data, a single driving observation period was typically segmented into various components with similar cross-section and traffic attributes. The segment designation allowed for the observers to note any changes in roadway characteristics, such as lane configuration or speed limit. For example, if an interstate expanded from two lanes to three lanes, this lane configuration change indicated an end point for the previous segment and a starting point for a new recording segment. This was done so that the driver observations could be analyzed according to similar roadway configurations from different driving periods.

In total, 17 separate driving periods were completed, resulting in a total of 89 roadway segments with associated driver observations. These 89 segments or sections of roadway were a combination of single occurrence observation roadways and repeated observation roadways.

Variables and Variable Levels for Field Observations

As noted previously the direct observation experiment was initiated with two separate beta test drives, which provided an opportunity to refine the data collection approach and variables that were possible to accurately capture. For example, some of the initially desired variables proved to be a bit complex for capturing in the field when traveling at high speeds. By comparison additional areas of information were also introduced to help clarify certain aspects of the selected variable levels. A revised version of the form was created and used for the duration of the data collection effort. The revised form is presented in Figure 11.

VEHICLE	TRAVEL LANE	ACTION	DRIVER				PASSENGER			
Passenger	Left Lane	Passing	Male	Age 16-19	**Distraction:**	**Holding Position:**	Adult	1 Child	Seated Front	**Action:**
SUV	Middle Lane	Non-passing	Female	Age 20-39	Cell Talk	12:00	Elder	2 Children	Seated Back	Alert
Pick-Up	Right Lane	Stopped	Unknown	Age 40-59	Cell Touch	3:00 / 9:00	Teen	3 Children		Cell Use
Mini-Van	Other:	At Crosswalk		Age 60+	iPad/Tablet	6:00	Child			Sleeping
Commercial		Other:		Unknown	Other:	Other:	None			Other:
					No Distraction					

Figure 11. Variables and Variable Levels for Data Collection

Field Observations Procedure and Protocol

During the first beta test drives, the procedure and protocol described within the methodology was slightly revised in an effort to obtain highly-accurate observations in an efficient manner. The original concept was to have one observer dictate observed variables as a driver passed or was being passed while a different research transcribed the results to an observation sheet. Conceptually the idea seemed logical, however this task proved more difficult to reliably capture observations in the field. As a result, each research observer in the vehicle (excluding the driver) made independent observations and recordings. To avoid duplication or missing a vehicle, the research team would assign approaching vehicles to a specific researcher. There was no selection process for deciding which vehicles were recorded because the goal was to record every surrounding vehicle. Throughout the observation process, the driver remained exclusively engaged in the driving task.

Field Observations Results

The resulting field observation trips resulted in a total of 1,575 recorded driver observations. Detailed results for across each of the captured variables are provided in the sections that follow. The variables that were collected include the following:

- Vehicle Type (Commercial, Mini-van, Passenger, SUV)
- Vehicle Travel Lane (Left Lane, Middle Lane, Right Lane, Other)
- Vehicle Action (Passing, Non-passing, Stopped, At Crosswalk, Other)
- Gender (Male, Female, Unknown)
- Age (16-19, 20-39, 40-59, 60+, Unknown)
- Distraction Type (Cell Talk, Cell Touch, iPad/Tablet, Other, No Distraction)
- Holding Position (12:00, 2:00/10:00, 6:00, Other)
- Passenger Age Group (Elder, Adult, Teen, Child, None)
- Passenger Child Information (1 Child, 2 Children, 3 Children)
- Passenger Seating Position (Seated Front, Seated Back)
- Passenger Action (Alert, Cell Use, Sleeping, Other)
- Roadway Characteristics (Speed Limit, Shoulder Width, Traffic Conditions, Pavement Wet/Dry, Start Boundary, End Boundary)

The distraction categories of cell talk, cell touch, no distraction, and other were recorded for each of the 1,575 vehicles. The number of occurrences and percentages of observations for each distraction are provided in Table 5. The option of "Other" was also accompanied by notes recorded by the research member. The type of "Other" distraction varied, but were also summarized in Table 6 where the "Other" activity description and number of times the activity was recorded are provided. Categories that had only a single occurrence were grouped into the "Miscellaneous" description type. The "Miscellaneous" activity types include the following: driver had eyes closed/was sleeping, driver was brushing hair, driver was distracted by dog in the car, driver was drinking a beverage, driver was wearing a Bluetooth device, and driver was talking along with the radio.

Table 5. Distraction Type Summary from Field Observations Count and Percentages of Observations

Distraction Type	Count	Percentages of Observations
Cell Talk	124	7.87%
Cell Touch	74	4.70%
Other	71	4.51%
No Distraction	1,306	82.92%
Total	**1,575**	**100.00%**

Table 6. Distraction Type "Other" Descriptions Count

Distraction Type "Other"	Count
Driver was applying makeup	6
Driver was eating	23
Driver was reading papers	4
Driver was smoking	12
Driver was touching GPS	2
Driver was using Bluetooth	3
Driver was wearing headphones	3
Miscellaneous	6
No description provided	12
Total	**71**

Of interest was the action of the vehicle at the time the observation was made as it relates to the driver's likelihood of engagement in a distracting task. The two categories of non-passing and passing were recorded in relation to the motion of the vehicle containing the research team. For example, if a vehicle was driving past the probe vehicle, this recording was classified as

“Passing”, but if the probe vehicle was driving past a vehicle in the process of being recorded, this vehicle was recorded as “Non-passing”. A “Stopped” vehicle was motionless either due to a signalized intersection on an arterial or congested traffic conditions. The vehicle action category of “1 Lane” corresponds to the downtown environment where there was only one travel lane per direction, and a vehicle within this classification was traveling at free flow speed. It was observed that drivers engaged in distraction activities regardless of the vehicle action as shown in Table 7. There was a higher percentage of observations where drivers were both stopped and texting (18.81%) as shown in Table 8.

Table 7. Vehicle Action and Distraction Type Count

Vehicle Action	Cell Talk	Cell Touch	Other	No Distraction	Total
Non-Passing	59	23	32	481	595
Passing	39	15	21	408	483
Stopped	3	19	12	67	101
1 Lane	23	17	6	350	396
Total	**124**	**74**	**71**	**1,306**	**1,575**

Table 8. Vehicle Action and Distraction Type Percentage of Observations

Vehicle Action	Cell Talk	Cell Touch	Other	No Distraction
Non-Passing	9.92%	3.87%	5.38%	80.84%
Passing	8.07%	3.11%	4.35%	84.47%
Stopped	2.97%	18.81%	11.88%	66.34%
1 Lane	5.81%	4.29%	1.52%	88.38%
Total	**7.87%**	**4.70%**	**4.51%**	**82.92%**

Percentages of observations also differed as a function of the vehicle type. For example, there were only a total of 75 mini-van driver observations as compared to 910 passenger car records. Nevertheless, the recorded observations were relatively reflective of the vehicle fleet in general and sufficient observations of each vehicle type were made to allow for comparison of distraction by vehicle type. Table 9 presents the vehicle type and observed distraction type count while Table 10 shows the vehicle type and observed distraction type frequency. These numbers reflect all 1,575 driver observations that were made on varying types of roadways. Commercial drivers were frequently engaging in "Other" activities, such as eating, and they composed nearly all of the recordings where the driver was wearing or using a Bluetooth device. According to the data in Table 10, the percentage of observations where drivers were recorded as "No Distraction" ranged from approximately 78.8% to 84% across all vehicle types and recorded sample sizes. For vehicle types with at least 100 total observations (commercial, passenger, pick-up, and SUV), the percentage of observations for texting while driving ranged from approximately 2.3% to 5.3% with commercial vehicles having the lowest percentage of observations and passenger cars having the highest percentage of observations (48 drivers out of 910 total drivers).

Table 9. Vehicle Type and Observed Distraction Type Count

Vehicle Type	Cell Talk	Cell Touch	Other	No Distraction	Total
Commercial	10	3	14	101	128
Mini-Van	9	3	3	60	75
Passenger	57	48	40	765	910
Pick-Up	17	7	8	119	151
SUV	31	13	6	261	311
Total	**124**	**74**	**71**	**1,306**	**1,575**

Table 10. Vehicle Type and Observed Distraction Type Percentage of Observations

Vehicle Type	Cell Talk	Cell Touch	Other	No Distraction
Commercial	7.81%	2.34%	10.94%	78.91%
Mini-Van	12.00%	4.00%	4.00%	80.00%
Passenger	6.26%	5.27%	4.40%	84.07%
Pick-Up	11.26%	4.64%	5.30%	78.81%
SUV	9.97%	4.18%	1.93%	83.92%
Total	**7.87%**	**4.70%**	**4.51%**	**82.92%**

Gender was recorded for each observation that was made. The count for distraction type according to the driver gender are found in Table 11. The observed sample sizes were not evenly split, but both samples were large enough to reflect gender trends. The "Unknown" gender represents a missing field in the observation spreadsheet, and this was left blank due to human error during the data collection process. Overall, females had a lower total number of recorded observations (664 drivers) than the males (903 drivers). Table 12 shows that the percentage of observations for texting while driving was larger for females than males. This means that female drivers were more likely to be recorded as texting while driving or engaging in secondary activities than male drivers.

Table 11. Gender and Distraction Type Count

Gender	Cell Talk	Cell Touch	Other	No Distraction	Total
Female	58	37	32	537	664
Male	64	36	39	764	903
Unknown	2	1	0	5	8
Total	**124**	**74**	**71**	**1,306**	**1,575**

Table 12. Gender and Distraction Type Percentage of Observations

Gender	Cell Talk	Cell Touch	Other	No Distraction
Female	8.73%	5.57%	4.82%	80.87%
Male	7.09%	3.99%	4.32%	84.61%
Unknown	25.00%	12.50%	0.00%	62.50%
Total	**7.87%**	**4.70%**	**4.51%**	**82.92%**

Drivers were categorized by approximate age ranges as observed, somewhat subjectively, by the research team. To once again limit “guesses” by the research team, “Unknown” was an allowable response. Table 13 shows the counts for distraction type according to these pre-determined age ranges. It should be noted that the age group of 16-19 year old drivers only had 19 recorded observations, so this sample size is not large enough for adequate population representation. The age group of 20-39 year old drivers had the largest recorded number of observations (770 total drivers). The percentage of observations are shown in Table 14 for each distraction type and age group. Excluding the age group of 16-19 year olds, drivers ranging from 20-39 years old had a high percentage of observations for texting while driving (7.01%)

and talking on the phone while driving (9.09%). It was not surprising the drivers who are 60 years old or older had the lowest recorded percentage of observations for cell talk, cell touch, and other. It is likely that distraction counts and percentage of observations fluctuate among the driver age groups due to generational differences and technology dependence.

Table 13. Observed Age Group and Distraction Type Count

Age Group	Cell Talk	Cell Touch	Other	No Distraction	Total
16-19	4	1	1	13	19
20-39	70	54	36	610	770
40-59	46	18	27	507	598
60+	4	0	7	173	184
Unknown	0	1	0	3	4
Total	**124**	**74**	**71**	**1,306**	**1,575**

Table 14. Observed Age Group and Distraction Type Percentage of Observations

Age Group	Cell Talk	Cell Touch	Other	No Distraction
16-19	21.05%	5.26%	5.26%	68.42%
20-39	9.09%	7.01%	4.68%	79.22%
40-59	7.69%	3.01%	4.52%	84.78%
60+	2.17%	0.00%	3.80%	94.02%
Unknown	0.00%	25.00%	0.00%	75.00%
Total	**7.87%**	**4.70%**	**4.51%**	**82.92%**

Another interesting variable was the holding position of the steering wheel for distracted vs. non-distracted. The holding position category was added to the variables in an effort to replicate the data collected from the project completed by Fitch et al. (8). The term "holding position" was originally meant to correspond to the driver's positioning of the cell phone while texting as shown previously in Figure 2. For these field observations, however, it was modified, and it captured the drivers' steering wheel holding positions. By doing this, data was able to be captured for both non-distracted and distracted drivers. Table 15 displays the count of observed distraction types and the drivers' hand placement on the steering wheel at the time of the data collection. The category of "Other" was recorded when a driver had an unusual hand placement or, in rare circumstances at low speeds, was not holding the steering wheel at all. There were a large number of holding position variables that were not accounted for during the data collection process. This is due to lack in communication among the research team members as to whether or not it was necessary to record the holding position if the driver was not distracted. The percent of observations for each holding position and distraction type are shown in Table 16. This table indicates that it is likely that drivers who are engaging in distraction related activities will hold the steering wheel at 12:00 and 6:00 (top or bottom of the steering wheel). Drivers with a higher percentage of observed "No Distraction" events were more likely to be found driving with hands at 2:00/10:00. For further comparison of the collected variables, Table 17 shows the steering wheel holding position for various age groups and distraction types. In general across all age groups, it appears that drivers prefer to talk on the phone and hold the steering wheel at 12:00. Some drivers chose to hold the steering wheel at 6:00, but few drivers talked on the phone while holding the steering wheel at 2:00/10:00. For all ages, it appears that a common holding position for an attentive driver is most commonly at 2:00/10:00. This is especially evident in the largest recorded driver age group of 20-39 years old.

Table 15. Steering Wheel Holding Position and Distraction Type Count

Holding Position	Cell Talk	Cell Touch	Other	No Distraction	Total
12:00	78	24	32	232	366
2:00/10:00	8	12	10	311	341
6:00	19	25	14	170	228
Other	1	6	1	14	22
Not Recorded	18	7	14	579	618
Total	**124**	**74**	**71**	**1,306**	**1,575**

Table 16. Steering Wheel Holding Position and Distraction Type Percentage of Observations

Holding Position	Cell Talk	Cell Touch	Other	No Distraction
12:00	21.31%	6.56%	8.74%	63.39%
2:00/10:00	2.35%	3.52%	2.93%	91.20%
6:00	8.33%	10.96%	6.14%	74.56%
Other	4.55%	27.27%	4.55%	63.64%
Not Recorded	2.91%	1.13%	2.27%	93.69%
Total	**7.87%**	**4.70%**	**4.51%**	**82.92%**

Table 17. Steering Wheel Holding Position and Distraction Type Count by Age Group

Holding Position by Age Group	Cell Talk	Cell Touch	Other	No Distraction	Total
16-19	**4**	**1**	**1**	**13**	**19**
12:00	1	0	1	1	3
2:00/10:00	0	0	0	5	5
6:00	3	1	0	1	5
Not Recorded	0	0	0	6	6
20-39	**70**	**54**	**36**	**610**	**770**
12:00	50	19	17	122	208
2:00/10:00	3	8	3	141	155
6:00	7	20	10	88	125
Other	1	4	0	4	9
Not Recorded	9	3	6	255	273
40-59	**46**	**18**	**27**	**507**	**598**
12:00	26	4	10	91	131
2:00/10:00	3	4	5	111	123
6:00	9	4	3	65	81
Other	0	2	1	9	12
Not Recorded	8	4	8	231	251
60+	**4**	**0**	**7**	**173**	**184**
12:00	1	0	4	18	23
2:00/10:00	2	0	2	54	58
6:00	0	0	1	16	17
Other	0	0	0	1	1
Not Recorded	1	0	0	84	85
Unknown	**0**	**1**	**0**	**3**	**4**
12:00	0	1	0	0	1
Not Recorded	0	0	0	3	3
Total	**124**	**74**	**71**	**1,306**	**1,575**

To capture a wide range of distraction data, the research team drove on roadways with various functional classifications. Generally speaking, three different roadway types were used to capture data: Arterial (Route 9), Interstate (I-91) and Downtown (South Pleasant St.) environments. Route 9 has a speed limit of 35 mph, 2 designated through lanes (designated left turn lanes appear at various signalized intersections), and the roadway's shoulder width is approximately greater than 1 foot. I-91 is a high speed roadway with a speed limit of 65 mph, 2 travel lanes in the northern half which becomes 3 lanes around the Springfield region, and the roadway's shoulder width is approximately greater than 1 foot. The road of S Pleasant Street runs through the heart downtown Amherst; the speed limit is 30 mph, there is 1 lane per direction of travel, and the roadway's shoulder width is approximately equal to 1 foot. The distraction distribution fluctuates among the three roadway types as shown in Table 18, Table 19, and Table 20. Drivers on the interstate had a lower percentage of texting while driving observations (2.83%) than the drivers on the downtown road (5.23%) or the arterial (10.34%). The arterial had a considerably high percentage of observations for both talking on the phone (11.49%), texting while driving (10.34%), and other (7.66%). This may be due to the stop and go nature of the traffic and low speeds on this roadway. Drivers may be more likely to challenge themselves with a secondary activity if the primary activity of driving on this roadway is not generating a challenge. The percentage of observations for texting while driving on the interstate (2.83%) was lower than that of the downtown roadway (5.23%), but the percentage of observed drivers talking on the phone on the interstate (7.47%) was higher than that of the downtown roadway (5.46%). A difference between the arterial and downtown setting may be that drivers were anticipating random events such as a bus along the side of the road at a stop or a pedestrian crossing the street.

Table 18. Arterial Distraction Summary

Distraction Type	Count	Percentage of Observations
Cell Talk	30	11.49%
Cell Touch	27	10.34%
Other	20	7.66%
No Distraction	184	70.50%
Total	**261**	**100.00%**

Table 19. Downtown Distraction Summary

Distraction Type	Count	Percentage of Observations
Cell Talk	23	5.46%
Cell Touch	22	5.23%
Other	9	2.14%
No Distraction	367	87.17%
Total	**421**	**100.00%**

Table 20. Interstate Distraction Summary

Distraction Type	Count	Percentage of Observations
Cell Talk	37	7.47%
Cell Touch	14	2.83%
Other	21	4.24%
No Distraction	423	85.45%
Total	**495**	**100.00%**

Due to the wide range of variables that were recorded during the observations, a unique type of comparison could be made for roadway type, vehicle type, and observed distraction type. Again, the three types of roadways, arterial, interstate and downtown, were used in this analysis. Table 21 displays the vehicle type and distraction type count for the arterial road, and Table 22 shows the percentage of observations for the various vehicle types and distraction types for the arterial. Similarly, Table 23 and Table 24 provide the same variables for the downtown road. Lastly, Table 25 and Table 26 show this information for the interstate. Passenger cars composed the majority of the observations for all three roadway types with the exception of SUVs on the interstate. Passenger cars were more likely to be observed texting while driving on an arterial (10.65%) than the downtown area (7.07%) or the interstate (1.98%). Since the passenger car vehicle type is the only classification with over 100 observations for all three roadway types, it would not be an accurate representation to compare the other recorded vehicle types.

Table 21. Arterial Vehicle Type and Distraction Type Count

Vehicle Type	Cell Talk	Cell Touch	Other	No Distraction	Total
Commercial	1	0	2	9	12
Mini-Van	1	1	2	8	12
Passenger	19	18	12	120	169
Pick-Up	2	4	1	7	14
SUV	7	4	3	40	54
Total	**30**	**27**	**20**	**184**	**261**

Table 22. Arterial Vehicle Type and Distraction Type Percentage of Observations

Vehicle Type	Cell Talk	Cell Touch	Other	No Distraction
Commercial	8.33%	0.00%	16.67%	75.00%
Mini-Van	8.33%	8.33%	16.67%	66.67%
Passenger	11.24%	10.65%	7.10%	71.01%
Pick-Up	14.29%	28.57%	7.14%	50.00%
SUV	12.96%	7.41%	5.56%	74.07%
Total	**11.49%**	**10.34%**	**7.66%**	**70.50%**

Table 23. Downtown Vehicle Type and Distraction Type Count

Vehicle Type	Cell Talk	Cell Touch	Other	No Distraction	Total
Commercial	2	0	1	21	24
Mini-Van	2	0	0	21	23
Passenger	11	20	8	244	283
Pick-Up	5	0	0	39	44
SUV	3	2	0	42	47
Total	**23**	**22**	**9**	**367**	**421**

Table 24. Downtown Vehicle Type and Distraction Type Percentage of Observations

Vehicle Type	Cell Talk	Cell Touch	Other	No Distraction
Commercial	8.33%	0.00%	4.17%	87.50%
Mini-Van	8.70%	0.00%	0.00%	91.30%
Passenger	3.89%	7.07%	2.83%	86.22%
Pick-Up	11.36%	0.00%	0.00%	88.64%
SUV	6.38%	4.26%	0.00%	89.36%
Total	**5.46%**	**5.23%**	**2.14%**	**87.17%**

Table 25. Interstate Vehicle Type and Distraction Type Count

Vehicle Type	Cell Talk	Cell Touch	Other	No Distraction	Total
Commercial	1	1	5	34	41
Mini-Van	3	2	0	23	28
Passenger	15	5	12	221	253
Pick-Up	5	2	3	38	48
SUV	13	4	1	107	125
Total	**37**	**14**	**21**	**423**	**495**

Table 26. Interstate Vehicle Type and Distraction Type Percentage of Observations

Vehicle Type	Cell Talk	Cell Touch	Other	No Distraction
Commercial	2.44%	2.44%	12.20%	82.93%
Mini-Van	10.71%	7.14%	0.00%	82.14%
Passenger	5.93%	1.98%	4.74%	87.35%
Pick-Up	10.42%	4.17%	6.25%	79.17%
SUV	10.40%	3.20%	0.80%	85.60%
Total	**7.47%**	**2.83%**	**4.24%**	**85.45%**

Crash Report Analysis

Using the UMass Safety Data Warehouse, several queries were created to extract crash report information for analysis. Several of the specific variables of interest to the research team were related to general trends in distracted driving within Massachusetts. One specific point of interest was the prevalence of distracting driving after the Massachusetts Safe Driving Law was passed. Another specific crash question was related to the role of the crash report narrative in providing additional details related to the true influence of distraction in the true crash outcome.

General Trends

The general trends and analyses were constructed using 2012 and 2013 crash data which are representative of the most recent years of complete data. An item of interest was the number of distracted crashes for various ages over this two-year period. As a base condition, the distracted crashes for 2012 were filtered by using the crash data with driver age, driver contributing code "Distracted Fault", and the year 2012. This information was trimmed and is depicted in Figure 12. As shown, the highest number of distracted crashes in 2012 happened for those who are 19 years old (1,077 crashes). In general the number of distraction related crashes was significantly higher between the ages of 16-19 as compared to all other ages. This age range corresponds to the age range used for the field observations because it is a target age group for distraction involved crashes due to driver inexperience and high technology dependence.

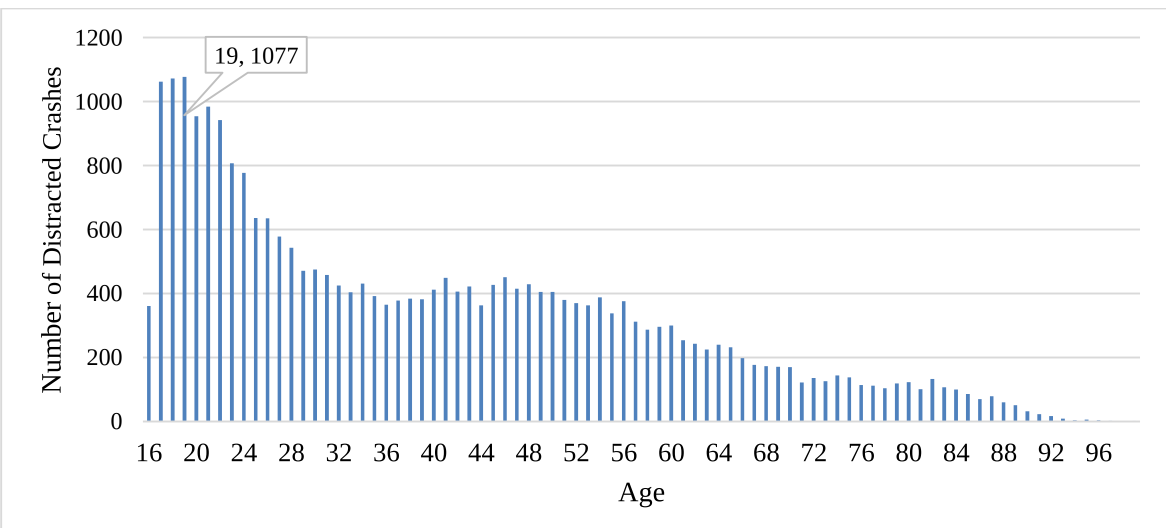

Figure 12. Number of Distracted Crashes by Age for 2012

Although investigating distraction related crashes by age is important, an effort was made to normalize the crash data by the number of licensed drivers at each age range. A running average from a 5-year period (2004 to 2008) of licensed drivers by age was calculated and used for normalization. The normalized rates of distraction related crashes for 2012 is presented in Figure 12. At first glance, it may appear that 16 year olds have a lower crash count, but in comparison to the percent of licensed drivers at age 16 who are involved in a distraction related crash, this number is significantly large. Just over 2% of all licensed 16 year olds were in a distracted crash in 2012. As the drivers' age increases, the percent of licensed drivers involved in distraction related crashes generally decreases. There is an exception to this trend that occurs after the age of 94 due to the low number of crash occurrences and fewer registered drivers.

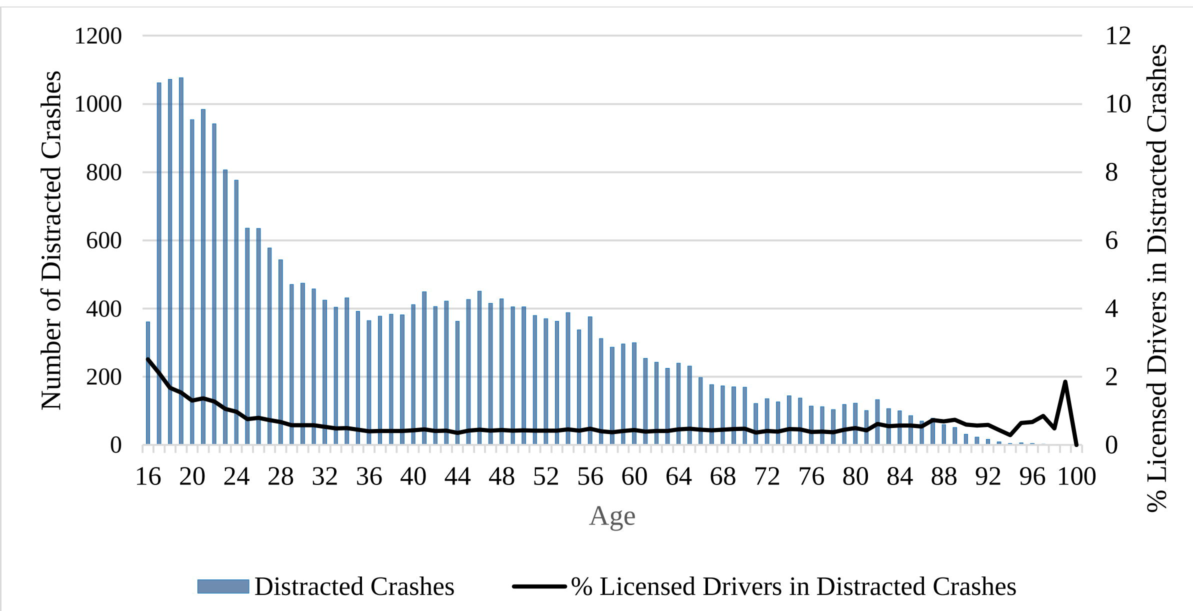

Figure 13. Distracted Crashes Compared to Percent of Licensed Drivers Involved in Distracted Crashes for 2012

After analyzing the crash data from 2012, a secondary analysis of 2013 was completed. The addition of 2013 data allowed for a snapshot glance of quick trends within the two most recent years of data. The number of distraction related crashes for 2012 and 2013 are depicted in

Figure 14 accompanied by a secondary axis showing the percent increase in distraction crashes per age over the two year period. To avoid data misrepresentation, the highest driver age used was 94 because, as it was evident in Figure 13, there was limited data available for these ages, so it would appear skewed. The highest number of distraction involved crashes for 2013 occurred at the age of 18 (1,363 crashes). This data point is alarming because not only has the age with the highest number of distraction related crashes been lowered from 19 years old to 18 years old, but also, this peak crash count is larger than the one found in 2012. Given the increased frequency and year-to-year comparison, there is evidence to suggest a recent increase in distraction related crashes for all ages.

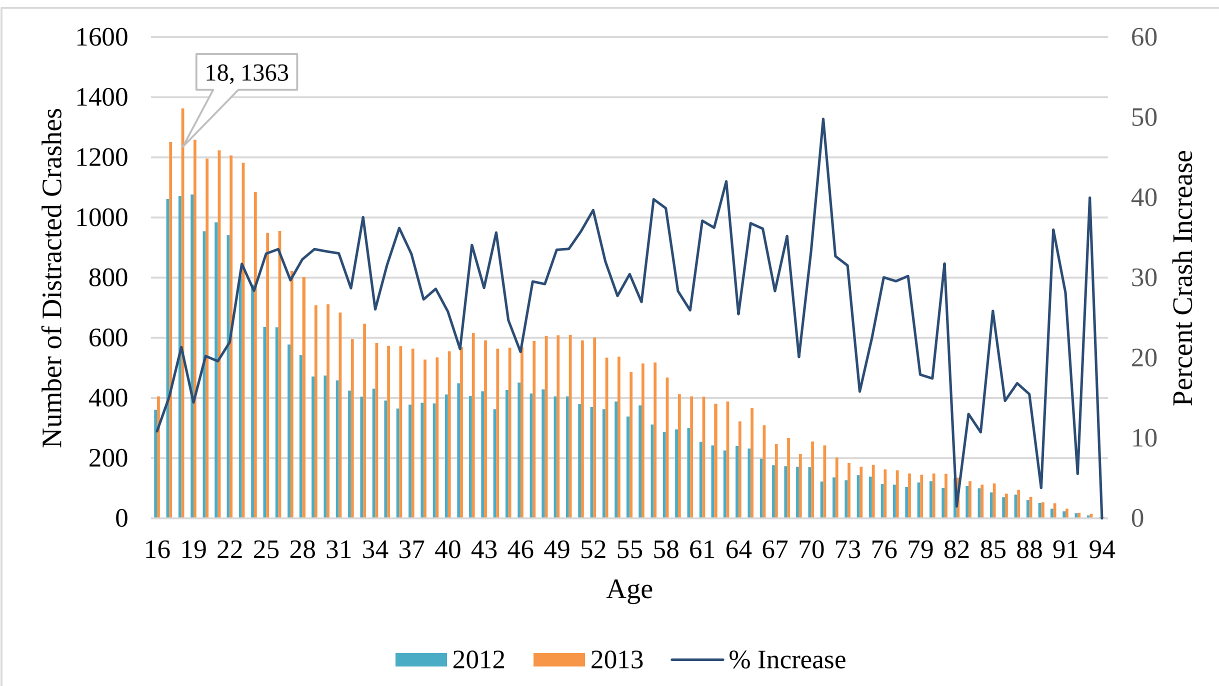

Figure 14. Distraction Involved Crashes from 2012 and 2013

Before and After Massachusetts Safe Driving Law

The Massachusetts Safe Driving Law went into effect on September 30, 2010. This law restricted cell phone use for junior operators and banned texting while driving for drivers of all ages. Crashes were analyzed from two years before and two years after the establishment of this law. The "before law" two year period was September 29, 2008-September 29, 2010. The "after law" two year period was January 1, 2012,-December 31, 2013. The rationale behind this is as follows: this provides two full years of crash report data up until the texting ban went into effect, and the full years of 2012 and 2013 were chosen to provide more recent data for comparison purposes. By excluding data from September 30, 2010 through the end of 2011, this allowed for a transition period in crash reporting and police adaptation to the new law in effect. The overall number of crashes before and after the law can be found in Table 27. For added comparison, the before and after law data was broken down into the driver contributing code categories of "Distracted Fault", "No Fault", or "Other Fault". Table 28 presents this crash data. Please note that some crash reports were missing information in this area on the report form, resulting in a lower overall number of crashes used within the analysis.

Table 27. Number of Crashes Before and After MA Safe Driving Law (Count)

Description	Number of Crashes
Before MA Safe Driving Law	437,762
After MA Safe Driving Law	451,312
Total	**889,074**

Table 28. Driver Contributing Codes for Crashes Before and After MA Safe Driving Law (Count)

Description	Distracted Fault	No Fault	Other Fault	Total
Before MA Safe Driving Law	43,547	170,139	98,451	312,137
After MA Safe Driving Law	66,729	195,636	115,129	377,494
Total	**110,276**	**365,775**	**213,580**	**689,631**

As shown in Table 28, not only has the number of distraction involved crashes increased since the enforcement of the Massachusetts Safe Driving Law, but the number of crashes for the other two categories has also increased. This increase in crashes could have been caused by several factors, but one influential reason might have been the increased quality of crash reports completed by the police. The way that crashes were reported in 2008 might have been of lesser quality than those reported in 2010 and beyond. For this reason, perhaps crashes that were distraction related in the "Before MA Safe Driving Law" category were incorrectly reported as such. In the past few years, distraction has become a prevalent cause in crashes, and more recently, there was a modification to the crash report form to include an additional section for distraction type. Additionally, it could be argued that cell phones have become more popular and used more frequently in the years 2012 and 2013 as opposed to 2008-2010, so this could be an influential factor with regards to the increase in distraction related crashes after the texting ban was established. It should be noted that the crash totals for Table 27 and Table 28 are not equal. Crash reports are frequently missing crucial pieces of information such as crash causation, so crashes that had blank information rather than a listed crash fault make up the crash count differential between the two tables.

GIS Analysis

Several theme maps were created using the crash report data for the state of Massachusetts. This was done using GIS software. Taking the data used for the before and after analysis of the Massachusetts Safe Driving Law, Equivalent Property Damage Only (EPDO) scores were assigned for the crashes. This was completed by assigning numerical values to a crash based on the information reported in the crash max injury category. Since there were thousands of rows of data, an Excel "If" function was created in order to fill all of the cells quickly and accurately. The scale used for EPDO values was obtained from UMass Safe, and it was used in the office's most recent publications. See Table 29.

Table 29. Equivalent Property Damage Only Scale

Max Injury Severity	EPDO Weight
Fatal injury	9.5
Non-fatal injury – Incapacitating	4.5
Non-fatal injury – Non-incapacitating	3.5
Non-fatal injury – Possible	2.5
No injury	1
Not Applicable	1
Not Reported	1
Reported but invalid	1
Unknown	1
Deceased not caused by crash	1

Once the EPDO column was populated, tables with total values for towns within Massachusetts were created for different time periods including before and after the Massachusetts Safe Driving Law and for the years 2012 and 2013. All of the tables with EPDO values were filtered so that only the crashes categorized as "Distracted Fault" were captured. The classifications and ranges for the theme maps were determined according to the algorithms within GIS. The following theme maps were generated with the available crash data from the UMass Safety Data Warehouse:

- Number of Distracted Crashes in 2012 (Figure 15)
- Number of Distracted Crashes in 2013 (Figure 16)
- Percent of Distraction Related Crashes 2012 (Figure 17)
- Percent of Distraction Related Crashes 2013 (Figure 18)
- Equivalent Property Damage Only (EPDO) Before MA Safe Driving Law (2008-2010) (Figure 19)
- Equivalent Property Damage Only (EPDO) After MA Safe Driving Law (2012-2013) (Figure 20)
- Distracted Crashes Locations in MA (2008-2013) (Figure 21)

Through use of the distraction crash data and pivot tables, the first analysis completed was to compare the number of distraction involved crashes. The years 2012 and 2013 were chosen for analysis because they represent the two most recent and complete years of data. Figure 15 and Figure 16 show the number of distraction related crashes in 2012 and 2013. The darker the shade of the city or town is, the more distraction crashes that area experienced in that given year. Very few areas experienced a decrease in crashes from 2012 to 2013, but rather many areas experienced an increase in the number of distraction crashes. It was not surprising that the darker areas appear around major cities such as Springfield, Worcester, and Boston because these three large cities have a higher number of crashes in comparison to a smaller and less populated town.

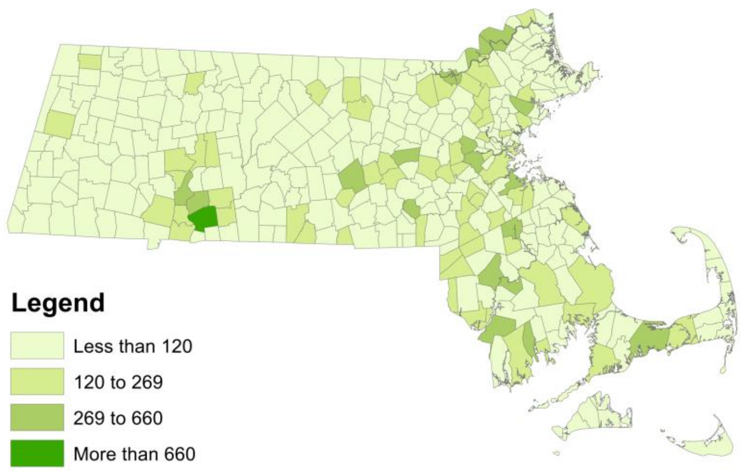

Figure 15. Number of Distracted Crashes 2012

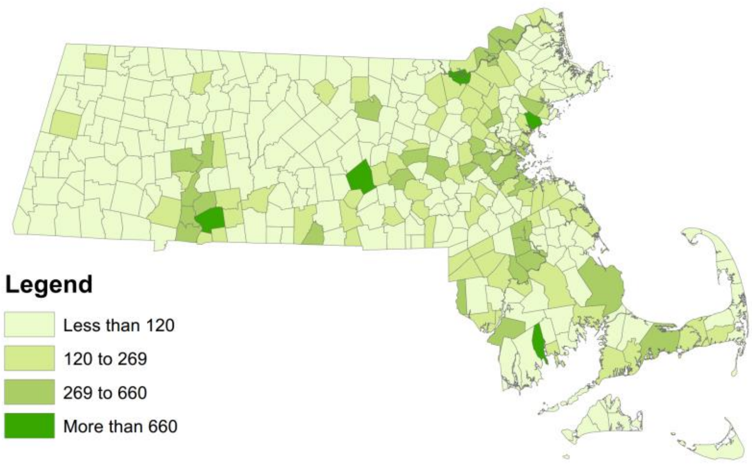

Figure 16. Number of Distracted Crashes 2013

Since the number of crashes is not always an accurate representation of the issue at hand, a second type of analysis was completed using the same crash data. The number of crashes labeled as "Distracted Fault" were put over the total number of crashes for the individual cities or towns in an effort to normalize the distraction related crashes against the total number of crashes. This was completed using calculation functions within pivot tables. Again, this data was separated into the years 2012 and 2013 to show the most recent trends with the crash data, and the maps are shown in Figure 17 and Figure 18. The percent of distracted driving crashes increases from 2012 to 2013 according to the associated color scheme found in the legend.

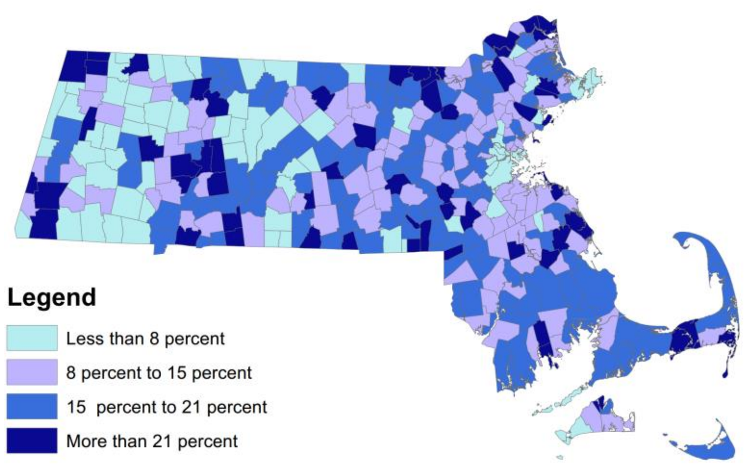

Figure 17. Percentage of Distraction Related Crashes 2012

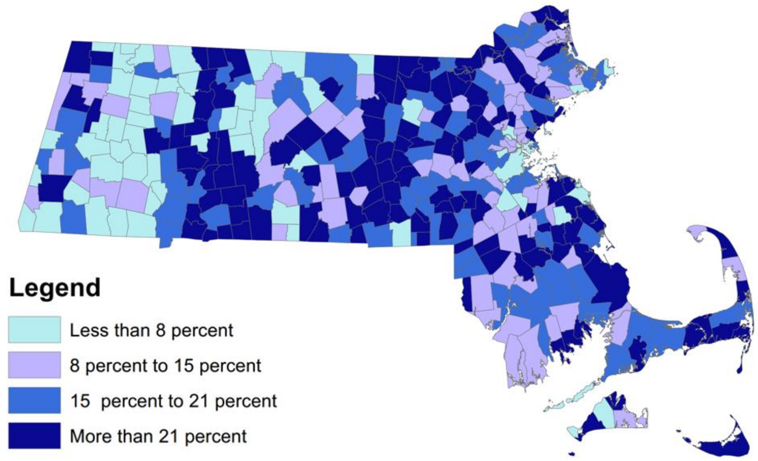

Figure 18. Percentage of Distraction Related Crashes 2013

The next set of theme maps incorporates the equivalent property damage only (EPDO) scores for the corresponding cities and towns within Massachusetts. These numbers were calculated using the previously discussed values from Table 29. These two theme maps are found in Figure 19 and Figure 20. The "after" map appears generally darker than the "before" map, and this could be due to several factors such as improvements with crash reporting, increased cell phone dependence, or increased popularity of cell phones. In recent years, the crash report database has gone from paper reporting to an electronic system, so this might have also increased the quality of crash reports. Police are also more aware of cell phone use while driving, so perhaps they are more familiar with how to report a distraction related crash. There are no definite reasons for the crash increase, but these are a few valid assumptions that could be made.

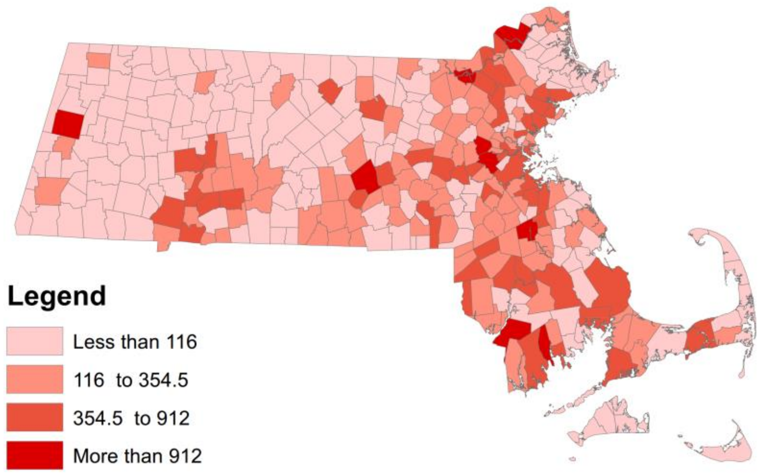

Figure 19. Town EPDO Scores before MA Safe Driving Law (2008-2010)

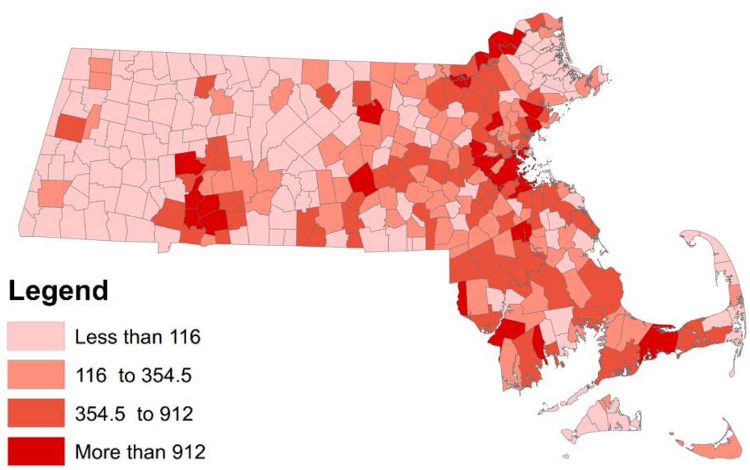

Figure 20. Town EPDO Scores after MA Safe Driving Law (2012 and 2013)

Along with the analysis of the individual cities and towns within Massachusetts, a map consisting of individual distraction related events was plotted using a red dot to represent a single crash. All of the crash report data from 2008-2013 was used when composing this map. All data points are shown in Figure 21. The crashes all occur on various roadways within the state, so this creates the appearance of a network or veins. The town distinctions are lightly present in the background for location reference purposes only.

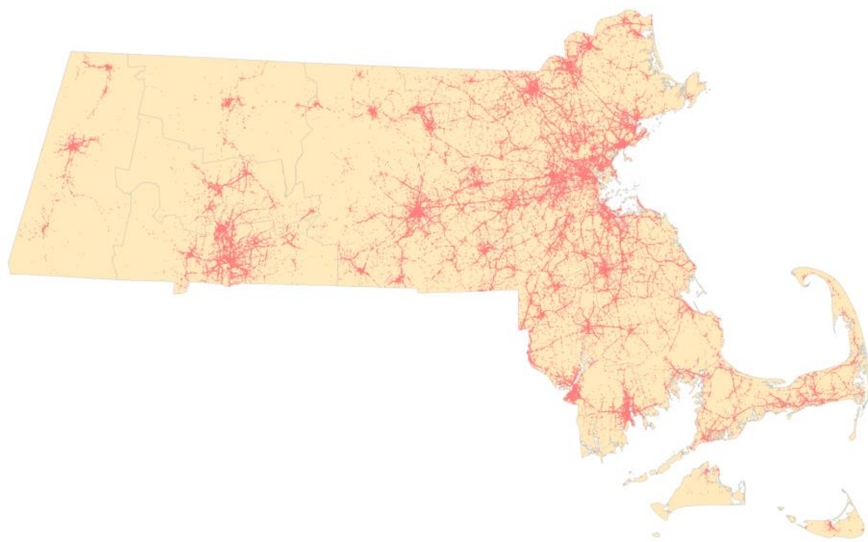

Figure 21. Distraction Involved Crashes in MA (2008-2013)

Crash Report Double Blind Narrative Search

This goal of this portion of the research was to evaluate the efficacy of the narrative as a resource for expanded analysis as related to distraction related crashes. The methodology employed replicated that of a work zone-related crash study completed by Swansen et al. (5). Crash report narratives from crashes with the primary driver contributing code of “distracted” from 2012 and 2013 were reviewed, and key words or phrases that indicated driver distraction were noted. Due to the confidential nature of the crash report narratives, the file containing the information was only accessed within the UMass Safe office and behind a secure firewall. Seven research assistants individually reviewed a total of 40 crash reports from a random sample of 200 crash report narratives—100 were classified as caused by distraction and 100 excluded distraction as a primary driver contributing code. Some narratives were reviewed by a single source while others were reviewed by multiple researchers, using a double blind approach to ensure reliability and consistency in scoring across researchers. A worksheet was provided to each researcher containing the list of predetermined key words or phrases.

The chosen key words and phrases included the following:

- Phone
- Cell
- Text
- Texts
- Texting
- Distract
- Distracted
- Looked Down
- Looked Away
- GPS
- Smartphone
- iPod
- Adjust
- Change Radio
- Change Station

Additional space was provided for the researchers to write in any words or phrases that they thought indicated a possible distraction. Whenever a word or phrase appeared, the reviewer recorder the observation on the worksheet. Ultimately, after reading a narrative, the reviewer made a decision (yes or no) as to whether or not the crash report narrative indicated distraction involvement. An example of the narrative review worksheet is shown as

			Indicate the number of times a search word or phrase is present															Other words or phrases which indicate distraction			
Number	Enter Narrative Number	Indicates Distraction Involvement (Y/N)	phone	cell	text	texts	texting	distract	distracted	looked down	looked away	GPS	smartphone	iPod	adjust	change radio	change station				
1																					
2																					
3																					
4																					
5																					
6																					
7																					
8																					
9																					
10																					

Figure 22. Crash Report Narrative Review Worksheet

Out of the 100 random crash reports classified as distraction related from the years 2012 and 2013, 28 of the reports did not contain words linked to distraction involvement. This means that only 72 of the 100 reports contained words or phrases that indicated distraction. Of the 72 narratives categorized by the reviewers as distraction related, 5 did not contain a single word or phrase related to distraction, but the context of the narrative was sufficient to allude that distraction evident. There were 33 randomly chosen double blind narrative reviews, and 5 out of the 33 narrative reviews resulted differing opinions as to whether or not the crash involved distraction. Excluding these 5 narratives, 25 out of the remaining 95 crashes that were classified as distraction related were marked as non-distraction involved by the reviewers. Out of these 25 reports that were marked as non-distraction related, 23 narratives contained zero key words of phrases that would potentially indicate distraction; 2 narratives were marked as having key words or phrases appear, but the overall narrative did not indicate a strong link to distraction according to the reviewer. This means that only 70 distraction crash reports out of the random 100 sample were classified as distraction related by the reviewer and contained at least 1 key word or phrase indicating distraction. The results of the key word or phrase narrative search can be found in Table 30. Some narratives contained multiple words that indicated distraction, so the word count does not represent individual narrative events. For example, one crash report could contain the words phone, distracted, and looked down within a single narrative.

Table 30. Double Blind Narrative Search Results

Key Word or Phrase	Number of Distraction Related Narratives Containing Words	Frequency in Non-distraction Related Crash Narratives Containing Words
Distracted	39	1
Phone	17	0
Looked Down	14	1
Cell	10	0
Eyes off the Road*	8	0
GPS	5	0
Change Radio	4	0
Not Paying	4	0
Adjust	3	0
Looked Away	2	0
Reading*	2	0
Looked At*	2	0
Dropped*	2	1
Rang*	2	0
Attempted to	1	0
Organizing*	1	0
Bee*	1	0
Reached*	1	0
Shut off Radio*	1	0
Looking For*	1	0
Physical Attention*	1	0
Looked Out*	1	0
Paperwork*	1	0
Altercation*	1	0
Eating*	1	0
Bug*	1	0
Texting	1	0
Distract	1	0
Sun Glare	0	2
Text	0	0
Texts	0	0
Smartphone	0	0
iPod	0	0
Change Station	0	0

* Indicates key word or phrase added by narrative review team

For non-distraction related crash reports, 5 out of 100 random narratives contained key words or phrases that indicate driver distraction, and 4 out of these 5 narrative reviews were classified incorrectly as distraction involved crashes. A summary of the crash report narrative search findings is presented in Table 31. Unknown to the reviewers, these 4 narratives actually had the following 4 primary driver contributing codes: Disregarded traffic signs, signals, or road markings, Inattention, Wrong side or wrong way, and Operating vehicle in erratic, reckless, careless, negligent, or aggressive manner.

Table 31. Crash Report Narrative Search Summary

Reviewer Determination	**Crash Report Information**	
	Distraction Related	Non-Distraction Related
Distraction Related	70	4
Non-Distraction Related	25	96

The main point that this crash report narrative search summary displays is the following: distraction related crash report narratives do not always have a useful written description containing distraction related words. Crash report narratives can often be insightful, but as this research task proved, not every narrative accurately reflects the reported crash causation. It is also possible that some non-distraction related crashes are incorrectly classified as inattention or reckless driving. While these two classifications may be true, perhaps the primary cause is cell phone or distraction related and the inattention or reckless driving is instigated by the distraction.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

Field Observations

The field observations were completed in an effort to standardize an additional method for driver data collection. Since there was no prior research to base the procedure on, there were several slight changes that were made as the research progressed. It was not surprising that more people seemed to engage in distracted behaviors on roads with lower speed limits. There is a sense of lower risk when a driver is using the phone on a 35 mph arterial or local road rather than a 65 mph interstate.

The data collection process went fairly well with limited issues. Since nearly all of these observations were taken from a passenger car, it would have been better to make observations from a higher vehicle such as an SUV. This way, the collectors would be able to look either slightly down or directly into vehicles due to the raised seat height. Additionally, the data was collected in hardcopy form on printed spreadsheets and then entered manually on an electronic spreadsheet for all 1,575 driver observations and accompanying variables. It would be time and cost efficient to transform this spreadsheet into an interactive electronic application of some sort, and perhaps this could be done using a touch screen tablet.

Since all of the data was collected without having any information on the passing drivers, there is no way to know how accurate the age data was. It was especially difficult to determine whether a younger driver was 16-19 years old or 20-39 years old, so a driver who was 18 years old may have been categorized as 20-39 years old. Perhaps some training could be established in order to help a research team determine various ages for drivers of different genders and ethnicities. On roadways where traffic was moving at a slower speed, it was easier for the research team to collect data without feeling rushed because fewer cars would pass quickly due to the nature of the road.

Crash Report Analysis

The subtasks within the crash report analysis provided insights about the trends and challenges that face the state of Massachusetts. Some issues with the crash data involve various typos in the electronic system due to human error. For example, many ages were listed as negative numbers or numbers extending beyond 600 years old. These errors may cause the results of this study to be slightly off or underestimated. For the purpose of this research, however, the crash data obtained through the UMass Safety Data Warehouse was extremely useful.

Before and After the Massachusetts Safe Driving Law

With the implementation of the Massachusetts Safe Driving Law, some would assume that texting while driving and overall driver distraction has decreased, but the crash report data does not reflect these ideas and opinions. Using the crash report data from the UMass Data Safety Warehouse, crashes categorized as "Distracted Fault" were separated and analyzed for the two most recent full years of data (2012 and 2013). These graphs showed that within two years, distraction involved crashes have increased for every age. This means that even after the Massachusetts Safe Driving Law went into effect (September 30, 2010), distraction is a prevalent issue on the roadways. Additionally, the increase in crashes may also be due to the increase in distraction awareness and more accurate reporting of the crashes caused by driver distraction rather than driver inattention.

GIS Analysis

Using crash report data, theme maps were created using GIS software. These theme maps depicted various types of information for cities and towns in Massachusetts. When comparing the most recent years of 2012 and 2013, there is an evident trend that driver distraction has increased within that two year period. Generally, this is the case, but some towns might have experienced a decrease in distracted driving. These few towns are outnumbered by the towns that change to a difference range category, and the corresponding color darkens.

Crash Report Narrative Double Blind Search

The crash report narrative demonstrated that there is a broad range of words or phrases that may indicate distraction, and every crash narrative is unique. Some narratives are informative and give detailed information while others lack a thorough description and do not explain why the report was labeled as distraction involved. This inconsistency is often a problem with crash report narratives across the various crash codes. Several distraction involved crashes did not have specific key words or phrases that indicated distraction, so the reviewer ultimately decided that the narrative referred to a non-distraction related crash. On the other hand, some of the randomly pulled non-distraction related crashes contained key words or phrases that indicated distraction, and these narratives were incorrectly categorized by the reviewer as distraction related.

Future Research

This research contributes to the continuous research within the field of distracted driving, and it is the first mobile observation research of its kind. It provides a new methodology for real-time data collection, and it also allows potential windows for future research. Some of the previously mentioned recommendations could be taken into account and a research team could attempt to replicate the data collection procedure. One item of interest would be to determine a popular time of day for distraction involved crashes. This could be done through the use of field observations and crash report analysis. It is evident that crash reports often leave out crucial areas of information or the cause of the crash is labeled incorrectly. Future research might include training for distraction involved crash identification. Police may need to use some of the key words of phrases that indicate distraction so that there is no confusion about whether a crash was or was not caused by distraction. Since distraction has somewhat of a broad definition, it can often be confused with driver inattention.

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