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Technical Assistance Report 17-02TA-SA

Distracted Driving: Strategies and State of the Practices

by

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16. Abstract
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Nationally, the state of the practice to address distracted driving and improve roadway safety focused on improving data collection, legislation, enforcement, improving infrastructure, and communication and outreach.

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ABSTRACT

This technical assistance report conducted an extensive literature review to obtain the state of knowledge on existing research on distracted driving in the US. The objective of this report was to review relevant studies on distracted driving including measurements, strategies, legislation, employer policies, and technologies used nationally to prevent distracted driving, to acquire the information needed to address distracted driving in Louisiana. Distracted driving has been measured in several type of studies, including crash data, observational, attitudinal, enforcement, naturalistic driving, and driving simulators. The number of states that included distracted driving as an emphasis area in their SHSPs has increased over the last few years. The strategies used to address distracting driving are typically focused on improving data collection, education, enforcement and adjudication, engineering, and legislation. Nationally, there are hand-held cell phone bans, text messaging bans, and all cell phone bans. Currently, 16 states and 4 territories have hand-held cell phones bans for all drivers as a primary enforcement law while 47 states and 4 territories ban text messaging for all drivers. The effectiveness of hand-held cell phone bans on hand-held phone use appeared to maintain long term reductions but on crashes showed mixed results. Employers have begun implementing their own policies regarding hand-held cell phone use while driving. National Road Safety Partnership Program of Australia and the National Safety Council released kits that can be used as groundwork by employers to develop their distracted driving policy. Distracted driving technologies ranges from being completely free to upwards of $150, depending on if they are app-only or what type of hardware is required. Overall, there are varying degrees of distracted driving prevention for drivers, ranging from simply rendering the phone useless while in motion to actually changing the capabilities of the vehicle. However, there is no research data to support the effectiveness of these technologies. Nationally, the state of the practice to address distracted driving and improve roadway safety focused on improving data collection, legislation, enforcement, improving infrastructure, and communication and outreach.

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INTRODUCTION

Distracted driving is recognized as a major problem in the United States and worldwide. Due to the changing nature of distracting tasks, the rapid advance of technology-based distractions, and the limitation in availability of distracting driver data sources, continuous efforts to gain a more in-depth understanding of distraction factors and the risk associated with these are underway. Research continues to point out the dangers of distracted driving and has shown that engagement in secondary tasks while driving results in increased crash risks and declining driving performance *[1]*.

Traffic safety experts pointed out that human choice and errors are major contributing factors to traffic crashes. Traffic fatalities and injuries due to distractions have increased in the last few years. According to the National Highway Traffic Safety Administration (NHTSA) Traffic Safety Facts in 2015, there were 3,477 people killed and 391,000 injured in motor vehicle crashes involving distracted drivers *[2]* . In Louisiana in 2015, 172 people were killed and 466 severe injured due to distracted or inattentive driving, representing 22.9 percent of all fatalities and 33.6 percent of all severe injuries, respectively. Furthermore, in 2016 in Louisiana, distracted driving fatalities accounted for 20.6 percent of all fatalities while severe injuries caused by distracted driving accounted for 36.2 percent of all severe injuries, numbers that have stayed almost the same in the last 5 years.

To prove distracted driving requires finding out what activities the driver was doing in the car, preserving proof of those activities through witnesses and forensics, and determining what consequences resulted from that choice. Therefore, it is important to train law enforcement officers in collecting crash data and documenting/preserving evidence of distractions encountered in distracted driving cases.

In an effort to improve the highway safety and reduce roadways fatalities and serious injuries, the Federal Highway Administration (FHWA) requires states to develop, implement, evaluate, and update a Strategic Highway Safety Plan (SHSP). A SHSP is a statewide-coordinated data-driven, multi-year comprehensive plan that establishes goals, objectives, and key emphasis areas *[3]*. Louisiana developed its first SHSP in 2006 and updated it twice,

in 2011 and 2017. The last updated edition has five emphasis areas: impaired driving, occupant protection, infrastructure and operations, young drivers, and distracted driving. It is important to mention that distracted driving is a new emphasis area added in the 2017 Louisiana' SHSP, therefore more information is needed to develop effective strategies.

The information in this report was collected at the request of the Louisiana Department of Transportation and Development (DOTD) Highway Safety Section to obtain the state of knowledge of existing research on measuring and preventing distracted driving. This report provides a review of existing research on distracting driving measurements, strategies, laws, effectiveness of hand-held cell phone bans, employer policies, and technologies to prevent distracted driving in order to document state of the practices to address distracted driving in Louisiana, as needed by the Distracted Driving Emphasis Area Team leaders. This research will establish a foundation on which potential distracted driving strategies and initiatives could be planned by the Louisiana SHSP Distracted Driving Emphasis Area Team.

OBJECTIVE AND SCOPE

The objective of this report was to conduct an extensive literature review to obtain the state of knowledge of existing research on measuring and preventing distracting driving. Specifically, this study focused on distracted driving measurements, strategies used nationally, laws, employer policies, and technologies to prevent distracted driving, in order to document state of the practices to address distracted driving in Louisiana.

LITERATURE REVIEW ON DISTRACTED DRIVING

There is no generally accepted definition of driver distraction. The Louisiana SHSP Implementation Team has defined distracted driving as: "A distracted or inattentive driver is one who is actively engaged in any activity that diverts his/her attention away from the task of driving. The distraction could be inside or outside the vehicle"*[4]*. In 2010, NHTSA released the Driver Distraction program and used the term "distraction as specific type of inattention that occurs when drivers divert their attention away from the driving task to focus on another activity instead" *[5]*. Distraction can be classified in three distinct groups: visual (requires the driver to look away from the roadway to visually obtain information), manual (requires the driver to take a hand off the steering wheel and manipulate a device), and cognitive (involves thinking about something other than the driving task). Some reports use the terms *inattention* and *distraction* synonymously but it is important to be aware that distraction is a subset of inattention.

Based on the needs of Louisiana's SHSP Distracted Driving Emphasis Area Team, the literature review in this report is organized into five topics: measurement of distracted driving, strategies to address distracted driving, distracted driving legislation, distracted driving employer policies, and technology to prevent distracted driving. These topics will be presented in the following sections.

Measurement of Distracted Driving

The role of distracted driving in crashes is difficult to measure. It is believed that it is underreported in fatal and serious injury crashes because of the many challenges police officers have confirming this factor *[6]*. The wide range of distractions (cell phone use, texting, talking with another passenger, eating, spilling, adjusting vehicle controls, reaching for some objects, and many other external distractions) is likely to affect driving performance and consequently elevate crash risks *[7]*. Although most of the research is based on the use of cell phones and other electronic devices, studies show that electronic devices represent a relatively small portion of a bigger distraction problem.

Research on distracted driving has been growing and it has been focused on different types of studies to assess the safety problems of driver distraction. Several types of research studies will be discussed in the sections below.

Crash Data Studies

Crash-based studies provide direct information about the safety implications of distracted driving but many times it is difficult to accurately determine if driver distraction was the contributing factor in a crash, resulting in underreported data. A recent NHTSA publication provides guidance to assist state and local attorneys, law enforcement, and other members of the judiciary in investigating and prosecuting distracted driving cases that involve fatalities and serious injuries *[8]*. The study highlighted the importance of training law enforcement officers in collecting crash data and documenting/preserving evidence of distractions (such as physical, event data recorder, testimonials, non-electronic, and electronic evidence) encountered in distracted driving cases.

The effects of distracted driving can be assessed using three primary sources of data: the Fatality Analysis Reporting System (FARS), the National Automotive Sampling Systems (NASS) General Estimates System (GES), and the National Motor Vehicle Crash Causation Survey (NMVCCS). The first two sources are police accident report-based and the last one is on-scene investigation-based data.

Distractions contribute to more than 3,000 fatalities every year. In 2015, there were 3,477 people killed nationally (10 percent of overall fatalities) and about 391,000 injured in motor vehicle crashes involving distracted drivers *[2]*. Furthermore, 551 non-occupants (pedestrians, bicyclists, and others) were killed in distraction-affected crashes in the same year. Cell phone use represented 14 percent of fatalities reported as distraction-affected crashes in 2015 *[2]*.

Observational and Attitudinal Studies

Observational studies to collect direct information on distracted tasks that drivers attempt while driving have been conducted, but they are limited to a single point in time. There have been a number of probability-based observational studies on driver electronic devices collected nationwide by NHTSA through the National Occupant Protection Use Survey (NOPUS). Annually, NOPUS collects observational surveys of driver electronic devices at randomly selected traffic-controlled intersections, just for the stopped vehicles, for three types electronic devices used while driving: holding phones to their ears, speaking with visible headsets on, and visibly manipulating hand-held devices. The NOPUS found that the percentages of drivers holding cell phones to their ears decreased from 4.3 percent in 2014 to 3.8 percent in 2015, speaking with visible headsets on increased from 0.4 percent in 2014 to 0.6 percent in 2015, and visibly manipulating hand-held devices or texting remained constant at 2.2 percent *[9]*.

NHTSA's National Phone Survey on Distracted Driving Attitudes and Behaviors reports the findings from nationally representative telephone surveys, conducted in November and December 2010, with the goal to assess drivers attitudes and self-reported behaviors about distracted driving as well as perceptions of safety, cell phone use, laws, fines, and enforcement *[10]*. A large number of drivers (6,002) from all 50 states and DC responded to these surveys, and most of the drivers reported that driving becomes more dangerous if they take their attention off the road for more than 2 seconds. According to this report, one-third of the young drivers reported that driving starts to become dangerous when they take the eyes off the road for 3 to 10 seconds. Most of the drivers reported that they will take a call while driving. About 18 percent reported that they have sent text messages or emails while driving. The findings showed that most commonly distracted driving behaviors were talking to other passengers (80 percent), adjusting the car radio (65 percent), eating and drinking (45 percent), talking on the phone (40 percent), and interacting with children in the back seat (27 percent).

The second National Phone Survey on Distracted Driving Attitudes and Behaviors, conducted by NHTSA in 2012, developed a driver typology based on the pattern of responses

across multiple distracted driving behavior questions *[11]*. Two distinct groups of drivers with similar overall behavioral tendencies were identified in this analysis: 33 percent are distraction-prone and 67 percent are distraction-averse. Almost half of the survey respondents reported answering their cell phone while driving and continue to drive while completing the conversation. Only 17 percent of drivers who answered their phone while driving reported that they informed the callers that will call them back, 14 percent handed the phone to a passenger in the car, and 11 percent pulled over to safe locations to continue the conversation. Furthermore, one in ten respondents reported sending text messages or e-mails while driving at least sometimes. Half of the drivers who talk on the cell phone while driving feel safe and reported that they do not change their driving when compared with not talking on cell phone.

The ninth annual Traffic Safety Culture Index survey published by the American Automobile Association (AAA) Foundation for Traffic Safety showed that people in the US widely use cell phones while driving. For example, more than 2 in 3 drivers reported talking on their cell phone while driving in the past month, and nearly 1 in 3 reported doing it regularly *[12]*. Regarding texting or emailing while driving, nearly 1 in 3 (31.4 percent) admitted to typing or sending a text message or email while driving in the past month, and 2 in 5 (40.2 percent) reported reading a text message or email while driving in the past month.

Hassani et al. reported the findings from a pilot study developed with the goal to reduce the frequency of distracted driving behaviors among college students *[13]*. An interactive, public education event (workshop) was implemented and evaluated on 19 colleges and universities in the Chicagoland area. A total of 444 college students completed three surveys: prior to the workshop, immediately after, and three months following the workshop. The results of this study revealed significant improvements in short-term attitude-knowledge and behaviors (immediately and three months after workshop). However, the participants must be followed over a longer duration to assess long-term effects.

Enforcement Studies

NHTSA funded observational studies, such as distracted driving high-visibility enforcement demonstrations, in several states that have laws banning the use of hand-held cell phones while driving. These studies used stationary observers to record drivers using cell phones for moving traffic only, for one hour at each site. Four distracted driving high-visibility enforcement waves were conducted over the course of one year in Connecticut and New York from April 2010 to April 2011 and three waves in California and Delaware from November 2012 to June 2013 *[14-16]*. Public awareness surveys at driver licensing offices, with the exception of California that used drivers stopped at pre-selected gas stations, had also been collected during these waves. The studies showed that the use of hand-held phones decreased 32 percent in Syracuse, 57 percent in Hartford, 34 percent in California, and 33 percent in Delaware. The awareness surveys at all demonstration sites also showed a significant increase in public awareness that cell phone laws were being enforced. These NHTSA demonstration programs suggest that conducting high-visibility enforcement is effective and may have a positive impact on modifying driver distractions by reducing hand-held cell phone use.

Another study evaluated the enforceability of texting laws and tested different methods for enforcing these laws *[17]*. Four waves of enforcement in conjunction with earned media activities were conducted in Connecticut and Massachusetts during 2013 and 2014. The participating officers logged 7,300 hours and reported over 8,700 citations for texting and other distracted driving offenses. This evaluation collected insights from the participating law enforcement agencies and highlighted the importance of conducting officer training, holding roll calls focused on texting enforcement, pre-planning operational strategies, creating partnerships with local and state enforcement agencies, and establishing leadership priority for conducting texting enforcement. The officers demonstrated that spotter, stationary, and roving patrol strategies and different variations (one- and two-officer patrols, uniformed and plainclothes officers, marked and unmarked patrol vehicles such as SUVs, vans, pickup trucks, motorcycles, and cruisers) could be used to enforce texting laws. Furthermore, this evaluation measured the outcome of the enforcement and earned media activity on observed driver behavior, self-reported behavior, and public awareness. Observations of driver

behavior conducted before and after each wave found no effect in almost all cases, with the exception of statistically significant declines in hand-held phone use among male drivers for Wave 2 in Connecticut and in texting among female drivers and the total sample in Wave 4 in Massachusetts. In addition, the awareness surveys for both Connecticut and Massachusetts administered just for the last two waves showed a limited public awareness implying that either more earned media or paid media is required to influence public awareness. However, it is important to note that in this study the baseline surveys were not administered before the program started.

Every year NHTSA kicks off (now in its fifth year) a high-visibility enforcement campaign "U Drive. U Text. U Pay" during the National Distracted Driving Awareness Month (April) to look out for drivers texting or using their phone behind the wheel *[18]*. The campaign, which targets motorists aged 18 to 34, is supported by national media buy with ads in English and Spanish on television, radio, and digital platforms.

Naturalistic Driving Studies

In recent years, naturalistic driving studies have been emerging as one approach to ascertain direct information about the distracting driving. On these studies, video cameras and other eye-tracking technology are used to monitor driver behavior every day for an established period of time. For example, Virginia Tech Transportation Institute conducted naturalistic driving study for more than one year, known as *100-Car Study*, and tracked the behavior of the drivers of 100 vehicles equipped with video and sensor devices *[19]*. A large database was created from this study: 241 total drivers, nearly 2,000,000 vehicle miles of driving for almost 43,000 hours of data, 12 to 13 months of data collection for each vehicle. During this study 82 crashes, 761 near crashes, and 8,295 critical incidents were reported. The results indicated that driver inattention was a contributing factor in almost 80 percent of all crashes and in 65 percent of all near-crashes. The most common distractions for drivers involved in incidents, near-crashes, crashes, and minor collisions are the use of hand-held wireless devices along with looking at/reaching for object-in-vehicle and passenger-related secondary tasks *[20]*.

Another large-scale naturalistic driving study, the second Strategic Highway Research Program Naturalistic Driving Studies (SHRP2 NDS), collected data from six states across the United States (Florida, Indiana, New York, North Carolina, Pennsylvania, and Washington) during a three-year period with the central goal to address the role of driver performance and behavior in traffic safety *[21]*. This study contains information from 3,147 volunteer drivers (corresponding to all age and gender groups) for more than 3,900 vehicle-years, and more than 1 million hours of video. A Roadway Information Database (RID) was also created from this study, containing more than 5.5 million trips taken for about 50 million vehicle miles. The data from this study is available for purchase for research studies.

The Louisiana Transportation Research Center (LTRC) published a research project that explored this SHRP2 NDS database to identify useful performance measures to detect distracted driving behavior and to provide an outline for a crash index model that can be used to quantify the crash risk associated with distracted driving behavior *[22]*. The objective was to detect whether a driver was engaged or not in one of the three specific secondary tasks talking or listening on a hand-held phone, texting/dialing on a hand-held phone, and driver interaction with an adjacent passenger using selected performance measures. Although multiple logistic regression analysis did not provide a statistically good fit of the data, the neural network analysis proved to be good tool for detecting drivers' engagement in secondary tasks. The research team proposed a framework of crash index calculation that can be used to quantify the crash risk associated with distracted driving behavior.

A recent naturalistic driving study, published by the AAA Foundation for Traffic Safety, examined the behavioral, roadway, and environmental factors present in crashes involving teenage drivers with the goal to identify critical events and potential contributing factors that led to crashes *[23]*. Drive Cam systems collected video (8 seconds before and 4 seconds after the trigger), audio, and accelerometer data when the driver triggered the device by hard braking, fast cornering, or an impact with a certain *g*-force. The study reviewed over a thousand (1,691) moderate-to-severe crashes involving young drivers ages 16-19 (single vehicle and vehicle to vehicle crashes with no fatalities) and showed that up to 58 percent of all crashes were caused by distracting behaviors. The most frequent distracting behaviors

were attending to passengers (14.9 percent) and cell phone use (11.9 percent). Cell phone use was more common in the case of road departure crashes than any other type of crashes (34 percent vs 9.2 percent) and contributed to significantly longer reaction times (2.8s vs 2.1s for drivers not engaged in any behaviors). For example, in the case of road departure crashes, distracted drivers were looking away from the roadway prior to the crash for a significantly longer time (4s). The most common distracting behaviors resulting in the longest mean eyes-off-road times were: using electronic devices (3.9s), attending to a moving object in the vehicle (3.6s), using a cell phone (3.3s), and reaching for an object (3.3s). Drivers engaged in cell phone use had mean eyes-off-road times that were twice as long as those drivers who were attending to passengers (3.3s vs 1.5s). Additionally, the average eyes-off-road time for drivers who were operating or looking at their phone was 4.1s, compared to 0.9s for drivers who were talking or listening. The driver showed no reaction at all before impact in over half of rear-end crashes when using a cell phone. When drivers were examined by gender, results indicated that males and females were equally likely to be engaged in potentially distracting behavior. However, more females had been using a cell phone (14 percent vs 10 percent), engaged in personal grooming (7 percent vs. 5 percent), or singing/dancing to music (9 percent vs 6 percent) prior to the crash compared to males *[23]*.

Another naturalistic driving study, published by the AAA Foundation for Traffic Safety, collected in-vehicle data among newly licensed teen drivers (the provisional licensing stage of GDL) to study distracted driver behaviors and potentially distracted conditions *[24]*. The researchers examined video, audio, and accelerometer data obtained in certain triggering events from 52 teen drivers during a total period of 228 months (6 months times 38 vehicles). The results showed that teenagers engage in a wide variety of distracted driving behaviors (with adjusting controls in the vehicle being the most common). Furthermore, the crash risk increases when multiple teenage passengers are present. The use of electronic devices and other distracted driver behaviors were strongly associated with looking away from the roadway and were more frequent when driving alone. In fact, an electronic device was used in 8.1 percent of cases and other distracted behaviors were engaged in 16.9 percent when driving alone but these behaviors were least common when carrying parents or other adults. Although a weak relationship between electronic device use and serious incidents or higher

g-force events was observed in this study, potentially distracting conditions such as loud conversation and horseplay were strongly associated with serious incidents and high *g*-force events.

Naturalistic driving studies represent a good approach for studying driver distraction. Although results from naturalistic driving studies have some limitations, remarkable progress has been made to assess driver's exposure to different types of distractions during near-crash, pre-crash, and crash events. Data from naturalistic driving studies are valuable because they allow researchers to directly observe driver and passenger behaviors in a high level of detail and to quantify real crash risk.

Driving Simulator Studies

Driving simulator studies collect driving performance measures in a controlled and safe driving environment. However, the information obtained is not achieved in real life situations and depends substantially on the simulator characteristics (with high-level simulators offering the most realistic driving environment) and the sample size (number of drivers participating in the study). Driving simulator studies are very helpful to assess the potential for distractions associated with in-vehicle systems/technologies.

Raney et al. conducted several driving simulator experiments to assess distraction potential for in-vehicle information systems and portable devices used while driving as well as to evaluate the sensitivity of detection response task metrics to differences in attentional load *[25-27]*. Ishak et al. conducted driving simulator experiments for an LTRC study "Distracted Driving and Associated Crash Risks" and found that texting and talking to passengers while driving impaired driver performance *[28]*. Papantoniou et al. published a review of existing driving simulator studies on driver distraction *[29]*. In this review, a critical assessment of more than 45 scientific papers on driving distraction was performed with respect to the driving simulator design and to the sources of driver distractions.

Strategies to Address Distracted Driving

This section contains a review of the FHWA Strategic Highway Safety Plan (SHSP) database

for information about types of distracted driving emphasis area strategies used by each state *[30]*. Currently, 36 states and the District of Columbia have distracted driving either as a stand-alone primary or secondary emphasis area, or combined with other human behaviors under driver behavior areas. Several types of strategies outlined by the SHSPs distracted driving emphasis area, grouped by the strategy type, are shown below:

Data

- Improve data collection, quality, and reporting for distracted-driving crashes
- Evaluate and improve data quality for problem identification and program evaluation
- Improve and diversify data and research statistics, trends, and attitudes
- Explore options for measuring statewide cell phone use while driving (i.e., incorporate the collection of cell phone use into the annual seat belt survey)

Education

- Promote and conduct distracted driving awareness and educational campaigns
- Work with stakeholders to develop/implement statewide, community-based, grassroots, and peer-to-peer outreach efforts to raise awareness about distracted driving
- Explore optional training for distracted driving violations to reduce fines
- Train police officers to investigate/record cell phone usage as a contributing crash factor
- Use public figures in public service announcements on distracted driving
- Provide simulated distracted driving education by using hands-on distracted driving simulators, and partner with AT&T for Don't Text and Drive presentations
- Promote smartphone technologies to minimize distracted driving
- Promote increased hours for driver education and add distracted driving information/questions to driver license test and guide
- Partner with employers to adopt and implement employer policies that prohibit distracted driving
- Expand earned media and outreach of distracted driving by using innovative and unique delivery methods that reach specific segments of the targeted audience
- Educate older drivers on new vehicle technologies at dealerships or senior programs

- Establish “Best Practices” to assist law enforcement in identifying distracted drivers
- Enhance effectiveness and awareness of countermeasures, such as safety rest stops and safe texting areas

Enforcement/Adjudication

- Increase enforcement of existing laws and target high-visibility enforcement to high-crash corridors
- Improve adjudication of current distracted driving laws
- Review/update distracted driving laws to increase fines and points for multiple offenses
- Conduct multi-agency statewide high visibility enforcement campaigns
- Support increased use of roadway checkpoints
- Expand enforcement beyond cell phone use
- Implement and enforce employer policies to eliminate distracted driving
- Increase enforcement of commercial vehicle hours of service regulations
- Track citations written for texting while driving

Engineering

- Use technology to eliminate the use of cell phones and other mobile devices while driving
- Improve infrastructure and roadways to reduce the number and severity of crashes (i.e., geometric alignment pavement markings, raised markers, signs, shoulder and center line rumble strips, transverse rumble strips, stripes, cable barriers, flashing beacons with warning signs, improved way-finding signage, and installation/width of paved shoulders, and expand clear zones by removing or shielding trees and utility poles)
- Use DMS/fixed signs to convey laws and applicability
- Utilize audible/visual warning devices and alarms in work zones
- Provide additional safe stopping and rest areas to distracted drivers

Legislative/Policy/Programmatic

- Research and identify effective policies that can be implemented to discourage all forms of distracted driving
- Promote strong laws on distracted driving and increase penalties for violators of distracted driving laws (including distracted bicyclists)
- Target strategies for teens and youths
- Strengthen Graduated Driver Licensing (GDL) requirements and enhance the GDL law to ban cell phone use by beginner drivers
- Develop a distracted driving action plan
- Classify distracted driving offenses as "moving violations"
- Pass state law that prohibit drivers from using hand-held personal electronic devices at all times while the car is on the road. Ensure violations are reportable to insurance and employers.

Furthermore, the NCHRP *Report 500: A Guide for Reducing Crashes Involving Drowsy and Distracted Drivers* also outlined several strategies that can be employed to reduce distracted driving crashes, as shown below *[31]*:

- Install shoulder and/or centerline rumble strips
- Implement other roadway improvements
- Improve access to stopping and resting areas and improve rest area security and services
- Conduct education and awareness campaigns
- Visibly enforce existing statutes
- Strengthen GDL requirements for young novice drivers
- Incorporate information on distracted driving into education programs
- Implement targeted interventions for the high-risk populations

Distracted Driving Laws

The literature review in this section was conducted to document the existing distracted driving laws in the US and if there is any evidence about the effectiveness of hand-held cell

phone bans in reducing the overall use of cell phone while driving and crashes.

Distracted driving laws in the US can be grouped under three basic categories: hand-held cell phone ban, text messaging ban (all drivers, school bus drivers and novice drivers) and all cell phone ban (school bus drivers and novice drivers). According to the Governors Highway Safety Association (GHSA), as of June 2018 only 16 states (California, Connecticut, Delaware, Georgia, Hawaii, Illinois, Maryland, Nevada, New Hampshire, New Jersey, New York, Oregon, Rhode Island, Vermont, Washington, and West Virginia) and 4 territories (D.C., Puerto Rico, Guam, and Virgin Islands) prohibit all drivers from using hand-held cell phones while driving as a primary enforcement law *[32]*. Regarding text messaging, currently 47 states, plus D.C., Puerto Rico, Guam, and the US Virgin Islands ban text messaging for all drivers (43 states as primary and 4 states as secondary).

Several states have distracted driving preemption laws that prohibit local jurisdictions from enacting their own distracted driving bans: Florida, Iowa, Kentucky, Louisiana, Mississippi, Nevada, Pennsylvania, Oklahoma, Oregon, and South Carolina *[32]*.

Louisiana has hand-held cell phones ban just for learner or intermediate license drivers (regardless of their age), all cell phone ban as a primary law just for school bus and novice drivers (first year of license and for less than 18 years old), and text messaging ban for all drivers as a primary law. Louisiana also bans using a cell phone or other mobile device while driving through a school zone during posted hours. Furthermore, Louisiana is one of the states which has preemption laws that prohibit local jurisdictions from enacting their own distracted driving bans.

Due to the massive increase in cell phone and other electronic device usage while driving, as well as rises in fatalities and injuries caused by distracted driving, states are continuing to push for stricter laws. For example, the new Washington State distracted driving law (known as E-DUI), effective as of July 23, 2017, bans the use of all hand-held devices including cellphones, tablets, laptops and video games while driving even when stopped in traffic. That means no texting, checking social media, watching videos, using the camera or talking with

the device in hand. Using a hand-held device while driving is considered a primary offense and fines start at $136 for first citation, increasing at $234 for second citation, and furthermore the violations will be reported to the insurance companies. This new law was drafted due to a huge jump in fatalities caused by distracted driving, a 32 percent increase from 2014 to 2015.

Effectiveness of Hand-Held Cell Phone Bans

Several studies that looked at the effects of hand-held cell phone laws on actual crashes, citation data, and hand-held cell phone use have been identified and reviewed. The following paragraphs summarize the studies published in peer-reviewed journals or technical reports all of which were conducted in the United States and are grouped by state. This is by no means an exhaustive compilation of hand-held cell phone bans effectiveness literature.

California. A study done by the California Department of Motor Vehicles evaluated the impact of California's hand-held cell phone ban that went into effect in 2008 by performing an analysis of cell phone-distracted crashes *[33]*. The study examined crash data between 2003 and 2011 at crash level and driver level. The crash analysis revealed that most crashes in California did not involve inattention and when they did, non-cell phone inattention was more common than cell phone inattention. Hand-held cell phone use was more common in crashes than hands-free use. It was also found that the most common primary crash factors for cell phone-related fatalities and injuries were traveling at an unsafe speed, improper turning, traffic signal and signs, driving under the influence of alcohol/drugs, and automobile right-of-way. Regarding the driver level, it was found that drivers in the age group 21 to 30 accounted for the largest percentage of all drivers in cell phone-related fatalities/injuries, and those drivers were predominantly male. No strong conclusions to support the effectiveness of this law were extracted from this study. The study recommended further research with more advanced statistical analyses and incorporation of information obtained from individual driver records in order to determine if California's cell phone law is working.

Another study performed by Burger et. al. examined California's cell phone ban

effectiveness on reducing number of crashes on California highways *[34]*. The study analyzed over 500,000 highway incidents (including vehicular collisions) from January 1 to December 31, 2008, a six-month window on either side of state's ban. The findings showed little evidence of a decrease in crashes due to California's hand-held cell phone ban.

New Jersey. Since March 1, 2008, New Jersey bans the use of wireless telephone and electronic communication devices while operating a motor vehicle. A study performed by Maher and Ott in 2013 analyzed the effects of New Jersey's legislation on actual crash and citation data as well as on driver attitudes toward the legislative ban *[35]*. The study analyzed crash data for years 2006 through 2011, comparing the number of overall crashes to the number of crashes attributed to cell phone use and the number of overall citations written statewide to the number of citations written for illegal cell phone use. The results showed that overall crashes and injuries declined through 2011. The actual hand-held cell phone crashes initially declined but increased after the first year of the ban. Citations issued by law enforcement in cell phone related crashes also increased. Furthermore, this study surveyed New Jersey drivers to assess the public attitude towards distracted driving, including opinions, driving habits, and normal cellular phone usage. The results indicated that drivers were knowledgeable about this law but admitted to violating it anyway.

New York. In 2001, New York became the first state to enact the ban on drivers' hand-held cell phone use while driving. McCartt et al. examined the effects of legislation on driver hand-held phone use in New York and Connecticut over different periods of time *[36]*. Connecticut was used for comparison because it was an adjacent state without such law at that time. In New York the overall use of hand-held cell phones declined substantially in the first few months, from 2.3 percent pre-law to 1.1 percent shortly after. In comparison, overall use rates in Connecticut did not change before and after the ban was enacted in New York. One year later in New York the initial decrease dissipated and the cell phone use was 2.1 percent higher than immediately after and in the same time the publicity of the law declined after implementation *[36]*. The study noted that enforcement campaigns accompanied by publicity appear necessary to achieve longer term compliance with law.

In another follow-up multi-state study, McCartt et al. evaluated the long-time impact of the same law in New York, Washington DC, and Connecticut *[37]*. Trends in hand-held cell phone use were modeled using Poisson regression to estimate differences between actual rates and rates that would have been expected without the ban. It was observed that in New York, the cell phone use declined 47 percent immediately after the ban and 7 years later the use was 24 percent lower than expected without the ban. This means that hand-held cell phone use increased after the ban but at a rate much lower than predicted to happen if the ban has not been implemented. In Connecticut the cell phone use declined 76 percent immediately after the ban and 3.5 years later was 65 percent lower than would have been expected without the ban. The study concluded that the bans appear to have lasting effects on driver behaviors as shown by maintained reductions in hand-held cell phone use for the long term.

Nikolaev et al. studied the impact of hand-held cell phone use on traffic safety in New York *[38]*. The study compared the accident rates in all New York State counties for pre-law (1997–2001) and post-law (2002–2007) time periods and found that the ban had significant effects in reducing the mean fatal accident rate and the mean personal injuries accident rate. However, this study has several limitations as noted by authors and further analysis was recommended to account for unknown factors. In a follow up study, Sampaio accounted for unobservable variables (by using Pennsylvania, a state that did not have hand-held ban, as a control group) in his analysis and reached the same conclusion that the New York hand-held cell phone ban appears to have a negative effect on fatal automobile accidents *[39]*. Jacobson et al. improved the results of Nikolaev et al. by controlling for more confounding factors as well as grouping the New York State counties by driver density and developing an estimate for each of these groupings *[38, 40]*. Pennsylvania was again used as a control state. The findings showed that the hand-held ban in New York was effective in reducing accidents in all but very rural counties. Furthermore, counties with higher driver densities showed higher effectiveness in reducing the rates of personal injury accidents *[40]*.

Washington, DC. The short-term and long-term effects of Washington, DC's hand-held cell phone law (effective July 1, 2004) on hand-held cell phone use was evaluated by McCartt et al. in several studies *[37, 41, 42].* The short term effects were analyzed several months before and again several months after the law took effect through daytime observations at signalized intersection. This study showed that observed cell phone use dropped nearly 50 percent, from 6.1 percent before to 3.5 percent immediately after the law went into effect *[41].* When the observed cell phone use was measured one year later it was found that it is still significantly lower (4.0 percent) than baseline *[42].* The cell phone usage while driving was also measured 5 years later and it was observed that the rate was 43 percent lower than would have been expected without the ban *[37]*. These studies show that the cell phone bans have reduced hand-held cell phone use and appear to maintain reductions for long term. However, it is not known if drivers switched to hand-free devices.

In a recent study, Rudsill and Zhu assessed the association between hand-held phone conversations and universal hand-held cell phone bans by analyzing the data from 2008-2013 National Occupant Protection Use Survey *[43]*. The results of this study suggest that the bans were associated with significantly lower hand-held cell phone conversations across all driver subgroups, including those of different ages, sexes, races, and geographic locations. However, these findings are arguable given the limitations of observational surveys as noted by the authors in the study.

Distracted Driving Employer Policies

The literature review in this section focused on reviewing what kind of employer policies or guidelines exist, which companies have implemented these policies, and consequences/effectiveness of employer policies, if any. Regarding consequences/effectiveness of employer policies on crashes or cell phone use little information was found.

With the popularity of cell phones and other devices increasing, distracted driving has steadily become a more prevalent problem. Due to the high risk of employees driving while distracted, businesses have had little choice but to begin implementing their own policies

regarding using phones while driving. A simple example of this is a distraction-free driving policy that a business can have its employees to sign. This is a cost-efficient way to encourage distraction-free driving, relying greatly on honesty and integrity.

The National Road Safety Partnership Program of Australia published a guide for creating a cell phone use while driving policy, which includes why such a policy needs to be developed, how to develop the policy, policy templates, and surveys *[44]*. The National Road Safety Partnership Program also outlines leadership, education, communication, training, analysis, and enforcement as key elements in developing a successful cell phone policy. The templates provided address the objective, scope, policy, responsibilities, and breach of policy as a guide to help employers develop their own rules and regulations. Lastly, the surveys are directed toward worker mobile phone risk and manager mobile phone risk, focusing on identifying how crucial cell phone use while driving is to productivity *[44]*.

Likewise, the National Safety Council (NSC) released a kit to aid employers in protecting their employees from distracted driving. Their guide breaks down effective implementation of distracting driving policies into three sections: understanding the issue, building buy-in from leadership, and educating the employees *[45]*. The NSC also published a document outlining employer liability when it comes to cell phone policy *[46]*. The purpose of this document is to inform employers of the urgency and importance of enacting a cell phone policy for their employees. The NSC stated that following the law is not enough, as the laws represent the bare minimum and do not necessarily equate to safety. Employers must take it upon themselves to ensure a safe work environment. The document includes guidelines for what to include in the policies, as well as provides in depth information of what can happen if the employer is sued after a crash *[46]*. The kit highlights that a cell phone policy should include hand-held and hands-free devices, all employees, all company vehicles and cell phone devices, and all work-related communications. Furthermore, employers need to educate all employees about the policy, enforce it, monitor compliance, and address violations. Lastly, the document has case studies of employer lawsuits that have to do with distracted driving with a cell phone that range in settlements anywhere from $500,000 to $8.7 million. These crash scenarios highlight business-related crashes, including driving during

work hours, employer-provided and employee-owned vehicles and cell phones, and driving to or from work, all of which resulted in employer liability *[46]*.

The Texas Department of Insurance has a workplace program enacted to prevent the use of cell phones while driving. This program can be used as an outline by any company, and urges employers to prohibit any cell phone use that violates laws or that it otherwise unsafe, enact a policy that reflects the organizations risk tolerance, and reinforce regularly *[47]*. Also included in the policy is a sample print out, similar to the one mentioned previously, for both employees and their supervisors to sign *[47]*.

Since this method of trying to reduce distracted driving has the most established foundation, many companies, such as Owens Corning, have adapted a policy of this nature. Owens Corning used the NSC Cell Phone Policy Kit and videos as the groundwork for their plan for their drivers to use neither hand-held nor hands-free devices, as well as required their CEO to follow the policy for 90 days before implementation *[48]*. The CEO then testified that following the policy for 90 days had no interference with his work, showing other employees that it is feasible to implement. In addition, Owens Corning came up with fourteen tips to assist with employee compliance. These tips include suggestions such as making it clear on the employees' voicemail messages that they are a cell-free driver and will return their call when they can safely do so, as well as to plan rest periods every two or three hours to return calls and messages *[48]*. The company's Internal Communications and Corporate Media Relations Leader admitted that once the initial buzz of the policy dies down, they may encounter problems trying to keep the material fresh and interesting *[48]*. Owens Corning received the 2014 Green Cross for Safety medal from the NSC for their policy, and cited a 95 percent reduction in recordable injuries over the previous 12 years *[49]*. However, there is no data suggesting how much of this is from the cell phone policy, which was implemented in 2011 *[50]*.

Like Owens Corning, Cummins, Inc. also used the NCS's tools for enacting a cell phone distracted driving policy *[51]*. Cummins chose to enact a hand-held and hands-free cell phone ban when creating its Driver Safety program, due to the overwhelming data showing

that the two are nearly equally as distracting. Their policy states that every single employee has to review and sign their safe driving pledge, which states that anyone driving a vehicle for anything related to Cummins, Inc. must not use any cellular devices. Only after signing the pledge do people declare themselves drivers or not. If they are a driver, they must complete additional training on safe driving practices. Unlike Owens Corning, Cummins did experience a disruption in work patterns, and employees had to shift their call schedules to only scheduling calls during stops. According to Cummins, Inc.'s Internal Communications and Global Road Safety and Special Projects Leader, the most difficult part of the implementation was introducing the program to almost 50,000 employees, but that after the implementation crash rates have declined; however, the company does not specify how much the crash rates have declined by *[51]*.

At the federal level, several agencies passed rules that prohibit texting and/or using hand held cell phone while driving. Former President Obama issued an Executive Order on October 1, 2009, which prohibits federal employees from engaging in text messaging when driving government-owned, government-leased, or government-rented vehicles, or privately-owned vehicles on official government business, or when using electronic equipment supplied by the government while driving *[52]*. The Federal Railroad Administration restricts the use of mobile telephones and other electronic devices by railroad operating employees in trains and on the ground around trains *[53]*. The Federal Motor Carrier Safety Administration and Pipeline and Hazardous Materials Safety Administration passed a joint rule, effective January 3, 2012, to restrict the use of hand-held mobile telephones by drivers of commercial motor vehicles *[54]*.

Technologies to Prevent Distracted Driving

Cell phone blocking technology has been introduced to try to counter the distracted driving problem. This technology can do anything from prohibit calls and texts to block audio features and certain apps. The cell blocking technology can come in the form of a service on a wireless plan, an app on a phone, or installing an in-car device that puts a virtual barrier around the driver *[55]*. There are numerous apps available to drivers that help curb phone use while driving, with some taking advantage of cell blocking technologies and others

taking a different approach. The following paragraphs provide a summary of these apps, with the statement that the intention was to provide examples and not a comprehensive list. Focus is an app that does not lock the phone while in use, but instead starts off with gentle reminders to pay attention while driving. If the driver keeps using their phone, the reminders get more aggressive. The user also gets report cards emailed to them to see how they did. Focus is unique in that it also works while walking and texting, encouraging the user to stop looking at their phone. Focus is available for free for iOS users only *[56]*.
LifeSaver is an app that approaches the problem of distracted driving from a parental standpoint. This app runs silently in the background, blocking Android users' phones and showing a "Keep your eyes on the road" message for iPhone users while the car is in motion. While the car is in motion, drivers still have access to navigation apps. The Lifesaver app takes distracted driving prevention even further by allowing access to the driver's behaviors to their loved ones. A loved one can monitor the driving through the driver portal, and can even reward the driver for their safe behavior. If the phone needs to be used by a passenger, the 'Passenger Unlock' feature can be enabled, which then sends a text notification to the loved one monitoring the driving. Parents even have the ability to remove the passenger unlock capability. The fleet option and parent portal do cost to obtain, but the apps for everyday drivers is free for Android and iOS users *[57]*. One notable complaint on the app's review page from an insurance agent is that even though the phone silences notifications, all of those notifications can get pushed to the driver's smart watch, which can prove to be even more distracting *[58]*.

Continuing with apps that help prevent distracted driving is TextLimit, available for iOS, Android, and Blackberry for $24.99 per phone per year. TextLimit is unique in its feature of using cell block technology to allow phone features to be disabled below a specified speed that the user chooses. TextLimit also has an option for fleet use, allowing the employer to limit a phone's screen while driving, receiving speeding alerts, obtaining a history of where the phone has been, and receiving an alert if the employee deletes or disables the app. The fleet option comes at the same price of $24.99 per phone per year. TextLimit has several videos showing how the app looks on different devices, but it should be noted that this app appears to be more outdated and overpriced compared to similar options *[59]*.

AT&T DriveMode is another app that is free for both iOS and Android. AT&T DriveMode can silence incoming calls and alerts, automatically reply to text messages letting friends know that the user is driving, and allows access to music and navigation. DriveMode turns on when the vehicle is moving at 15 mph, and also sends a text message to a parent if the app is turned off, auto-mode is disabled, or a new speed-dial number is added. The website does not mention how to unlock the phone if the user is a passenger *[60]*.

Another app that targets distracted driving is eBrake. eBrake uses vehicle motion detection to restrict the driver from using their smart phone. eBrake has a proprietary unlock test that can be completed by a passenger so they can have unrestricted access to their phone. For the driver, eBrake silences incoming calls and texts, but allows access to music, maps, the ability to call 911, and voice activated features like Siri. eBrake does not require any in-vehicle hardware, and users can even schedule a free demo. Claiming to be the only mobile option that cannot be turned off by a driver, eBrake is not yet available in the iOS App Store or Google Play *[61]*.

Probably the most popular distracted driving app is Drive Mode, with almost 23,000 reviews in the Google Play store and over one million downloads. Drive Mode does not make the driver's phone unusable, but instead enhances the features to make it quicker and safer to use while driving. Drive Mode allows for voice activated messaging through several apps, including Facebook Messenger, WhatsApp, and Slack. It also allows access to Spotify, Google Play, Pandora, and other music apps aside from the default one. Waze, Mapquest, Sygic, and other navigation apps are also all available for use while driving, as opposed to only Google Maps. They have branded a "no look" interface that allows for more voice activation and larger, brightly colored icons on the phone's screen. Drive Mode is completely free, and has partnered with Automatic, Vinli, and KKP Controller to allow those users to even more features and data. Drive Mode is available for Android only *[62]*.

Aside from app-only distracted driving prevention, there are several options that utilize hardware in the vehicle. A standout for this category is Groove, created by former NASA (National Aeronautics and Space Administration) engineer Scott Tibbitts. Tibbitts was able

to convince Sprint to partner with him to allow his company to use their network to stop texts. By using telematics, Tibbitts created a small black box that sends a wireless message that the car is moving to the servers. Simultaneously, the cell phone sends its own message about its location to the servers for Groove. An algorithm then determines who is the driver of the car based off of where other drivers are currently located. Unlike other options, Groove does not need an app download. Thanks to Sprint, everything is conducted through the black box *[63]*. Groove does not provide any pricing information on their website, but there is an option to sign up for a waitlist for a rewards program that rewards safe driving through Groove. The most unique aspect of Groove is its ability to block messages from coming through, as opposed to just silencing the notifications. After arriving at the end destination, all texts and calls will then be received *[64]*.

Ford is another major company to try their hand at distracted driving prevention. Ford MyKey technology allows parents to program their teen's key to a restricted driving setting. MyKey is hardware-only, comes with several Ford models, and can also be added to a custom model. MyKey has four programmable driving modes, including a seat belt reminder with the message center displaying "Buckle Up to Unmute Radio," limiting the vehicle's top speed to either 65, 70, 75, or 80 mph, blocking stations labeled "explicit," and an earlier low-fuel warning. There are also a few other options such as parking aid, limiting audio value to 44 percent of total volume, and limiting tire spin. Like LifeSaver, this particular distracted driving measure is heavily parent- or guardian-based. MyKey costs vary depending on vehicle model and the amount of options *[65]*.

Another form of distracted driving prevention entering the work place is cell phone blocking technology. Cell phone blocking technology is a third-party application installed on a phone that detects when the phone is moving, and prevents activities like answering or placing calls and sending or receiving messages from happening *[66]*. In a study of cell phone blocking done on a medium-sized organization, participants overall responded that they were in slight disagreement with their employer blocking their cell phone use while driving. Regarding software-only and hardware-only applications, the software-only applications were received more negatively, likely due to the reduction of battery life. Even with the cell phone

blocking application, overrides were performed at a rate of 1.06 per day for the software-only group with 1.53 phone operations being performed per override *[66]*. Three of the seven managers at the company reported negative productivity impacts from the cell phone blocking application, while four reported no impact. In addition to not having much employee support for cell phone blocking, there are also a lot of external factors that would need to be considered before implementation into a company. These include employees having their own personal cell phones that they can still receive calls on, an override procedure that is possibly more distracting than answering a call, and the severe effects on phone battery life. The report states that there was no evidence of any significant positive lasting effects after the cell phone blocking technology was removed *[66]*.

Apps that Track Driver Behaviors

Smartphone applications designed to track driver behavior came into the spotlight in the late 2000s. Some of these original apps include Sprint Drive First, FleetSafer, DriveSafely, Textecution, Cellcontrol, and KyrusFleet, with a few of them still functioning today *[67]*. Most of these focus on reducing distracted driving. Within recent years, competing for the lowest insurance rate has become a popular subject, and getting a lower rate can sometimes require proving that you're a safe driver. This is where the more recently developed apps enter the market. Newer apps actually track driver behavior, and often give the driver a score of how well they drive. There are also apps that have a mix of both distracted driving prevention and driver behavior tracking.

Betterways is one of the many apps that tracks driver behavior. Available on both Android and iPhone, Betterways works through app and does not require any hardware to be installed. It is free for up to two people, $14/month per person for 3-10 people, $13/month per person for 11-20 people, and $12/month per person for 21-40 people. These options make it a great choice for both personal and company use. Betterways calculates a driving-behavior score through motion and location data for each drive, and since it is app-only, it can be used with any car. Betterways also has a unique feature of an On/Off Duty button. This is especially convenient when using the app for business, because the driver can choose drives that are only done during work hours. This way, the employer will have no access to the drives that

are done on personal time. A downside to Betterways is that the driver must switch to "On Duty" for the app to track behavior. It is also the responsibility of the employer to incentivize the app and encourage drivers to use it *[68]*.

EverDrive is another app-only tracking system for individuals. EverDrive was created by the team behind EverQuote, a website used to find cheaper car insurance. This app is available on both Android and iPhone for free, and shows trip summaries and details on maneuvers by automatically detecting when driving starts and stops. EverDrive even allows users to compete with friends, family, and other drivers nearby for the best driving score *[69]*. Data such as accelerometer, device screen usage, time of day, GPS location, gyroscope data, and an email address is all used. The driving score is calculated by comparing the driver's speed to posted speed limits, monitoring harsh acceleration, braking, and cornering, and phone distraction. Google maps and Bluetooth device connection do not count as device screen usage *[70]*. EverDrive even hosts an annual giveaway of $1,000 to the safest driver in each state based on driver scores. The EverDrive Safe Driving Challenge kicked off on June 7 and ended on Labor Day to promote the 100 deadliest days of driving for teen drivers *[71]*. A notable downfall of EverDrive is that it does not work if the phone battery is at 10 percent or less. Like Betterways, it can be used with any vehicle *[70]*.

As previously mentioned, some systems track driver behavior as well as help prevent distracted driving. CellControl is one of the older apps on the market, but is still very popular. Using a hardware device mounted on the windshield, CellControl can be used to prevent distracted driving by customizing white-listed numbers and blocking certain apps. This allows for users to accept phone calls from important contacts, and still be able to use navigation and music apps. CellControl also comes with detailed reports on driver performance that measures braking, acceleration, speeding, and device usage *[72]*. CellControl offers two purchasing options. Users can have access to the distracted driving features only for $7.95/month, or can have access to distracted driving and driver performance for $9.95/month. Both require a onetime $39.95 activation fee. CellControl works on iPhone and Android, and all vehicles *[73]*.

In addition to CellControl, bSafeMobile also acts as a distracted driving tool while tracking driver behavior. bSafeMobile works with an OBD-II (On-Board Diagnostics) port and Bluetooth to connect to an app for iPhone or Android. The app is free, and only the OBD-II needs to be purchased. When the vehicle's engine is on, a curtain screen blocks access to the keyboard and screen, and all notifications and alerts are suppressed. The apps track behavior such as the number of times the driver tampers with the screen, how many texts were sent, how many passenger overrides, and many more aspects. These are all used to determine a safe driving score for the driver *[74]*.

Life360 is another popular app used to track driver behaviors. This app is geared towards families who want to keep track of members' whereabouts to ensure safety. In Life360, "circles" can be created, which are essentially groups of users that are able to see each other's whereabouts and message one another. This app also sends an alert to everyone in the group if someone exits a set parameter or gets in a car accident *[75]*. Unlike other apps, there is no scoring of driver performance. Instead, Life360 is focused on keeping families connected and making parents aware of their children's location in case of an emergency. The Life360 website cites stories about tracking down children in attempted abductions, locating children in a storm, and knowing that their child is safe while driving as user stories worth sharing *[76]*. However, the app can also be used to track driver behavior. Life360 contains location tracking, crash detection and emergency response, and weekly driver reports. The weekly driving reports include phone usage, rapid acceleration, hard braking, and top speed, as well as the location of the occurrences *[77]*. Life360 is available for iPhone and Android, and is completely free *[77]*.

Although several apps track driver behavior, this is not necessarily where states get their distracted driving information from. States often get their data from insurance agencies like State Farm or Progressive. These insurance agencies get their data from telematics based OBD-II devices in their insured cars, which is then given to the Department of Transportation. This is similar to the ways these apps get their data, but disregards any information regarding the use of a phone *[78]*.

ACTIONS TO REDUCE DISTRACTED DRIVING IN LOUISIANA

Louisiana adopted the strategic vison "Destination Zero Deaths" and has made tremendous strides in improving traffic safety in the last years. The Louisiana SHSP uses a comprehensive, data-driven, multidisciplinary approach to identify the most severe traffic safety problems and the most effective approaches to solve them *[4]*. Louisiana's efforts on the distracted driving problem have been related to research, crash data collection, education and prevention, legislation and enforcement. An important step forward was adding distracted driving as a stand-alone emphasis area in the 2017 Louisiana SHSP along with the goal to reduce by one-half fatalities and severe injuries by 2030.

Crash Data

Louisiana's crash reports collect driver distractions by code including the following categories: cell phone, other electronic devices, other inside vehicle, other outside vehicle, not distracted, and unknown. HSRG is responsible for collecting, maintaining, storing, analyzing, and distributing crash related data captured from law enforcement and other agencies throughout the state of Louisiana using the state's crash reporting software LACRASH. The SHSP dashboard reports are displayed in very meaningful forms grouped by Emphasis Area Selection, Target Setting, Crash, Driver, Person, Bike Pedestrian, Crash-Normalized, and Person-Normalized to make the data more accessible to everyone. Information about distracted driving contributing factor can be extracted from all these dashboards.

Surveys

In 2018, Louisiana conducted a statewide observational distracted driving survey under a contract funded by the Louisiana Highway Safety Commission *[79]*. The observational surveys were collected for a period of 60 minutes per observational site, for a total of 13,087 drivers (36.2 percent drivers stopped at intersections and 63.8 percent drivers in free-flowing traffic). The findings showed that 31 percent of Louisiana drivers engage in secondary tasks while driving, more frequently when stopped at the intersections than when they are in moving traffic. The most commonly observed distracted driving behaviors were manipulating a phone (7 percent), talking/singing (6.8 percent), holding a phone to the ear (6

percent), and eating or drinking (4 percent). Holding a phone to ear was more prevalent for moving drivers than for drivers stopped at intersections. It was also observed that the rates of manipulating a phone or holding a phone to the ear increased when no passenger was present and the rates for talking/singing significantly increased with the presence of a passenger in the vehicle. Furthermore, the findings indicated that female drivers as well as younger drivers (age 16-25) engage more in distracted driving behaviors.

Communication/Education and Outreach

In terms of communicating the danger of distracted driving, highway safety partners in Louisiana have done education and outreach activities to address distracted driving. Regional safety coalitions collaborate with educators, police officers, and health professionals to engage the public at safety expos, festivals, and school events all around the state. Louisiana Highway Safety Commission supports and funds training and educational programs and projects that address distracted driving. There are young driver programs implemented in different parts of the state that educate drivers aged 15-24 about the dangers of being on the phone behind the wheel. These programs include:

- Think First
- Sudden Impact
- Ready, Set, Drive!
- Alive at 25
- New Driver Simulator Program
- Arrive Alive
- B.R.A.K.E.S. (Be Responsible and Keep Everyone Safe)
- Traffic Safety Diversity Outreach Program

Furthermore, AT&T's *It Can Wait* distracted driving simulator program is being integrated into child seat checks, in-person school talks, civic club presentations, and safety campaigns such as Distracted Driving Awareness Month in April, Drive Safely Work Week and Teen Driver Safety Week in October.

Enforcement

All Louisiana drivers are prohibited from texting while driving but there is no prohibition on cell phone use except for novice drivers, bus drivers, and driving through a school zone during posted hours. Louisiana increased the fines for texting while driving from $175 to $500 for first violation and from $500 to $1000 for each subsequent violation. The enforcement for texting while driving has increased also in the last years. For example, in 2016, the enforcement efforts resulted in 515 texting while driving convictions compared to 461 in the previous year.

Although Louisiana is moving forward in addressing distracted driving, more outcome-specific data is needed to collect to be able to track and measure effects of enforcement efforts, legislation, and education campaigns in Louisiana.

STATE OF THE PRACTICES TO ADDRESS DISTRACTED DRIVING

Developing effective countermeasures for preventing and reducing distracted driving is challenging due to the many difficulties in measuring and observing distracted driving as well as in influencing driver behaviors. A multidisciplinary approach is being used at the national level to combat distracted driving. Behavioral strategies attempt to remove some of the underlying causes and to promote awareness of the distracted driving risks. Unfortunately, studies show that the behavioral countermeasures of laws and enforcement are not enough to reduce distracted driving. Research findings suggest the standard countermeasures should be used in conjunction with other strategies such as safer infrastructure, in-vehicle technology, and education programs to be effective in preventing and reducing distracted driving fatalities and injuries.

NHTSA's report *Countermeasures That Work: A Highway Safety Countermeasure Guide for State Highway Safety Offices* identified three types of countermeasures that can be used to reduce distracted driving *[80]*:

- Laws and enforcement (GDL requirements for beginning drivers, cell phone and text messaging laws, high visibility enforcement),
- Communication and outreach, and
- Other countermeasures (employer programs),

The countermeasure GDL requirements for beginning drivers proved to be the most effective for nighttime and passenger restrictions followed by high visibility cell phone/text messaging enforcement. Unfortunately, the high visibility enforcements are expensive and require 4 to 6 months to plan and implement. The cell phone and text messaging laws have short implementation time and are inexpensive; however, their effectiveness is still to be determined. The employer programs effectiveness is still undetermined *[80]*.

Several state of practices to address distracted driving are discussed in the following sections. This is by no means a comprehensive summary of all distracted driving state of the practices.

Improve Data Collection on Distracted Driving

In order to assess the magnitude of distracted driving, it is critical to collect data to be able to determine distraction as the primary cause of a crash. The types of data that are most commonly collected by states include crashes, distracted driving violations, and surveys for tracking distracted driving.

The fifth edition of MMUCC (Model Minimum Uniform Crash Criteria) (2017) recommends the following attribute values that need to be recorded at a minimum in the crash reports, in terms of action and source:

- Action: not distracted; talking/listening; manually operating (texting, dialing, playing game, etc.); other action (looking away from task, etc.); and unknown
- Source: hands-free mobile phone; hand-held mobile phone; other electronic device; vehicle-integrated device; passenger/other non-motorist; external (to vehicle/non-motorist area); other distraction (animal, food, grooming); not applicable (not distracted); unknown

Surveys (observational and attitudinal) are important source of data collection for distracted driving. At the national level there are several types of surveys that collect distracted driving data, such as NHTSA's National Phone Survey on Distracted Driving Attitudes and Behaviors, NOPUS, and AAA Traffic Safety Culture. These surveys provide data that could be used to understand driver behaviors, to develop effective countermeasures, and to examine trends before and after enforcement campaigns.

Laws and Enforcement of Distracted Driving

Distracted driving laws vary across the United States; to effectively enforce them, the officers must be familiar with the applicable laws in their state/jurisdiction. The enforcement of distracted driving as well as collection of evidence in a distracted driving related crash requires more police officers with specialized skills to detect violations. Sometimes, however, enforcement efforts present challenges for officers, such as when they have to make judgments about driver age (especially for laws that are specific to young drivers) and/or prove/observe the texting behavior.

Lessons learned from high visibility enforcement campaigns implemented in several states:

- High-visibility enforcement campaigns do encourage compliance with state laws.
- Having a strong set of distracted driving laws helps with the enforcement.
- Combining enforcement strategies such as marked and unmarked patrol vehicles, uniformed and plainclothes officers, spotter, stationary, and roving patrol is effective in detecting large number of distracted drivers.
- Conducting officer training, engaging in pre-planning, and creating partnerships with local and state enforcement agencies for enforcement waves to multiply forces are critical for high visibility enforcement campaigns.

Improving Infrastructure

Regarding infrastructure improvement, the strategies for mitigating distractions are focused on making roadways safer and providing safe resting/texting areas. Rumble strips, both on the shoulder and the centerline, could be effective at addressing distracted drivers by warning distracted drivers with noise and vibration inside the vehicle. Research findings from a technology transfer project, funded by Southeastern Transportation Research, Innovation, Development and Education Center (STRIDE) recommended various approaches regarding infrastructure solutions such as rumble strips/rumble stripes, signage, and text stops to be used to help prevent distracted driving crashes and fatalities *[81]*. The survey results indicated that rumble strips are the most common countermeasures used by various states to minimize distracted driving crashes.

Communication and Outreach

According to GHSA survey of the states, 47 states and the District of Columbia have taken steps to implement public information and education campaigns to address distracted driving *[82]*. NHTSA and many other states use social media sites such as Facebook, Twitter, and YouTube to educate the public about distracted driving. Multi-level approaches incorporating technology, visual aids, messages, and videos are successful techniques that can be used to change knowledge, attitude, and behaviors. Implementing innovative education strategies, media campaigns, and partnering with others helps in promoting awareness of distracted

driving and eliminating crashes attributable to distraction.

Example of public information and education efforts:

- Engage schools and communities with safe hands-on activities, driving simulators, to promote distracted driving.
- Collaborate with government agencies and private organizations to educate employee and the general public about the dangers of distracted driving. Many states work with partners such as Ford (Ford Driving Skills for Life program), State Farm, Allstate Foundation, AT&T, and National Safety Council to reduce distracted driving and improve highway safety. Furthermore, many organizations (National Highway Traffic Safety Administration, Ad Council, Mazda, National Organizations for Youth Safety, U-Haul, Clear Channel Outdoor, and iHeartRadio) have joined forces to host a yearly Project Yellow Light/Hunter Garner Scholarship competition.
- Educate citizens about the local distracted driving laws and provide case examples of how police officers enforced the laws
- Update driver education curricula to include information on distracted driving

Some example of communications ant outreach campaigns at the national level:

- Distracted Awareness Month
- High-visibility enforcement campaign “U Drive. U Text. You Pay”

AT&T “Texting While Driving: It Can Wait”

CONCLUSIONS

Distracted driving is a societal issue that results from lifestyle patterns and choices. Nationally, there is a critical need to better understand distracted driving and the contributing factors. Traffic fatalities and injuries having distraction as a contributing factor have increased nationally in recent years. Therefore, distracted driving has become a priority of many states transportation agencies and other safety stakeholders. Louisiana developed its first SHSP in 2006 and updated it twice. In the 2017 SHSP edition, Louisiana added a new emphasis area, distracted driving. The purpose of this study was to conduct an extensive literature review to obtain the state of knowledge of existing research on distracting driving. Specifically, this report focused on ways to measure distractions, strategies, hand-held cell phone laws and their effectiveness, distracted driving employer policies, and technologies to prevent distracted driving, in order to help our SHSP Distracted Driving Emphasis Area Team to develop meaningful strategies and actions to address distracted driving in Louisiana.

In order to assess the magnitude of distracted driving, it is critical to collect data to be able to determine distraction as the primary cause of a crash. The types of data that are most commonly collected by states include crashes, distracted driving violations, and surveys for tracking distracted driving. At the national level, the effects of distracted driving have been measured in several types of studies such as crash data, observational, enforcement, naturalistic driving, and simulations. Crash data studies have shown that distractions contribute to more than 3,000 fatalities every year. Several primary sources of data such as FARS, NASS, and NMVCCS can be accessed to evaluate the effects of distracted driving. NHTSA, through the NOPUS, collects every year observational surveys of driver electronic devices at intersections, just for stopped vehicles, for three types of electronic devices (holding phones to their ears, spiking with visible headsets on, and visibly manipulating hand-held devices). Furthermore, NHTSA conducts national phone surveys on distracted driving attitudes and behaviors to assess drivers' attitudes, self-reported behaviors, and perceptions of safety, cell phone use, laws, fines, and enforcement. Another source that can be used to collect information about distracted driving is the Traffic Safety Culture Index

survey published annually by the AAA. High-visibility enforcement campaigns, conducted in several states, have shown that combining different enforcement strategies and conducting officer trainings are critical for the success of the campaigns. The research on naturalistic driving studies have shown stronger connections between crash risk and driver's engagement in technology-based distractions. All these distracted driving measurement studies have some weakness but their strengths are helpful for understanding how driving performance is affected by distractions. With the availability of data from the SHRP2 NDS, the largest naturalistic study ever conducted in the United States, there are opportunities to improve highway safety through an understanding of driving behaviors.

The number of states that have distracted driving emphasis area in their SHSPs has increased over the last years. Various distracted driving strategies have been used by many states to reduce distracted driving and improve roadway safety. These strategies typically focus on improving data collection, education, enforcement and adjudication, engineering, and legislation.

Nationally there are three basic categories of distracted driving laws: hand-held cell phone ban; text messaging ban (all drivers, school bus drivers and novice drivers); and all cell phone ban (school bus drivers and novice drivers). Currently, 16 states and 4 territories have hand-held cell phones bans for all drivers as a primary enforcement law, while 47 states, plus D.C., Puerto Rico, Guam, and Virgin Islands, ban text messaging for all drivers. The effectiveness of hand-held cell phone bans on crashes showed mixed results: either crashes initially declined but increased after the first year of the ban or no clear conclusion was obtained. Studies done over a long period of time, such as New York evaluation, showed significant effects in reducing the mean fatalities rate and personal injuries rate. The effectiveness of the bans on hand-held phone use while driving appeared to maintain long term reductions in hand-held phone use in several states.

To combat distracted driving, employers have begun implementing their own policies regarding hand held cell phone usage and driving. The National Road Safety Partnership Program of Australia and the National Safety Council released guide/kit to aid employers in

developing a distracted driving policy. These documents include facts about distracted driving, costs employers can experience due to distracted driving, policy templates, surveys, and case studies. The Texas Department of Insurance created tools like a workplace program and safety training talks to discourage distracted driving. Owens Corning and Cummins, Inc. have both implemented employee policies against distracted driving using a variety of these tools. Owens Corning cited a 95 percent reduction in recordable injuries over the previous 12 years, and Cummins, Inc. stated that their crash rates have declined, but did not give a specific number. At the federal level, several agencies passed rules that prohibit texting and/or using hand held cell phone while driving for federal employees. For example, Federal Railroad Administration restricts the use of mobile telephones and other electronic devices by railroad operating employees in trains and on the ground around trains, Federal Motor Carrier Safety Administration and Pipeline and Hazardous Materials Safety Administration restrict the use of hand-held mobile telephones by drivers of commercial motor vehicles.

Distracted driving technologies can be categorized into two separate groups: app-only technology and hardware-only technology. Focus, LifeSaver, AT&T DriveMode, eBrake, Drive Mode and TextLimit are all app-only options. Out of these options, Drive Mode appears to be the most popular, and can be paired with hardware for additional features. Hardware-only options include Groove and Ford MyKey, both costing unspecified amounts of money and having different advantages. Overall, there are varying degrees of distracted driving prevention for drivers, ranging from simply rendering the phone useless while in motion to actually changing the capabilities of the vehicle. However, there is no research data to support the effectiveness of these technologies. Overall, several apps were found that track driver behavior. Four of these apps, Betterways, EverDrive, Automatic, and Dash only track driver behavior. Three other apps, CellControl, bSafeMobile, and Life360 also have distracted driving measures implemented. The price of the apps ranges from being completely free to upwards of $150, depending on if they are app-only or what kind of hardware they require. All of the apps track acceleration, braking, and speeding.

Louisiana adopted the strategic vison “Destination Zero Deaths” and has made tremendous strides in improving traffic safety in the last 10 years. A comprehensive, data-driven,

multidisciplinary approach is used by the Louisiana SHSP to identify the most severe traffic safety problems and the most effective approaches to solve them. Louisiana's efforts on the distracted driving problem have been related to research, improving crash data collection, observational surveys, communication, education and outreach, and legislation and enforcement.

At the national level, the states of the practices to address distracted driving have been focused on multidisciplinary approaches. Developing effective countermeasures for preventing and reducing distracted driving is challenging due to difficulties in measuring and observing distracted driving as well as in influencing driver behaviors. The state of the practices to address distracted driving focus on: improving data collection, collecting observational and attitudinal surveys, enforcement of distracted driving laws, improving infrastructure, communication and outreach. Combining the efforts has shown to be an effective and comprehensive approach; however, further research is needed to prove this.

ACRONYMS, ABBREVIATIONS, AND SYMBOLS

AAA	American Automobile Association
DOTD	Louisiana Department of Transportation and Development
FARS	Fatality Analysis Reporting System
FHWA	Federal Highway Administration
GDL	Graduated Driver Licensing
GES	General Estimates System
GHSA	Governors Highway Safety Association
LTRC	Louisiana Transportation Research Center
MMUCC	Model Minimum Uniform Crash Criteria
NASA	National Aeronautics and Space Administration
NASS	National Automotive Sampling Systems
NHTSA	National Highway Traffic Safety Administration
NMVCCS	National Motor Vehicle Crash Causation Survey
NOPUS	National Occupant Protection Use Survey
NSC	National Safety Council
OBD	On-Board Diagnostics
PSAs	Public service announcements
RID	Roadway Information Database
SHSP	Strategic Highway Safety Plan
SHRP2 NDS	Strategic Highway Research Program 2 Naturalistic Driving Studies
STRIDE	Southeastern Transportation Research, Innovation, Development and Education Center

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