Final Report

Educating the Public about Distracted Driving and Evaluating Distraction-Prevention Technologies

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16. Abstract

Distracted driving is one of the main causes of injuries and fatalities in the United States. 3,142 people were killed, and 324,000 were injured because of distracted driving in 2020. According to previous studies, cell phone use is one of the main sources of distraction while driving. The percentage of young drivers who never text and drive under any circumstances is very low. Therefore, the goal of this study is to educate the public about distracted driving and distraction prevention technologies, and to evaluate these technologies using a driving simulator. To reach this goal, a comprehensive study was conducted on all the technologies related to preventing distractions while driving. These technologies are divided into two main categories. The first category includes technologies that are designed to prevent distraction while driving (e.g., Do Not Disturb While Driving, Lifesaver, etc.). The second category consists of technologies that are designed to keep drivers safe when they are distracted while driving (Head-up Display, Lane Departure Warning Systems, etc.). The study also attempted to educate drivers about distracted driving using an online webinar. The online webinar was held on April 15, 2022. In the webinar, the research team discussed these two categories of distracted driving prevention technologies and distracted driving awareness with participants. The informative fact sheet was developed by the research team and distributed manually and online to Maryland drivers. To evaluate the distraction prevention technologies, the research team used a driving simulator that can replicate real-world traffic situations without endangering drivers. In this high-fidelity driving simulator drivers' behaviors were examined while they used a cell phone blocking app. Some 35 participants drove in a simulated network under four scenarios (no distraction, texting, interacting with a cell phone, and driving with a cell phone blocking app). Participants also completed pre- and post-survey questionnaires. The results of this study support previous investigations regarding interactions with phones while driving. Results showed that drivers deviated from the center of the road, changed lanes significantly more often, and increased their steering velocity while interacting with a cell phone. The impact of cell phone blocking apps while driving was similar to the no distraction scenario while driving. This suggests that using cell phone blocking apps is one of the most effective ways to prevent distracted driving. Survey results indicated that 23% of drivers in the study used cell phone blocking apps before the experiment. However, 88% of the participants had a positive opinion about using cell phone blocking apps and indicated that they would use such apps. These findings support the importance of cell phone blocking apps from a policy perspective and highlight the need to educate drivers about distracted driving prevention technologies.

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LIST OF ACRONYMS

AAOS	American Academy of Orthopedic Surgeons
ACC	Adaptive Cruise Control
AEB	Automatic Emergency Braking System
BAS	Brake Assist System
BSW	Blind Spot Warning
DMS	Driver Monitoring System
DND	Do Not Disturb While Driving application
DSS	Driver State Sensing
FCW	Forward Collision Warning
GPS	Global Positioning System
HUD	Head-Up Display
IIHS	Insurance Institute for Highway Safety
LDW	Lane Departure Warning
LKA	Lane Keeping Assist
MHSO	Maryland Highway Safety Office
MOE	Measures of Effectiveness
NHTSA	National Highway Traffic Safety Administration
TASL	This App Saves Lives
TSEF	Traffic Safety Education Foundation

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ABSTRACT

Distracted driving is one of the main causes of injuries and fatalities in the United States. 3,142 people were killed, and 324,000 were injured because of distracted driving in 2020. According to previous studies, cell phone use is one of the main sources of distraction while driving. The percentage of young drivers who never text and drive under any circumstances is very low. Therefore, the goal of this study is to educate the public about distracted driving and distraction prevention technologies, and to evaluate these technologies using a driving simulator. To reach this goal, a comprehensive study was conducted on all the technologies related to preventing distractions while driving. These technologies are divided into two main categories. The first category includes technologies that are designed to prevent distraction while driving (e.g., Do Not Disturb While Driving, Lifesaver, etc.). The second category consists of technologies that are designed to keep drivers safe when they are distracted while driving (Head-up Display, Lane Departure Warning Systems, etc.). The study also attempted to educate drivers about distracted driving using an online webinar. The online webinar was held on April 15, 2022. In the webinar, the research team discussed these two categories of distracted driving prevention technologies and distracted driving awareness with participants. The informative fact sheet was developed by the research team and distributed manually and online to Maryland drivers. To evaluate the distraction prevention technologies, the research team used a driving simulator that can replicate real-world traffic situations without endangering drivers. In this high-fidelity driving simulator drivers' behaviors were examined while they used a cell phone blocking app. Some 35 participants drove in a simulated network under four scenarios (no distraction, texting, interacting with a cell phone, and driving with a cell phone blocking app). Participants also completed pre- and post-survey questionnaires. The results of this study support previous investigations regarding interactions with phones while driving. Results showed that drivers deviated from the center of the road, changed lanes significantly more often, and increased their steering velocity while interacting with a cell phone. The impact of cell phone blocking apps while driving was similar to the no distraction scenario while driving. This suggests that using cell phone blocking apps is one of the most effective ways to prevent distracted driving. Survey results indicated that 23% of drivers in the study used cell phone blocking apps before the experiment. However, 88% of the participants had a positive opinion about using cell phone blocking apps and indicated that they would use such apps. These findings support the importance of cell phone blocking apps from a policy perspective and highlight the need to educate drivers about distracted driving prevention technologies.

Keywords: Distracted Driving, Distraction Prevention Technologies, Cell Phone Blocking Apps

1. INTRODUCTION

One of the main causes of fatal crashes in the United States is distracted driving. The National Highway Traffic Safety Administration (NHTSA) stated that 3,142 people died in distracted driving crashes in the U.S. in 2020. Additionally, 324,000 injuries resulting from distracted driving were reported in 2020 (*1*). There are several different types of distractions: 1. Visual distractions that cause drivers to take their eyes off the road; 2. Auditory distractions that cause the drivers' focus to change; 3. Manual distractions that take your hands off the wheel; and 4. Cognitive distractions that divert drivers' attention from the road. Moreover, drivers between 15 to 20 have the highest percentage of fatalities from distracted driving (*2*). The percentage of young drivers who never text and drive under any circumstances is very low. All drivers, regardless of age, may drive in a way that negatively affects safety and traffic flow when distracted, yet educating and informing young people about the risks of using a cell phone while driving is needed (*3*).

Although cell phones might help by supplying traffic data (*4*–*6*), one of the most common distractions while driving is using a cell phone (*7*). At least one of the drivers that were involved in a crash caused by distracted driving was talking on, listening to, or engaged in some other cell phone activity at the time of the crash (*8*). When using cell phones or other devices, drivers drive more slowly, with more variation in speed, and look less at the road. In addition, more lane deviations and crashes occur during texting (*3*). Nowadays, there are many ways to limit and minimize cell phone interactions while driving. Limiting the function of cell phones while the car is moving is one strategy for combating distracted driving. Cell phone blocking applications are designed for this purpose. The majority of the time, when a car is moving, the apps can be used to silence the phone, send incoming calls to voicemail, or reply to texts with a preprogrammed response (*9*).

Therefore, this study aims to educate the public about distracted driving and distraction prevention technologies and to evaluate these technologies using a driving simulator.

1.1. Problem Statement

Two main problems have been identified for the purpose of this study. The first problem is that although researchers and authorities know about the issue of distracted driving and have worked to decrease the number of crashes due to distraction, most drivers are not aware of the different aspects of distracted driving's consequences.

The second problem is that despite advances in different technologies to prevent drivers from becoming distracted, the efficiency of these new technologies has never been evaluated. These problems are getting worse due to the increasing use of various in-vehicle information systems, including Global Positioning Systems (GPS), cell phones, and smartwatches. Modern vehicles are using more and more driver assistance technologies such as navigators, parking radars, digital rear-view mirrors, under-car cameras, intelligent headlights, voice-activated digital assistants, etc.

Although these new technologies are very useful, it is still critical that drivers avoid distractions while using them.

1.2. Goal

The main goal of this study is to reduce the number of crashes due to distracted driving by educating Maryland drivers and evaluating available distraction prevention technologies. To reach this goal, the following objectives will be undertaken.

- The first objective is to conduct comprehensive research on all the technologies related to distracted driving prevention.
- The second objective is to educate drivers through different methods, including developing and distributing an informative online fact sheet and an online webinar about distracted driving and distraction prevention technologies. These will inform the public about all aspects of distracted driving and how drivers can prevent crashes due to distracted driving.
- The third objective is to evaluate technologies that can prevent drivers from distractions in a driving simulator, which can replicate real-world situations without endangering drivers. The goal is to evaluate scenarios with and without distractions by measuring different Measures of Effectiveness (MOE), including lateral distance change, lane change, and steering velocity change, etc.

Therefore, the next section of this report includes a review of all the distraction prevention technologies. The third section consists of the fact sheet and the results of the webinar that we developed for the first objective. The fourth section consists of the results of the evaluation of the technologies in the driving simulator.

2. LITERATURE REVIEW

In this section, all the technologies related to distracted driving prevention are described. These technologies are categorized into two main sections. The first section is about technologies that are designed to prevent distractions while driving. The second category consists of technologies that are designed to keep drivers safe when they are distracted while driving.

2.1. Distracted Driving Prevention Technologies

Technologies that are designed to prevent distraction while driving include cell phone blocking apps, plug-in devices, and driver coaching.

2.1.1. Cell Phone Blocking Apps

The use of a cell phone while driving is one of the most common distracted driving behaviors. Apart from texting, one of the most distracting things a driver can do with a mobile phone is look at and browse through maps. There are many ways to limit and minimize cell phone interactions while driving. Phone docks are very useful for navigation purposes. Therefore, if there is a need to utilize maps while driving, using a phone dock to keep the phone in an easily viewable location is very helpful (*10*).

Another type of prevention involves smartphone apps that are designed to block and limit driver distractions. Cell phone blocking technology is often available as a smartphone application and is available via cellular carriers and organizations that specialize in such applications. The most fundamental technologies prevent drivers from making or receiving calls or texts while the vehicle is in motion. More advanced systems are capable of blocking audio features as well as tracking speed and sudden stops. Numerous companies offer text or email warnings to parents of young drivers, providing helpful information to parents while their children are driving (*10*). There are several apps that prevent distraction while driving, including:

- Apple CarPlay

CarPlay is a smarter, safer way to use iPhone while driving. It is a safe way to get to the destination without endangering other drivers. In simple terms, CarPlay beams the apps from the drivers' phone onto the infotainment screen in your car, complete with hands-free operation and a user-friendly interface (*11*).

- Android Auto

Google developed the Android Auto mobile app to display functions from an Android device, such as a smartphone, on the dashboard infotainment and entertainment head unit. Some Android apps can be mirrored on the display of the automobile if an Android device has been paired with the head unit (*12*).

- Do Not Disturb While Driving (DND)

Do Not Disturb While Driving (**Figure 1**) is an iPhone feature that mutes incoming phone calls, messages, and alerts while the driver is driving, allowing them to focus on the road and avoid distractions. Drivers can determine who can contact them while they are driving (*13*).

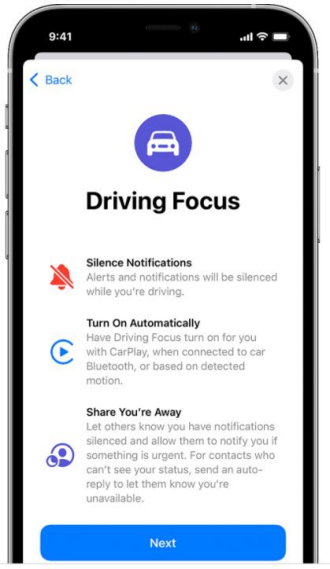

FIGURE 1 Do not disturb while driving (*14*)

- Drive Mode

Drivemode simplifies how drivers manage calls and messages while driving (**Figure 2**). With a streamlined interface to safely answer calls or send and hear messages, Drivemode's voice-enabled commands and large buttons let drivers focus on driving (*15*).

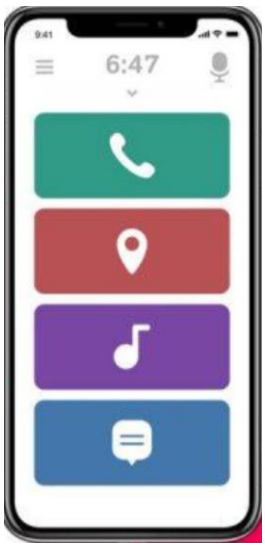

FIGURE 2 DriveMode features (*16*)

- DriveSafe.ly

Drivesafe.ly does not block calls or text messages. Instead, it announces callers by name so the driver can answer with a hands-free method. It also reads text messages and emails aloud if requested by the driver. It can also be set to autoreply (**Figure 3**). That way, the caller or texter receives an automated message stating that the driver is driving and will call them back shortly (*17*).

FIGURE 3 DriveSafe.ly app (*18*)

- This App Saves Lives (TASL)

The aim of this app is to put a serious dent in distracted driving by rewarding individuals who choose not to use their phones while driving. This smartphone app partners with well-known brands to provide meaningful rewards to drivers who choose not to engage in phone-based distracted driving. After downloading the TASL app, drivers earn rewards points for time spent driving undistracted (**Figure 4**). Points are redeemable for rewards from their brand partners both online and in-store (*19*).

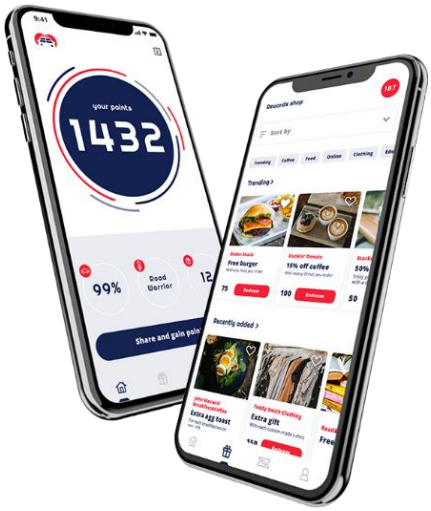

FIGURE 4 This App Saves Lives (*19*)

- OnMyWay

When driving more than 10 miles per hour, OnMyWay automatically enables and disables SMS and app notifications (**Figure 5**). If the phone is linked to in-vehicle Bluetooth, the driver can still make and receive phone calls. Other applications, such as Apple Maps, Google Maps, and music streaming services (Spotify / Pandora), will continue to function if they are activated prior to driving or while stopped (*20*).

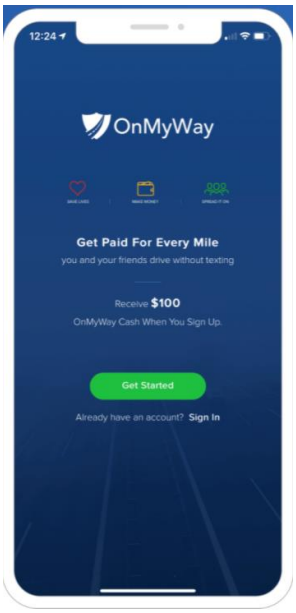

FIGURE 5 OnMyWay (*20*)

- Safe 2 Save

SAFE 2 SAVE aims to minimize distracted driving using rewards for safe driving, and it contributes to a safer community. SAFE 2 SAVE incorporates both a reward system and accountability to people the user cares about, allowing for the change of human behavior patterns that contribute to distracted driving (*21*).

- Lifesaver

LifeSaver deters distracted driving by automatically presenting a lock screen (alert) only if the driver attempts to turn on the phone's display while driving. The driver can open LifeSaver beyond the initial lock screen to perform the passenger unlock action or make an emergency call if these features are enabled within the LifeSaver app settings (*22*).

The lifesaver app emphasizes the fact that teen drivers may need an additional 'nudge' to encourage safe driving, and their innovative rewards system within their Driver Portal facilitates this. Parents can set up monthly rewards which are tied to safer, non-distracted driving; then, the driver portal scores these rewards automatically. Parents choose rewards that work for their teen driver, and the app takes it from there, handling the scoring and notifications. LifeSaver may also sponsor rewards through other programs. Such rewards are handled separately on a program-by-program basis (*23*).

- ZoomSafer

Individual customers who join ZoomSafer can utilize the GPS sensors on the drivers' phones to determine whether they are speeding and deactivate their phones until they come to a complete stop. ZoomSafer may be deployed to a full fleet of vehicles, automatically prohibiting workers from texting, tweeting, browsing, or engaging in any distracting activities that can be done with a phone while driving (*24*).

- Esurance

Esurance can block mobile phone calls, texts, emails, the Internet, or other smartphone apps while the vehicle is in motion. Parents can also receive email notifications if a teen driver attempts to disable or remove the device, delete the smartphone app, or switch off Bluetooth functionality (*25*).

- Evvy

Evvy is a distracted driving prevention app that uses an associated signaling device and a cloud-based dashboard to manage mobile device policies in fleet vehicles (see **Figure 6**). Evvy detects vehicle motion and puts the phone into safe driving mode, preventing dangerous options while keeping drivers safely connected. The app's patented "rogue" device detection capabilities can also identify driver's attempts to circumvent it (*26*).

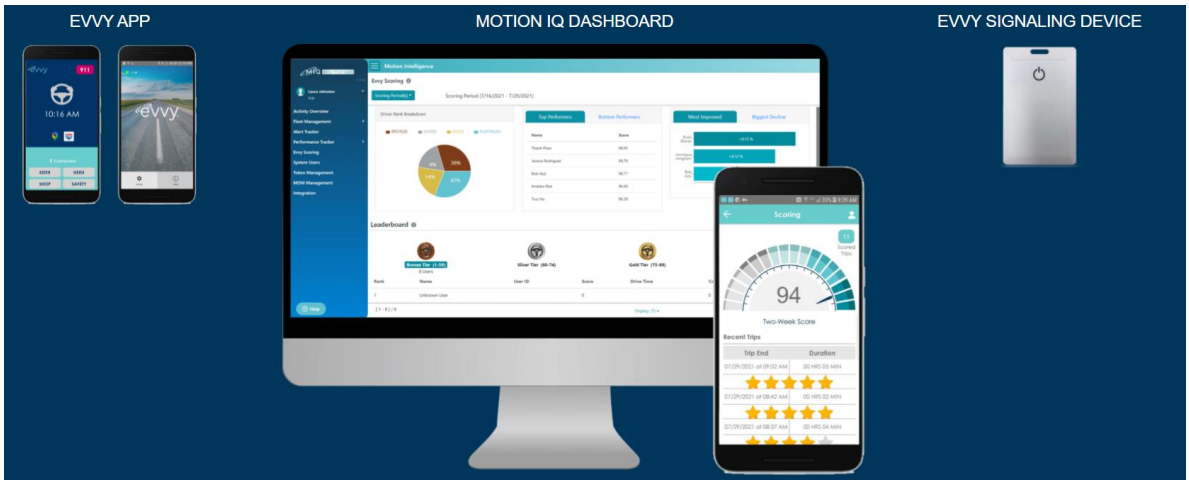

FIGURE 6 Evvy app, motion IQ dashboard and signaling device

- TextLimit

The TextLimit app works in conjunction with the GPS software on the smartphone to detect the speed of a vehicle. Beyond a certain speed, texting and the majority of phone features are disabled; however, emergency 911 features remain available. Licensed drivers in Kentucky and West Virginia can download the app for free on their smartphones (*27*).

- DriveScribe

DriveScribe is a free smartphone application that aims to transform the smartphone from a distraction to a coach by providing motivations for safe driving and generating a spirit of competitiveness among drivers. Following each trip in a motor vehicle, the program assesses the driver's performance and awards points for safe driving. Teens and parents may also monitor this data through a website. Additionally, the program limits distractions by delivering reply messages indicating that the user is driving (*28*).

2.1.2. Plug-in Devices

Numerous devices can be connected to a vehicle to notify the driver's wireless provider that they are driving. They can block all incoming messages and notifications, as well as all outgoing texts and updates. Anyone attempting to send the driver a message will also be notified that they are driving, thereby minimizing the distraction (*29*).

- Groove

Groove is a small device that plugs into a vehicle underneath the steering wheel and connects a driver's device to the cloud, letting their mobile phone provider know that they are driving. The wireless provider blocks all emails, text messages, and social networking updates and prevents drivers from sending messages and posting on social media while driving (*29*).

- TextBuster

The TextBuster system is composed of two parts. The first part is the actual hardware that is bought and installed in the vehicle (**Figure 7**). The second is a smartphone application for Android or BlackBerry phones. TextBuster prohibits the driver from engaging with text messages, instant chats, games, video apps, and social networking sites while driving by disabling alerts and programs (*30*).

FIGURE 7 TextBuster system

2.1.3. Driver Coaching

Another tool that helps drivers improve their driving behavior is the D2Go Driver Challenge, a novel approach to engaging, motivating, and coaching drivers. This method transforms driving into a competition (**Figure 8**). D2Go rates and compares drivers based on specified key performance indicators via the use of gamification. Trends in driving behavior are recorded and evaluated to provide insight into who needs improvement and who deserves appreciation for their efforts (*31*).

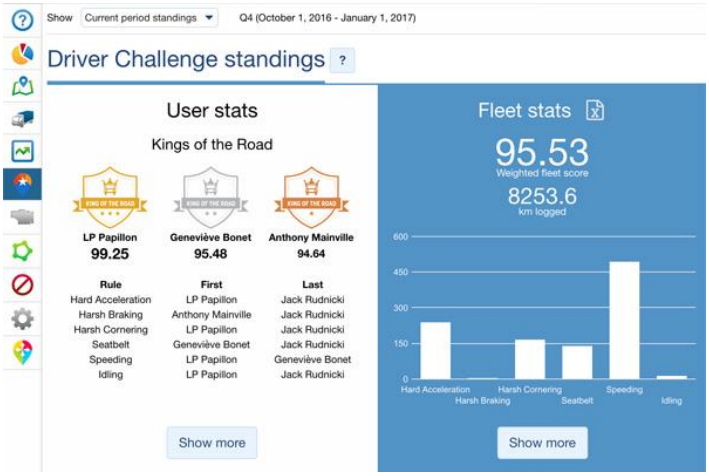

FIGURE 8 D2Go Driver Coaching (*31*)

Moreover, competitions are great ways for communities to be engaged in non-distracted driving. Points can be earned in the competition alongside family, friends, or co-workers. People can organize a competition on their own or join a competition using an invitation code provided by social groups, an employer, or a school. The safe-driving competitions are a fun and engaging way to get students, staff, and the entire community to put down their phones while traveling in a vehicle. Participants are awarded for every minute that they are traveling more than 10 mph and not touching their phones. Leaderboards on the app allow users to see how they are doing in the competition compared to the other participants (**Figure 9**).

FIGURE 9 Driver Coaching Examples

2.2. Safety Technologies for Distracted Drivers

Most new vehicles on the market now come equipped with full-service infotainment systems that enable the driver to operate the navigation, radio, and temperature inside the vehicle. Additionally, the infotainment system may enable the driver to add hands-free capabilities to their phone. As previously discussed, it may also send auto replies informing others that the driver is in driving mode. Connected vehicle (CV) technology also aims to improve drivers' situational awareness through audible and visual warnings, thus reducing the likelihood of crashes caused by human error (*32*). Recent studies have shown that connected vehicles (CVs) can help improve traffic mobility and safety while saving energy and reducing emissions (*33*). Along with these devices that help drivers avoid distractions while driving, there are others that may help lessen the probability of an accident if the driver becomes distracted. Lane departure warnings, automatic cruise control, and active lane assist are several technologies available in today's market (*34*).

2.2.1. Head-Up Display

The head-up display is a device that projects an image directly under the driver's line of sight onto the vehicle's windshield or a panel. Although it is a tool for gathering information, it is also a safety feature. It delivers different types of information without requiring the driver to look away from the road. There are different types of Head-Up Displays (*35*):

2.2.1.1. In-Car Head-Up Display

The built-in Head-Up Display, or HUD system, projects speed and other data onto the windshield of the vehicle. The in-car HUD provided by manufacturers, often including built-in navigation systems, provides for neater packing. The HUD features are integrated into the vehicle and go almost unnoticed by occupants (see **Figure 10**) (*35*).

FIGURE 10 In-Car Head-Up Display

2.2.1.2. Head-Up Display Apps

Several developers have developed HUD applications, which artificially produce a HUD display by reflecting vehicle information from the phone onto the vehicle's windshield in the same way as the built-in HUD does (see **Figure 11**). The driver can simply open the app and place his/her phone on the dashboard near the windshield. Although HUD applications lack the functionality of most built-in HUDs, they may display the vehicle's current speed, and some of them are advanced enough to project navigational information (*35*).

FIGURE 11 Head-Up Display App

2.2.1.3. Third-Party Head-Up Display

Dedicated HUD systems are available from several aftermarket providers. These are little boxes that are installed onto the dashboard of the vehicle (see **Figure 12**) and project a picture onto the windshield. They may be used in many vehicles and plugged into any 12-volt power outlet or OBD2 port (*35*).

FIGURE 12 Third Party Head-Up Display

- HUDWAY

The Hudway Drive system consists of a head-up display and an accompanying free smartphone app called "Drive." With Hudway's HUD, the driver can keep an eye on their speed without looking down and can reduce distractions by quickly discarding unwanted calls (**Figure 13**). In addition, the driver can view see real-time directions in front of them and receive notifications from 10+ messengers displayed right in front of the driver's eyes (*36*).

FIGURE 13 Hudway HUD technology (*36*)

2.2.2. Lane Departure Warning Systems

The lane departure warning is intended to help drivers avoid collisions caused by drifting or departing from their lane. The device recognizes lane markers and notifies the driver when a tire touches a lane marker (**Figure 14**). Typically, the warning is in the form of a flashing indicator or a beep from the corresponding side (*37*). There are different types of Lane Departure Warning and Prevention Systems, as follows:

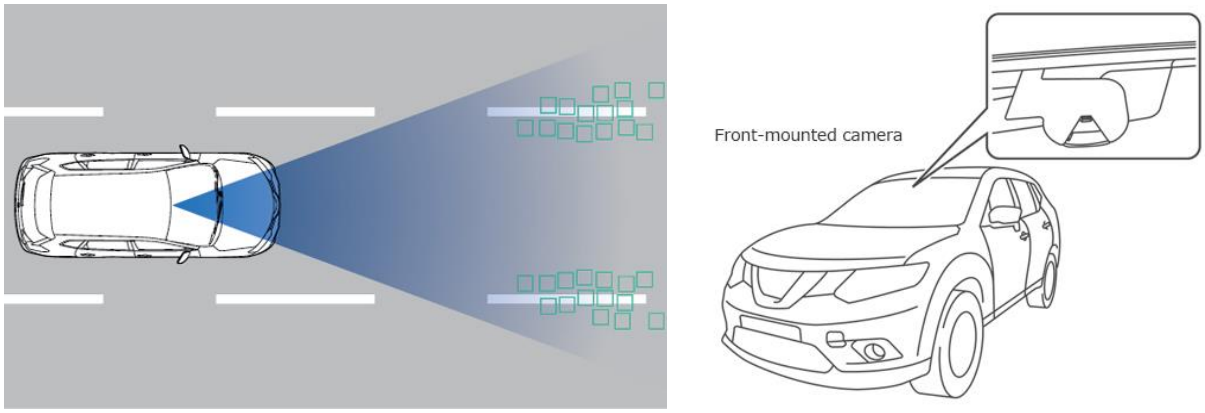

FIGURE 14 Lane Departure Warning Systems

2.2.2.1. Lane Departure Warning (LDW)

This technology is a "warning only" feature. The vehicle warns the driver if the vehicle is drifting near or over the lane marking, and the driver must act by steering the vehicle back to the middle of the lane. However, if there is no lane marking, this feature will not work (see **Figure 15**) (*38*).

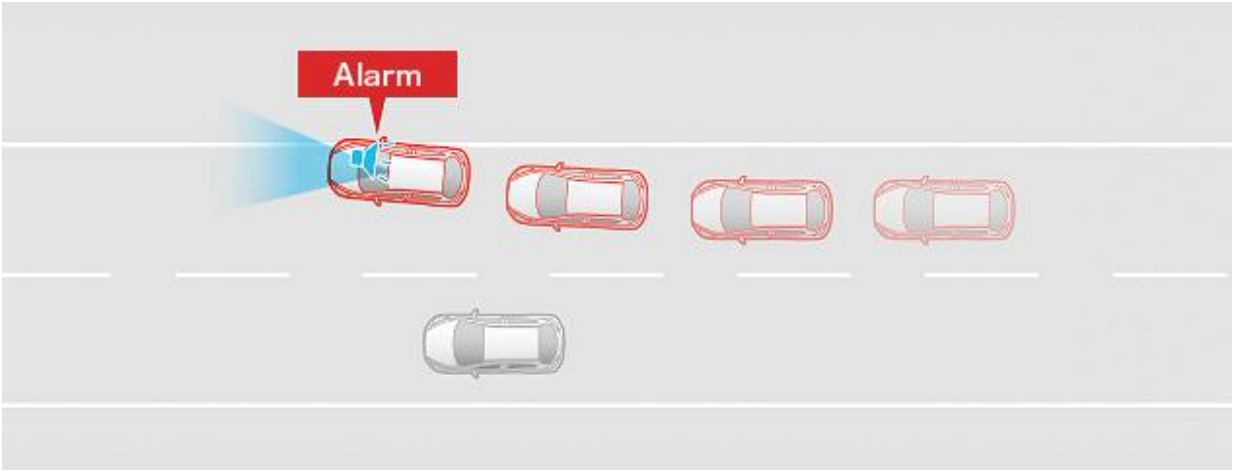

FIGURE 15 Lane Departure Warning (*39*)

2.2.2.2. Lane-Keeping Assist (LKA)

The lane-keeping assist tool can help drivers avoid a crash by returning the driver to their lane if they drift out of its bounds. This function also depends on painted lane lines. If a driver drifts out of their lane, they may receive an alarm, either through a sound, flashing light, or vibration (**Figure 16**). If they do not take action, this function may gently lead them back to the center of the lane (*40*).

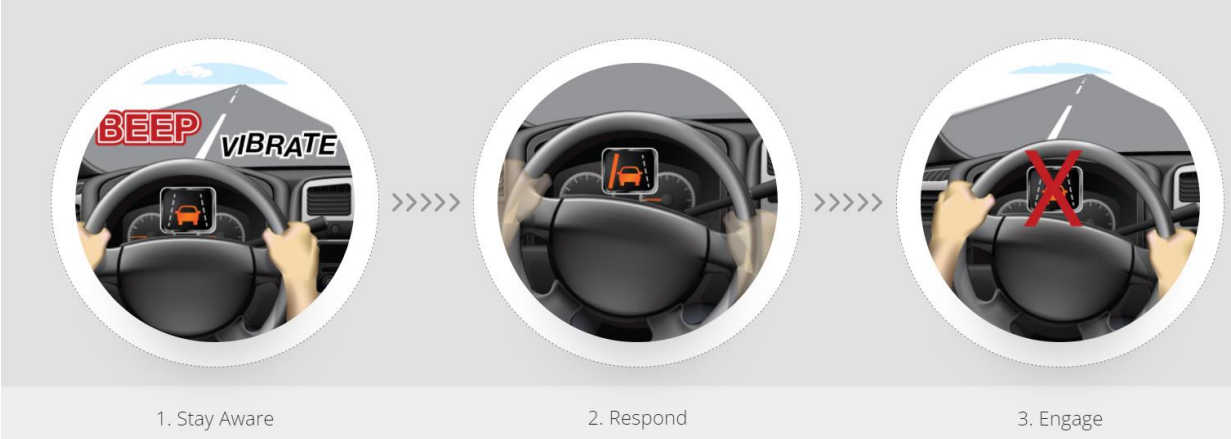

FIGURE 16 Lane-Keeping Assist

2.2.2.1. Lane Centering Assist

Lane centering assist is the newest form of lane departure warning system. Lane centering assist seeks to maintain the vehicle in the current lane. It works if the vehicle detects that a driver is holding the steering wheel lightly and ensures that the vehicle's turns are not too sharp (*38*).

2.2.3. Collision Warning/Avoidance Systems

A collision avoidance system, also known as a driver assistance system, is a safety technology that was developed to avoid or reduce the severity of an accident seconds before it happens. Once a collision has been identified, these systems can inform the driver by sound or light to assist in avoiding the accident. There are different types of Collision Avoidance Systems: (*41*)

2.2.3.1. Forward Collision Warning Systems

Forward collision warning (FCW) systems provide visual, audio, and/or tactile warnings to drivers of an approaching collision with a vehicle or object immediately in its forward path (**Figure 17**). The Insurance Institute for Highway Safety (IIHS) research suggests that FCW decreases rear-end accidents by 27% (*42*).

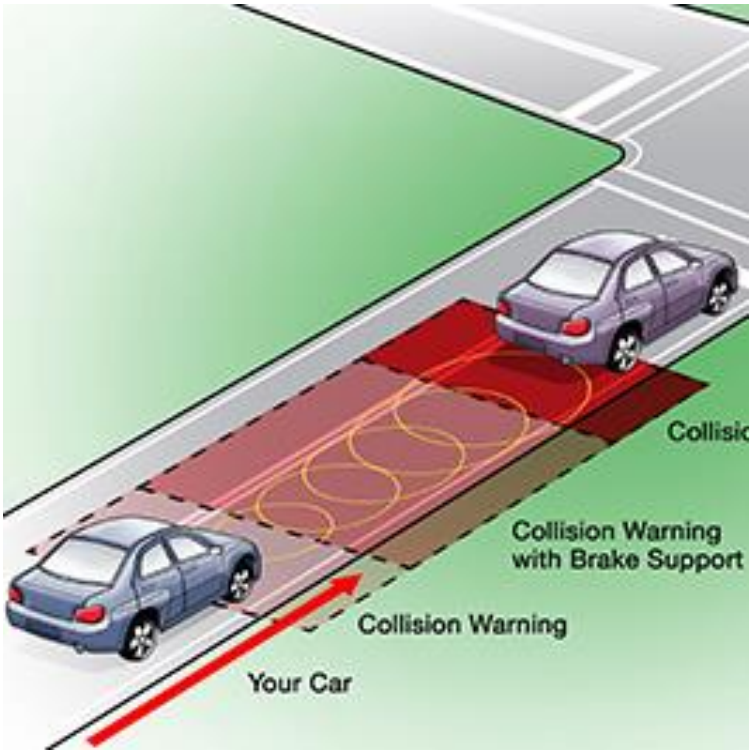

FIGURE 17 Forward-Collision Warning (*42*)

2.2.3.2. Pedestrian Detection System

Pedestrians and cyclists account for approximately a quarter of all fatalities on the road. A pedestrian detection system employs sensors to detect human movement on the road, such as cyclists or jaywalkers. This system assists drivers in spotting a moving object and avoiding it (*41*).

2.2.3.3. Automatic Braking System (AEB)

The Automatic Braking System combines various types of sensors, such as radar, video, infrared or ultrasonic sensors, to scan for possible objects in front of the vehicle and then use brake control to prevent a collision (**Figure 18**) (*43*).

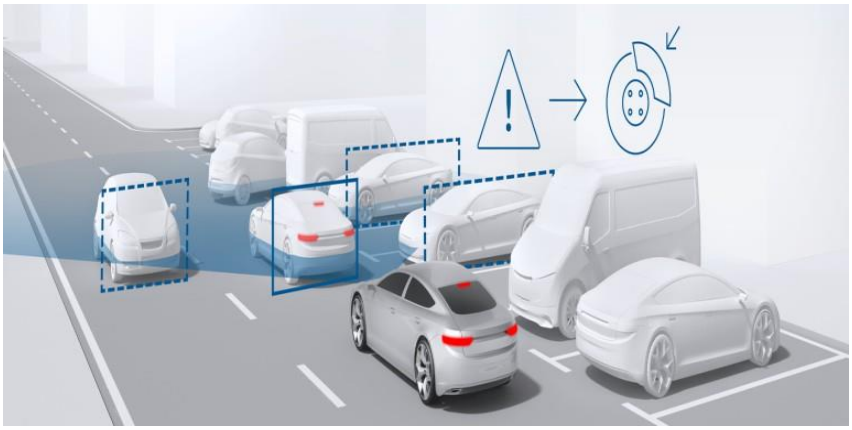

FIGURE 18 Automatic Braking Systems (*44*)

2.2.4. Adaptive Cruise Control

Adaptive cruise control (ACC) is a technology meant to assist vehicles in maintaining a safe following distance and remaining within the speed limit. This device changes a vehicle's speed automatically, so drivers do not have to (*45*). One of the best examples are HOV lanes (which are reserved for vehicles carrying more than two people (*46*)). Vehicles in HOV lanes travel at a constant rate, and drivers entering carpool lanes at a slower pace can lead to rear-end crashes (*47*).

2.2.5. Rear Cross-Traffic Alert

Rear Cross Traffic Alert is meant to assist drivers when backing out of spaces where they may not be able to observe incoming traffic, as sometimes occurs in parking lots (**Figure 19**). Rear cross traffic alerts check two areas behind the driver for vehicles approaching from the right or left sides (*48*).

FIGURE 19 Rear Cross-Traffic Alert

2.2.6. Driver Monitoring Systems

A driver-monitoring system—often called a driver state sensing (DSS) system—is a technological safety feature that employs a camera installed on the dashboard to track driver drowsiness or distraction, as well as to deliver a warning or alert to return the driver's attention back to the task of driving. Driver-monitoring systems (DMS) are likely to become a regular feature in modern vehicles as a consequence of regulatory and rating agency requirements (*49*).

2.2.7. Blind Spot Warning Systems

Blind spot warning (BSW) systems employ cameras, radar, and/or ultrasonic sensors on the outer portion of a vehicle to identify other vehicles that the driver cannot see next to or behind their vehicle (**Figure 20**). The system may send an additional warning if the turn signal is enabled and it is unsafe to merge or change lanes (*50*).

FIGURE 20 Blind Spot Warning System (*51*)

2.2.8. Brake Assist (BA/BAS)

According to studies conducted by vehicle manufacturers, most accidents can be prevented if the driver hits the brakes promptly and with more force after realizing the danger (see **Figure 21**). Therefore, vehicle manufacturers utilized brake assist, an electronic system designed to help drivers in close call or panic situations (*52*).

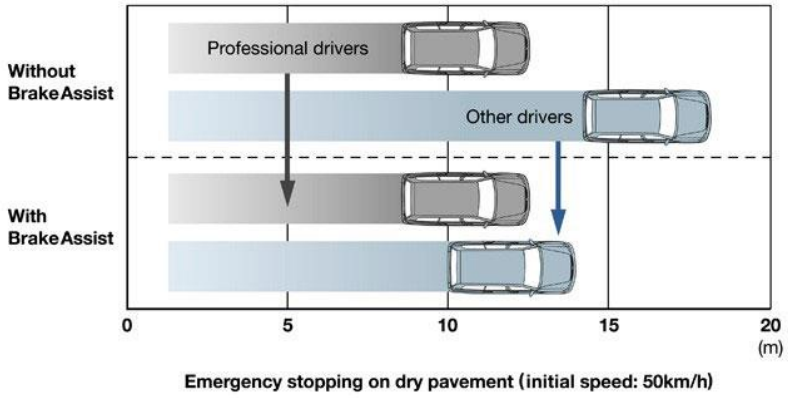

FIGURE 21 Advantages of Toyota Brake Assist

2.2.9. Adaptive Cruise Control

Adaptive Cruise Control (ACC) is the next generation of cruise control systems. With this technology, the driver can use the cruise control to automatically maintain the desired speed. This technique is useful when traveling at a steady pace since it considerably minimizes driver fatigue. All cruise control systems are deactivated when the driver presses the brake or the clutch pedal (*53*).

2.3. Distracted Driving Awareness Campaigns and Education

There are other ways to prevent distracted driving and raise awareness regarding this issue. One way is to educate drivers and residents through campaigns and education. Back in 2010, Congress passed a resolution to create a special month devoted to increasing awareness of the dangers of distracted driving. Ever since then, April has been the official Distracted Driving Awareness

Month, with safety organizations around the country running programs to help encourage drivers to keep their eyes on the road (*54*). There are also several campaigns related to the subject:

2.3.1. U Drive, U Text, U Pay

NHTSA's U Drive. U Text. U Pay. campaign reminds drivers of the deadly dangers and the legal consequences – including fines – of texting behind the wheel (*55*).

2.3.2. The Traffic Safety Education Foundation

The goal of the Traffic Safety Education Foundation (TSEF) is to educate, improve driving behavior, and raise awareness about the dangers of distracted driving. The foundation provides training to companies, parents, educators, and civic organizations (*56*).

2.3.3. "X the text" movement

This campaign was started by AT&T, and it attempted to provide an alternative to texting while driving. The concept was to send a quick answer like the following: #X anytime a driver receives an SMS while driving. Moreover, it is certainly a better option than reading and replying to SMS while driving (*34*).

2.3.4. Decide to Drive

This campaign is funded by the American Academy of Orthopaedic Surgeons (AAOS). The idea is to show the public that there are numerous distractions that may draw a driver's attention from the road, more than the widely recognized distractions of texting and talking on a cell phone (*57*).

2.3.5. It Can Wait

The "It Can Wait" campaign, developed by AT&T and featuring all the major wireless providers, encourages drivers to make a pledge to never text and drive while holding themselves responsible for a loved one. All drivers may take the pledge at ItCanWait.com and share their commitment on social media to promote the no-texting-and-driving movement (*58*).

3. DISTRACTED DRIVING PREVENTION TECHNOLOGIES WEBINAR

On April 15, 2022, the research team conducted a webinar to educate Maryland drivers about distracted driving. **Figure 22** shows the outline of the webinar.

FIGURE 22 Distracted Driving Webinar Outline

The webinar started with an introduction to distracted driving, explaining the issue, relevant facts, and statistics about the dangers of distracted driving. Distracted driving laws and penalties were also explained to the participants. The state of Maryland was then compared to other states with regard to texting and driving restrictions (**Figure 23**). An informative video was presented to the audience regarding this matter as well.

FIGURE 23 Distracted Driving Webinar – Laws and Penalties

After that, the classification of distracted driving technologies was explained to the audience. The first category was distracted driving prevention technologies, and the second category was safety technologies for distracted driving (**Figure 24**). Each technology was explained to the audience thoroughly, and a short video was presented to show the technologies and their implications.

FIGURE 24 Distracted Driving Webinar – Different Types of Technologies

In the distracted driving prevention technologies category, there were four types of technologies, including cell phone blocking apps, plug-in devices, etc. Each type of technology and its examples were explained to the audience (**Figure 25**).

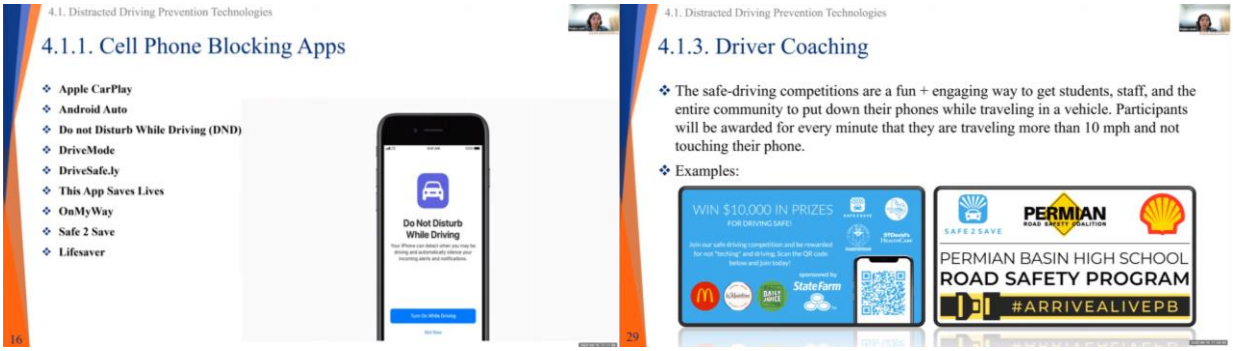

FIGURE 25 Distracted Driving Webinar – Distracted Driving Prevention Technologies

Safety technologies for distracted drivers were also explained, with eight examples of these technologies, such as blind spot warning systems, head-up displays, etc. (**Figure 26**).

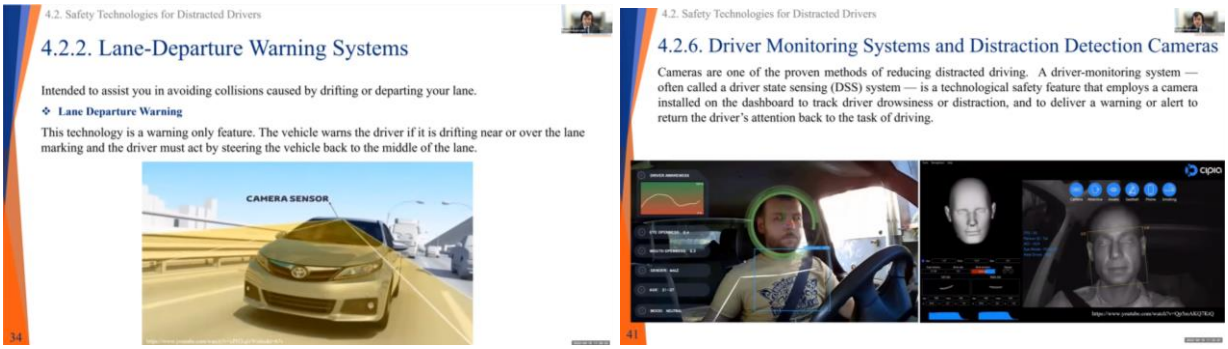

FIGURE 26 Distracted Driving Webinar – Safety Technologies for Distracted Drivers

After explaining the technologies, distracted driving awareness campaigns were explained to the audience (**Figure 27**).

FIGURE 27 Distracted Driving Webinar – Distracted Driving Campaigns

At the end of the presentation, some tips and routines were suggested to the audience to reduce distractions while driving (**Figure 28**), and a video explaining a summary of the webinar was presented to the audience.

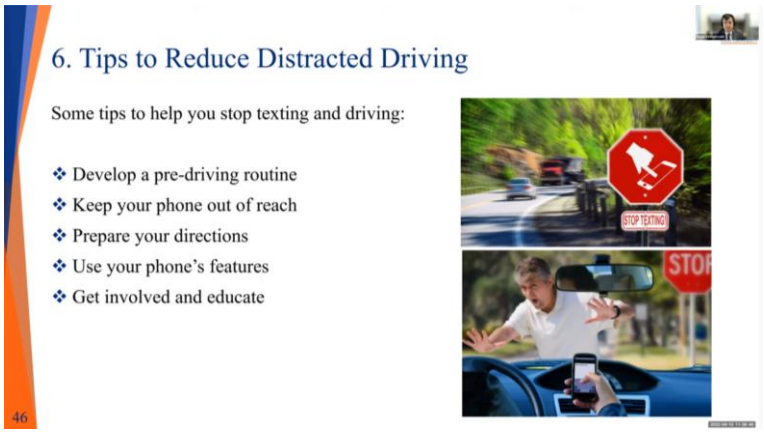

FIGURE 28 Distracted Driving Webinar – Tips

The link to the webinar recording can be found here: https://www.youtube.com/watch?v=hZSlCzH2i2s&list=PL3tN3CUqYVDDIA72q05CVukV3ClLUdDo2&index=3

4. DISTRACTED DRIVING FACT SHEET

One of the main goals of this study was to educate Maryland drivers about the dangers of distracted driving and how they can prevent distractions while driving. For this purpose, after reviewing the technologies in section two, an informative fact sheet was developed by the research team and distributed manually and online to 100 Maryland drivers. The information in the fact sheet includes the link to the recorded distracted driving webinar held on April 15, 2022. All the materials in section two of this report (literature review) and the summary of the materials on the webinar were also included in the fact sheet: Distracted Driving statistics, Distracted Driving Prevention Technologies, Safety Technologies for Distracted Drivers, and Distracted Driving awareness and Education (**Figure 29**).

Contact us for more information

The National Transportation Center (NTC) at Morgan State University advances U.S. technology and expertise in transportation, research, and technology transfer on the university level.
The NTC's current areas of research focus are connected and autonomous vehicles, transportation and traffic modeling, safety and distracted driving, and equity.

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Distracted Driving and Distraction Prevention Technologies

Scan to watch the full webinar

About the webinar

Distracted driving and distraction prevention technologies webinar was held in April 15, 2022.
The goal was to inform the public about all aspects of distracted driving as well as how drivers can prevent crashes due to distracted driving.

National Transportation Center

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National Transportation Center

MORGAN STATE UNIVERSITY
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Distracted Driving

Most drivers are not aware of different aspects of distracted driving's consequences and, they are not aware of the distracted prevention technologies. To have effective countermeasures, drivers should be educated through different methods, including an online webinar about distracted driving. Distracted driving technologies were categorized into two main categories in the webinar:

1. Distracted Driving Prevention Technologies
2. Safety Technologies for Distracted Drivers

Did you know?
Some Apps Pay You to Drive Safe!

There are several smartphone apps that pay their users not to use their phone while driving.
Users get paid for every mile they do not text and drive and can refer their friends to get compensated for them as well. The money earned can then be used for Cash Cards, Gas Cards, Gift Cards, Travel Deals, Sports Contests and Much, Much More...
You can simply keep your phone locked while driving to earn! Passengers get rewarded as well.

Texting is the most alarming distraction

According to the National Highway Traffic Safety Administration (NHTSA), distractions can be caused by anything that takes a driver's attention away from the task of safe driving including talking or texting on your phone, eating and drinking, talking to people in your vehicle, fiddling with the stereo, entertainment or navigation system — anything that takes your attention away from the task of safe driving.

1. Distracted Driving Prevention Technologies

1.1. Cell Phone Blocking Apps

- **Apple CarPlay**: Connect your iPhone to your car display.
- **Android Auto**: Connect your phone to your car display
- **Do not Disturb While Driving (DND)**: The iPhone's driving mode.
- **DriveMode**: transforms user's phone into a car's central computing device.
- **DriveSafe.ly**: reads your text messages and emails out loud.
- **This App Saves Lives**: earn $ for every mile you drive without distraction.
- **OnMyWay**: earn $ for every mile you drive without distraction.
- **Safe 2 Save**: earn $ for every mile you drive without distraction
- **Lifesaver**: setup monthly rewards for teenager.

1.2. Plug-in Devices

Numerous devices may be connected into the vehicle to notify the driver's wireless provider that they are driving. It blocks all incoming messages and notifications, as well as all outgoing texts and updates.
Plug-in devices such as:
- Groove
- TextBuster

1.3. Driver Coaching

The safe-driving competitions are a fun + engaging way to get students, staff, and the entire community to put down their phones while traveling in a vehicle. Participants will be awarded for every minute that they are traveling more than 10 mph and not touching their phone.

PERMIAN BASIN HIGH SCHOOL ROAD SAFETY PROGRAM #ARRIVEALIVEPB

2. Safety Technologies for Distracted Drivers

2.1. Head Up Display: projects speed, RPMs, and other data into the windshield of the vehicle.
2.2. Lane-Departure Warning Systems: assist the drivers in avoiding collisions caused by drifting or departing the lane
2.3. Collision Warning/Avoidance Systems: give visual, audio, and/or tactile warnings to warn a driver of an approaching collision
2.4. Adaptive Cruise Control: assist vehicles maintain a safe following distance and remain within the speed limit
2.5. Rear Cross-Traffic Alert: assist drivers back out of spaces where they may not observe incoming traffic
2.6. Driver Monitoring Systems and Distraction Detection Cameras: employs a camera installed on the dashboard to track driver drowsiness or distraction
2.7. Blind Spot Warning Systems: employ cameras, radar, and sensors beside the vehicle to identify vehicles driver can't see that are next to or behind the vehicle.
2.8. Brake Assist (BA/BAS): increases braking pressure in an emergency.

3. Distracted Driving Awareness and Education

Safety organizations around the country running programs to help encourage drivers to keep their eyes on the road:
- **April is Distracted Driving Awareness Month!**
- **U Drive, U Text, U Pay** (www.nhtsa.gov/campaign/distracted-driving)
- **The Traffic Safety Education Foundation (TSEF)** (www.tsef.org)
- **It Can Wait** (www.about.att.com/csr/itcanwait)

Some tips to help you stop texting and driving:

- Develop a pre-driving routine
- Keep your phone out of reach
- Prepare your directions
- Use your phone's features
- Get involved and educate

FIGURE 29 Distracted Driving Fact Sheet

5. DISTRACTED DRIVING TECHNOLOGIES EVALUATION

The research team conducted a study to evaluate distraction prevention technology using a driving simulator. Numerous research studies have focused on the impacts of distracted driving on drivers' behaviors and attitudes toward cell phone blocking apps. The results of these studies showed that using these applications significantly reduced interactions with a cell phone while driving. Many studies have investigated the impacts of cell phone use on drivers' crash risk and many studies used driving simulators to investigate driving behaviors (*59, 60*). However, to the best knowledge of the authors, no study evaluated the impacts of cell phone blocking apps on driver behavior and safety using a driving simulator.

For this study, participants were recruited from Morgan State University and the Baltimore metro area via flyers containing an outline of the study's details distributed manually and online. All participants were required to hold a valid driver's license, drive on a regular basis, and own a smartphone. After eligibility checks, potential participants were scheduled to drive in a simulated environment. Eventually, thirty-five licensed drivers drove in the simulator under several scenarios, which will be explained in the following sections.

5.1. Methodology

The research team conducted an IRB-approved driving task. The purpose of IRB review is to assure, both in advance and by periodic review, those appropriate steps are taken to protect the rights and welfare of humans participating as subjects in the research (*61*). To determine the impacts of their experiences on their driving behaviors, participants were asked first to sign a consent form (Appendix D) to complete a pre-survey questionnaire, drive for approximately ten minutes in various simulated scenarios, and then complete a post-survey questionnaire. First, the observer asked the participants to increase the volume of their cell phone's ringer volume up loud and have it nearby. The observer also made sure that the participants knew how to activate the "Do Not Disturb While Driving" setting on their cell phones. The observer then gave the participants a brief description of the simulator to get them familiarized with the simulator's surroundings. To evaluate driver performance during cell phone usage, participants completed the scenarios in a high-fidelity driving simulator which used three 40-inch LCD panels to exhibit the simulation. Participants sat in the driver's compartment of the simulator, which offered a view of the road and dashboard instruments such as a speedometer. Realistic engine noises, road noises, and passing traffic sounds were provided as well (**Figure 30**).

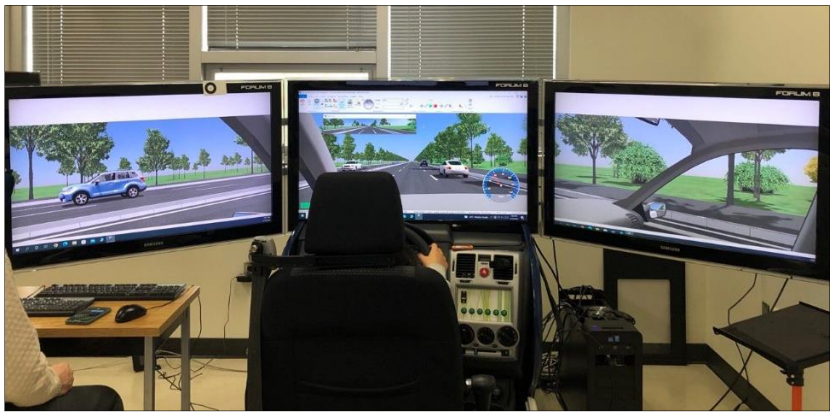


FIGURE 30 The Driving Simulator

5.1.1. Simulated Scenarios

The participants drove six scenarios on a six-kilometer-long network and consisted of six scenarios with three lanes and a 55-mph speed limit. Traffic flow and density were the same in all six scenarios. The first and last scenarios, which were the first and the last kilometer, were a warm-up and cool-down designed so that the participants became used to driving in the simulated environment. In the second scenario, which was from kilometer one to kilometer two, the participants drove in a base scenario with no distractions to compare normal driving behavior with distracted behavior. The third scenario (from kilometer two to kilometer three) included a distraction that occurred at exactly the same location for all participants. In this scenario, the observer texted the participants, who then needed to pick up their cell phones, read the text, and reply to the text. In the fourth scenario (from kilometer three to kilometer four), the observer asked the participants to activate their cell phone blocking app (e.g., "Do Not Disturb While Driving") on their cell phone settings. This scenario was considered as an interaction with their cell phone. In the fifth scenario (from kilometer four to kilometer five), the participants drove with their phones set to "Do Not Disturb While Driving." At the same exact location, the observer texted the driver and asked them to reply if they heard the text notification. **Figure 31** shows the structure of the network of the study.

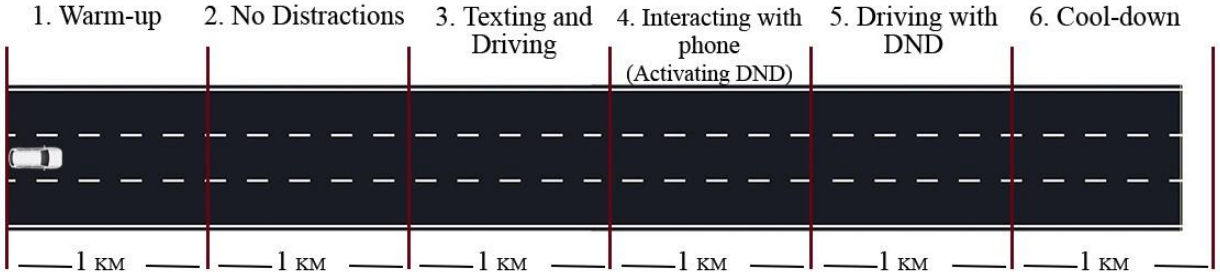


FIGURE 31 The Network of the Study

5.1.2. Data

The pre-survey asked about the participants' demographics and real-world driving behavior prior to the driving simulator experience, while the post-survey included questions related to real-world

driving behavior and the use of cell phone blocking apps following the driving simulator experience. Apart from pre-survey and post-survey data, several driving-related data were exported from the driving simulator. These variables include lateral distance, lane change, and steering velocity. **Table 1** shows the variables used in this study and their descriptions.

TABLE 1 Variables Used in This Study

Variable Name	Description
Lateral Distance	Lateral position of the vehicle toward the right side of the road
Lane change	Lane change frequency
Steering velocity	Rotation rate of the steering wheel (-1: Max left, 0: Middle (straight), +1: Max right)

Table 2 shows the results of the pre-survey questionnaire. The results show that 51.4% of the participants were male, and 48.6% were female. Participants were between 16 and over 65 years old, 28.6% of which were between 16 and 24 years old.

TABLE 2 Results of the Pre-survey

Variable		Frequency	Percent
Gender	Male	18	51.4%
	Female	17	48.6%
Age Group	16 to 24	10	28.6%
	25 to 34	8	22.9%
	35 to 44	8	22.9%
	45 to 54	3	8.6%
	55 to 64	2	5.7%
	More than 65	4	11.4%
Education Status	Less than high school graduate	0	0%
	High school graduate, including GED	5	14.3%
	Some college or associate degree	7	20%
	Bachelor's Degree	3	8.6%
	Graduate or professional degree	20	57.1%
Household Annual Income	Less than $19,999	8	22.9%
	$20,000 to $49,999	11	31.4%
	$50,000 to $79,999	7	20%
	$80,000 to $109,999	6	17.1%
	More than $110,000	3	8.6%
Race	Black or African American	23	65.7%
	White	10	28.6%
	Asian	1	2.9%
	Hispanic or Latino	1	2.9%
Employment Status	Full-time	17	48.6%
	Part-time	9	25.7%
	Unemployed	9	25.7%
Using any distraction prevention technologies before this experiment	Yes	8	22.9%
	No	27	77.1%

5.2. Results

Each section of the process is analyzed separately: pre-survey questionnaire results, driving simulator results, and post-survey questionnaire results.

5.2.1. Pre-survey Questionnaire Results

The results of the pre-survey questionnaire show that almost 23% of the participants used cell phone blocking technology while driving to prevent distraction. The questionnaire also asked about the type of blocking technology each participant used. The most common technology that participants used to prevent distraction was "Do Not Disturb While Driving (DND)," which is a feature on iPhone and Android cell phones designed to keep drivers safe on the road (*62*).

5.2.2. Driving Simulator Results

Many studies use statistical analysis to develop policies that improve traffic safety, investigate and forecast travel behavior, and pinpoint deficiencies in transportation policy (*63–66*). For this study, a descriptive statistic was first conducted to demonstrate the changes in variables under different scenarios. **Figure 32** shows the lateral change, lane change, and changes in steering velocity.

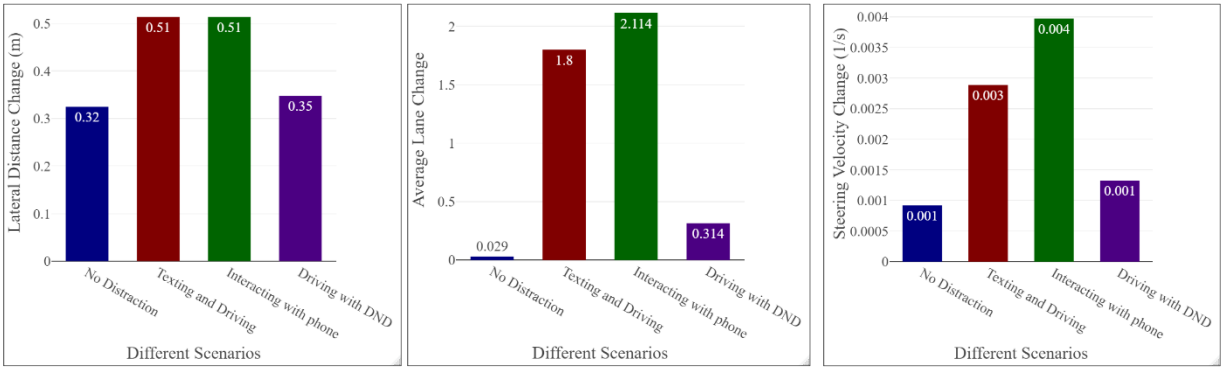


FIGURE 32 (a) Lateral distance change, (b) Lane change, (c) Steering velocity change

Moreover, we conducted several T-tests to compare driving behavior under different scenarios and conditions. To compare the statistical differences, a 5% significance level was used in this study. **Table 3** shows the results of the analysis and reveals the significant differences between variables in different scenarios. We can conclude from the results that the lateral changes, lane changes, and changes in steering velocity differ significantly between drivers who texted or interacted with their phones while driving and those who did not. Moreover, using DND while driving produced significant differences in lateral change, changes in steering velocity, and lane changes compared to driving while texting and driving. The results of the t-tests between the cell phone blocking app scenario and the no distraction scenario were not significant, which shows the similarity between the driver's behavior in these two scenarios. Other variables, including speed change, brake frequency, and acceleration, were also investigated in this study, none of which were significant.

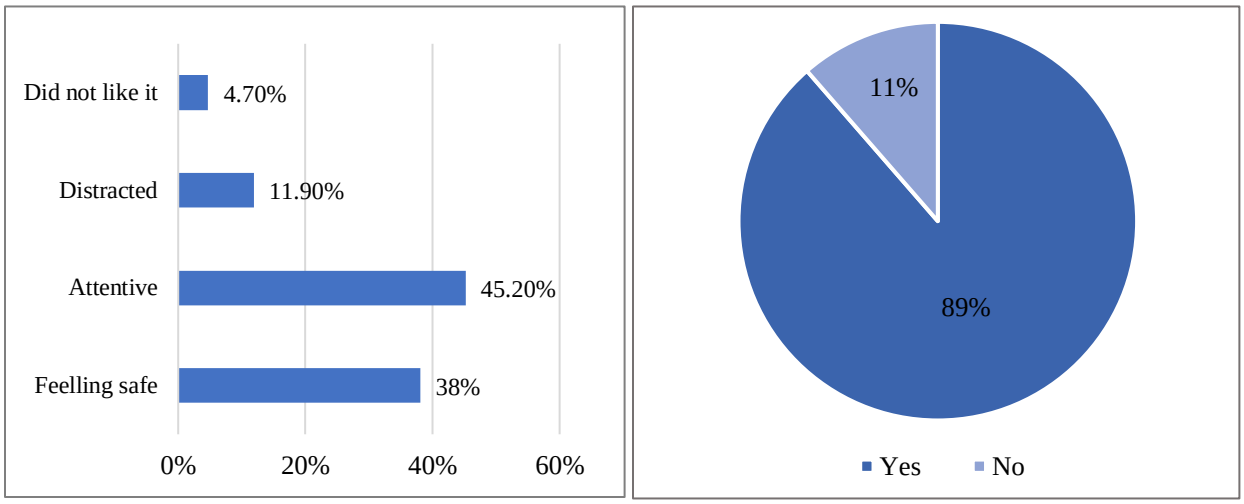
TABLE 3 Results of the T-test Comparing Different Scenarios

Variables	Scenarios		p-value	
Lateral Distance Change	No Distraction	Texting and Driving	0.0002063	*
		Interacting with phone (Activating DND)	0.0002232	*
		Driving with Activated DND	0.5599	

	Texting and Driving	Interacting with phone (Activating DND)	0.9998	
		Driving with Activated DND	0.002274	*
	Interacting with phone (Activating DND)	Driving with Activated DND	0.002383	*
Lane Change	No Distraction	Texting and Driving	0.001811	*
		Interacting with phone (Activating DND)	0.001973	*
		Driving with Activated DND	0.2087	
	Texting and Driving	Interacting with phone (Activating DND)	0.83	
		Driving with Activated DND	0.009895	*
	Interacting with phone (Activating DND)	Driving with Activated DND	0.008894	*
Steering Velocity	No Distraction	Texting and Driving	0.01666	*
		Interacting with phone (Activating DND)	0.004766	*
		Driving with Activated DND	0.3553	
	Texting and Driving	Interacting with phone (Activating DND)	0.388	
		Driving with Activated DND	0.07028	
	Interacting with phone (Activating DND)	Driving with Activated DND	0.01654	*
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1				

5.2.3. Post-survey Questionnaire Results

The post-survey questionnaire included questions about participants' experience and driving behavior after driving in the simulator. The post-survey questionnaire contained three questions. The first question asked about the participants' feelings when they drove while DND was activated. **Figure 33 (a)** shows the results, which indicate that most of the participants felt safe (38%) and attentive (45%) while driving with the DND activated, 11% felt distracted, and 4% did not like it. The answer for not liking the DND was, "I did not like it because I would not know when I am getting a message."



(a) **(b)**

Figure 33 (a) Participants' attitude regarding DND, (b) Participants' attitude regarding using DND in the future

In the second question, we asked the participants whether they would use distraction prevention technologies (such as "Do not Disturb While Driving" or any other apps) in the future to drive

safely after this experiment. Interestingly, more than 88% of the participants answered that they would use this technology in the future (**Figure 33 (b)**).

For the third question, a description of cell phone blocking apps that pay their users not to use their phones while driving was presented to the participants. Then, participants were asked which option they preferred to prevent distracted driving. **Figure 34** demonstrates that more than 51% of the participants stated that they would use their phone's built-in driving mode to prevent distracted driving, while 14% stated that they would use apps that pay to drive safely. In addition, 11% of all participants stated that they would not use any distraction prevention technologies while driving. Some of the reasons for not using these technologies were "I will put my phone out of reach," "I will put the phone on silent mode," and "I will use a smartwatch for important notifications."

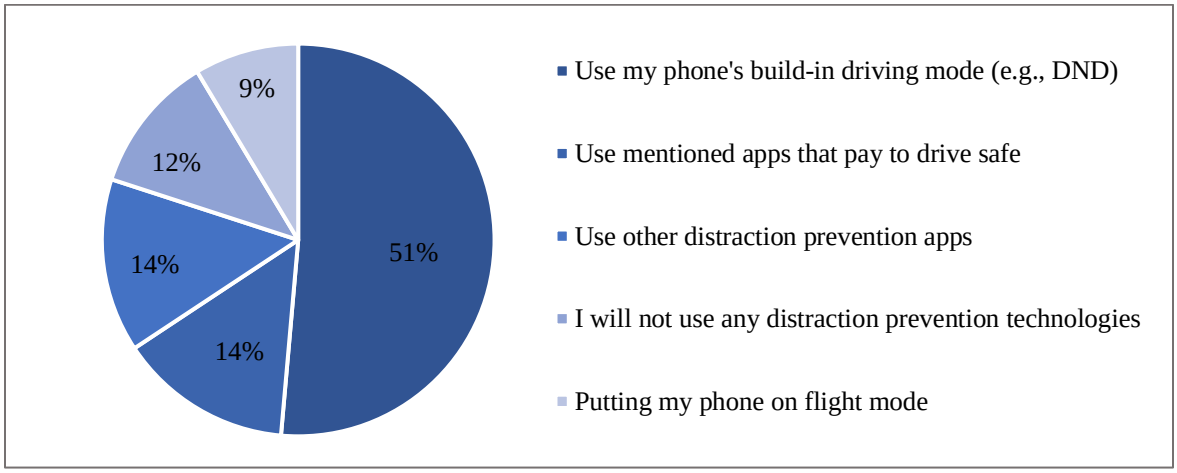


Figure 34 Participants' choice regarding distracted prevention technologies

5.3. Discussion

It is crucial that researchers consider the potential effects that new technological developments may have on transportation, both from a safety and a traffic operations standpoint, as they become more widespread. Distracted driving is one of the most important safety issues associated with emerging technologies, and concerns about its effect on driver safety are increasing significantly. Previous studies have indicated that interacting with a cell phone is one of the most common behaviors contributing to distracted driving, and cell phone blocking apps are designed to prevent this type of distraction.

The results of this study support previous investigations regarding cell phone use while driving. Our analysis shows significant changes in lateral control performance after texting or interacting with a cell phone (activating DND) while driving. Moreover, drivers changed lanes significantly more times and deviated from the center of the road when they were texting or interacting with a cell phone (activating DND). Also, the present study, unlike others, investigated the use of cell phone blocking apps using a driving simulator. It is particularly noteworthy that the impact of cell phone blocking apps while driving was similar to that of the no distraction scenario. This research also confirmed that steering is a crucial indicator of driver response. It can provide a timely warning of distraction due to its short time constant, which only requires milliseconds of driver

input. Moreover, the results of this study show that steering velocity increases significantly when interacting with a phone (activating DND) compared to using a cell phone blocking app. This suggests that the use of cell phone blocking apps is an effective way to prevent distracted driving.

The statistical analysis of this study also shows that only 23% of the drivers were using cell phone blocking apps before the experiment. After the experiment, however, more than 88% of participants stated that they had a positive opinion of cell phone blocking apps and would use one while driving in the future (**Figure 35**).

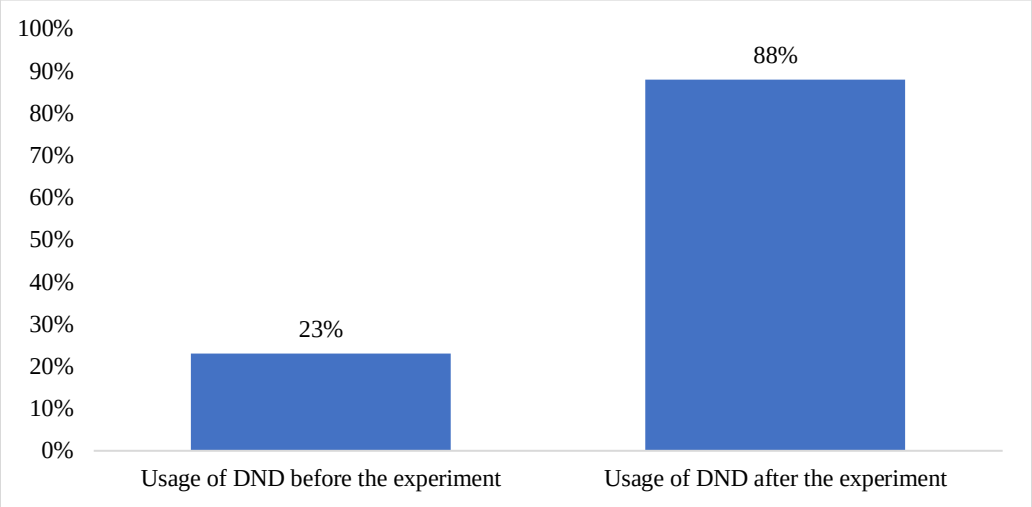


FIGURE 35 Participants Perception Regarding Using DND While Driving Before and After the Experiment

The most popular type of cell phone blocking app based on the questionnaire was the built-in cell phone blocking app on the drivers' cell phones. The results showed that 45% of the participants felt attentive, and 38% felt safe while using cell phone blocking apps. This shows that the opinion of drivers toward using this technology has been very positive.

One important contribution made by this study was to compare "no distraction" and "driving with an activated cell phone blocking app" scenarios in a driving simulator. It proposed the idea that driving while using a cell phone blocking app is similar to a situation with no distractions while driving. A limitation of this study is that it monitored driving behavior in a simulator that offered a safe, controlled setting rather than testing the participants' responses to various driving conditions. Therefore, future research could take a naturalistic approach to see if similar results occur when driving in actual driving situations. Moreover, future studies could focus on other variables such as speed, braking, and acceleration to investigate whether cell phone blocking apps can impact these variables as well.

6. SUMMARY AND CONCLUSION

There are several ways to prevent drivers from getting distracted. In this project, all the distraction prevention technologies were first reviewed. These technologies were then categorized into two

main categories: distraction driving prevention technologies and safety technologies for distracted drivers. To educate Maryland drivers, an online webinar and a fact sheet were developed.

The research team conducted a study to evaluate distraction prevention technologies using a driving simulator. Some 35 participants drove a base scenario (without distraction) and three other scenarios, including texting while driving, interacting with a cell phone while driving (activating DND), and driving with an activated cell phone blocking app on a realistic road network. The results showed that participants changed their lanes more frequently and changed their steering velocity and lateral distance more significantly while texting or interacting with a cell phone (activating DND). However, the results of the t-tests for the cell phone blocking app scenarios and the no distraction scenario were not significant, which shows the similarity of driver's behavior in these two scenarios. Attitudes toward using a cell phone blocking app were also assessed using pre- and post-trial questionnaires. The results suggested that 23% of the participants used cell phone blocking apps. After the experiment, however, 88% of the participants answered that they would use cell phone blocking apps while driving in the future.

The findings of this study support the need for more forceful enforcement of distracted driving laws and the importance of cell phone blocking apps from a policy perspective. The research findings also support the need for driver education about distracted driving prevention technologies.

7. REFERENCES

1. Distracted Driving Dangers and Statistics | NHTSA. https://www.nhtsa.gov/risky-driving/distracted-driving. Accessed May 16, 2022.
2. Distracted Driving Statistics 2022 | Bankrate. https://www.bankrate.com/insurance/car/distracted-driving-statistics/. Accessed Jul. 24, 2022.
3. Sadeghvaziri, E. Identifying State-Specific Distracted Driving Target Group. 2021.
4. Sadeghvaziri, E., M. B. Rojas IV, and X. Jin. Exploring the Potential of Mobile Phone Data in Travel Pattern Analysis. *Transportation research record*, Vol. 2594, No. 1, 2016, pp. 27–34.
5. Rojas IV, M. B., E. Sadeghvaziri, and X. Jin. Comprehensive Review of Travel Behavior and Mobility Pattern Studies That Used Mobile Phone Data. *Transportation Research Record*, Vol. 2563, No. 1, 2016, pp. 71–79.
6. Sadeghvaziri, E. Exploring Potentials in Mobile Phone GPS Data Collection and Analysis. 2017.
7. Distracted Driving Statistics + Research [Updated 2022]| The Zebra. https://www.thezebra.com/resources/research/distracted-driving-statistics/#page-author-bio. Accessed May 17, 2022.
8. National Center for Statistics and Analysis. Distracted Driving 2019 (Research Note. Report No. DOT HS813 111). National Highway Traffic Safety Administration, Apr, 2021.
9. Modest Use For IPhone “Do Not Disturb” Blocker. *Status Report*, Vol. 54, No. 1, 2019, p. n.p.
10. Technology Solutions - National Safety Council. https://www.nsc.org/road/safety-topics/distracted-driving/technology-solutions. Accessed May 17, 2022.
11. IOS - CarPlay - Apple. https://www.apple.com/ios/carplay/. Accessed Aug. 10, 2022.
12. Android Auto | Android. https://www.android.com/auto/?gclid=Cj0KCQjwrs2XBhDjARIsAHVymmSgQbBUCG684Z2cbzy3Y0s6zcEXsOf5i1iRjbFqTfmCaplAAYTg95YaAjavEALw_wcB&gclsrc=aw.ds. Accessed Aug. 10, 2022.
13. Do Not Disturb While Driving: IPhone Safety Feature Explained! https://www.payetteforward.com/do-not-disturb-while-driving-iphone-safety-feature-explained/. Accessed Aug. 2, 2022.
14. Use the Driving Focus on Your IPhone to Concentrate on the Road - Apple Support. https://support.apple.com/en-us/HT208090. Accessed May 17, 2022.
15. Drivemode: Handsfree Messages And Call For Driving - Apps on Google Play. https://play.google.com/store/apps/details?id=com.drivemode.android&hl=en_US&gl=US. Accessed Aug. 10, 2022.
16. DriveMode: Curbing the Urge To Text While Driving - Sue Scheff Blog. http://www.suescheffblog.com/drivemode-curbing-the-urge-to-text-while-driving/. Accessed Aug. 2, 2022.
17. Is New Technology Making Distracted Driving Worse? — Chicago Injury Blog — November 20, 2017. https://www.daveabels.com/is-new-technology-making-distracted-driving-worse/. Accessed Aug. 2, 2022.
18. Admin « DriveSafe.Ly. https://www.drivesafe.ly/author/admin/page/5/. Accessed Aug. 2, 2022.

19. This App Saves Lives: We Care Deeply about Ending Distracted Driving. https://www.thisappsaveslives.com/about_us.html. Accessed Aug. 10, 2022.
20. The Only Texting and Driving Solution That Pays | OnMyWay. https://onmyway.com/. Accessed Aug. 2, 2022.
21. Safe 2 Save | University Health. https://www.universityhealthsystem.com/services/trauma/injury-prevention/safe-2-save. Accessed Aug. 2, 2022.
22. Common Q&A for New LifeSaver App Users - LifeSaver Mobile. https://lifesaver-app.com/appinfo/. Accessed Aug. 2, 2022.
23. Fleet Distracted Driving Technology - LifeSaver Mobile. https://lifesaver-app.com/?utm_term=lifesaver%20com&utm_campaign=Brand+Campaign&utm_source=adwords&utm_medium=ppc&hsa_acc=5167735633&hsa_cam=2067572283&hsa_grp=81977821168&hsa_ad=553340586662&hsa_src=g&hsa_tgt=kwd-298008091349&hsa_kw=lifesaver%20com&hsa_mt=b&hsa_net=adwords&hsa_ver=3&gclid=CjwKCAjwj42UBhAAEiwACIhADhjV7N4R72Fzj46mH1IlTnUbzmPuf8WPkN9fZAU9QedBlJOoweE0tRoC4fsQAvD_BwE. Accessed May 17, 2022.
24. Don’t Text and Drive: ZoomSafer Automatically Locks Your Phone While o. https://www.fastcompany.com/1735964/dont-text-and-drive-zoomsafer-automatically-locks-your-phone-while-road. Accessed Aug. 2, 2022.
25. U.S. Auto Insurer Launches Distracted Driving Prevention Tool for Teens. https://www.canadianunderwriter.ca/insurance/u-s-auto-insurer-launches-distracted-driving-prevention-tool-for-teens-1002208622/. Accessed Aug. 2, 2022.
26. Distracted Driving App » Motion Intelligence. https://motionintelligence.com/distracted-driving-app/. Accessed Aug. 2, 2022.
27. TextLimit App One More Step in Cutting down Distracted Driving | Editorials | Timeswv.Com. https://www.timeswv.com/opinion/editorials/textlimit-app-one-more-step-in-cutting-down-distracted-driving/article_9b5bdfab-fbd2-597f-9b63-fd45b46325aa.html. Accessed Aug. 2, 2022.
28. Distracted Driving Discouraged Through New DriveScribe App. https://www.psbr.law/2012/08/distracted-driving-discouraged-through-new-drivescribe-app/. Accessed Aug. 2, 2022.
29. Is New Car Technology Leading to More Distracted Driving? | Automotive IQ. https://www.automotive-iq.com/autonomous-drive/articles/is-new-car-technology-leading-to-more-distracted-driving. Accessed Aug. 2, 2022.
30. TextBuster Review: Text- and App-Blocker Helps Keep Eyes on the Road - CNET. https://www.cnet.com/roadshow/reviews/textbuster-review/. Accessed Aug. 2, 2022.
31. D2GO The Driver Challenge | Geotab Marketplace. https://marketplace.geotab.com/solutions/d2go-driver-challenge-gamification-app/. Accessed Aug. 2, 2022.
32. Yang, G., M. M. Ahmed, and B. Subedi. Distraction of Connected Vehicle Human–Machine Interface for Truck Drivers. *Transportation research record*, Vol. 2674, No. 9, 2020, pp. 438–449.
33. Jeihani, M., A. Ansariyar, E. Sadeghvaziri, A. Ardeshiri, M. M. Kabir, A. Haghani, A. Jones, and E. Center. Investigating the Effect of Connected Vehicles (CV) Route Guidance on Mobility and Equity. 2022.

34. The Ultimate Distracted Driving Guide: What It Is & How to Prevent It | Jim Ellis Volkswagen of Chamblee. https://www.jimellisvwatlanta.com/blog/2019/may/7/the-ultimate-distracted-driving-guide.htm. Accessed Aug. 2, 2022.
35. Head-up Display: Why You Need It in Your Next Car - Kelley Blue Book. https://www.kbb.com/car-advice/head-up-display-why-need-next-car/. Accessed Aug. 2, 2022.
36. Heads-up Display to Stay Focused on the Road | HUDWAY Drive. https://hudway.co/drive?utm_source=google&utm_medium=cpc&utm_campaign=google_g&utm_content=485046867577&utm_term=carrobot%20c2%20lite%20head%20up%20display.b.c...&gclid=Cj0KCQiA_c-OBhDFARIsAIFg3ezVXMqbLiJqNJz9CK5c5VmqcKeXpycKU_4cg3jQ0mtWEBjMH13uOg0aAsTcEALw_wcB#rec221735603. Accessed Aug. 2, 2022.
37. Lane Departure Warning - My Car Does What. https://mycardoeswhat.org/deeper-learning/lane-departure-warning/. Accessed Aug. 2, 2022.
38. How Does Lane Departure Warning Work? - ExtremeTech. https://www.extremetech.com/extreme/165320-what-is-lane-departure-warning-and-how-does-it-work. Accessed Aug. 2, 2022.
39. MAZDA: LDWS | Active Safety Technology. https://www.mazda.com/en/innovation/technology/safety/active_safety/ldws/. Accessed Aug. 2, 2022.
40. Lane Keeping Assist System (LKAS): My Car Does What. https://mycardoeswhat.org/safety-features/lane-keeping-assist/. Accessed Aug. 2, 2022.
41. The Next Wave in Safety Tech: Collision Avoidance Systems. https://www.samsara.com/guides/collision-avoidance-system/. Accessed Aug. 2, 2022.
42. Guide to Forward Collision Warning - Consumer Reports. https://www.consumerreports.org/car-safety/guide-to-forward-collision-warning-a8423384882/. Accessed Aug. 2, 2022.
43. Technology Guide: What Is an Automatic Braking System? https://www.proctoracura.com/automatic-braking-system-guide. Accessed Aug. 2, 2022.
44. Automatic Emergency Braking. https://www.bosch-mobility-solutions.com/en/solutions/assistance-systems/automatic-emergency-braking/. Accessed Aug. 2, 2022.
45. What Is Adaptive Cruise Control? https://www.caranddriver.com/research/a32813983/adaptive-cruise-control/. Accessed Aug. 2, 2022.
46. Javid, R. J., J. Xie, L. Wang, W. Yang, R. J. Javid, and M. Salari. High-Occupancy Vehicle (HOV) and High-Occupancy Toll (HOT) Lanes. 2021.
47. CHP to Crack Down on Carpool Lane Violators. *Sacramento Injury Attorneys Blog*. https://www.sacramentoinjuryattorneysblog.com/chp-to-crack-down-on-carpool-lane-violators/. Accessed Oct. 25, 2022.
48. Rear Cross Traffic Alert - My Car Does What. https://mycardoeswhat.org/deeper-learning/rear-cross-traffic-alert/. Accessed Aug. 2, 2022.
49. What Is a Driver-Monitoring System? https://www.aptiv.com/en/insights/article/what-is-a-driver-monitoring-system. Accessed Aug. 2, 2022.
50. Guide to Blind Spot Warning - Consumer Reports. https://www.consumerreports.org/car-safety/guide-to-blind-spot-warning-a1263069503/. Accessed Aug. 2, 2022.

51. What Your Blind Spot Warning System Does - Gilbert & Baugh Ford Blog. https://www.gilbertbaughford.com/blogs/2815/albertville-ford-dealer/what-your-blind-spot-warning-system-does/. Accessed Aug. 2, 2022.
52. What Is Brake Assist (BA/BAS) in a Car ? - CarBikeTech. https://carbiketech.com/brake-assist-babas/. Accessed Aug. 2, 2022.
53. What Is Cruise Control System in Cars? - CarBikeTech. https://carbiketech.com/cruise-control/. Accessed Aug. 2, 2022.
54. April Is Distracted Driving Awareness Month | NHTSA. https://www.nhtsa.gov/es/april-distracted-driving-awareness-month. Accessed Aug. 10, 2022.
55. U Drive. U Text. U Pay. | Distracted Driving | NHTSA. https://www.nhtsa.gov/campaign/distracted-driving. Accessed Aug. 10, 2022.
56. Driver Safety Education | Traffic Safety Education Foundation. https://www.tsef.org/?gclid=Cj0KCQiA8ICOBhDmARIsAEGI6o1JE8s2Cu-LfcS4KC1_pgthiBOIs5ZtXXhCfU82DL5Yk45WWbC2RSMaAsvlEALw_wcB. Accessed Aug. 2, 2022.
57. About Our Distracted Driving Campaign - Decide to Drive. https://www.decidetodrive.org/about/. Accessed Aug. 2, 2022.
58. It Can Wait. https://about.att.com/csr/itcanwait. Accessed Aug. 2, 2022.
59. Sadeghvaziri, E., K. Haleem, P. Alluri, H. Fartash, and A. Gan. *Effects of Different Guide Signs on Driver Behavior at Express Lane Entrance: A Driving Simulation Study*. 2016.
60. Ansariyar, A., E. Sadeghvaziri, and M. Jeihani. Systematic Review of Bike Simulator Studies. *Journal of Science and Cycling*, 2021.
61. Institutional Review Boards (IRBs) and Protection of Human Subjects in Clinical Trials | FDA. https://www.fda.gov/about-fda/center-drug-evaluation-and-research-cder/institutional-review-boards-irbs-and-protection-human-subjects-clinical-trials. Accessed Aug. 24, 2022.
62. Do Not Disturb While Driving: IPhone Safety Feature Explained! https://www.payetteforward.com/do-not-disturb-while-driving-iphone-safety-feature-explained/.
63. Sadeghvaziri, E. Identifying State-Specific Distracted Driving Target Group. 2021.
64. Mamdoohi, A. R., M. Saffarzade, A. Taherpour, and M. Yazdan Panah. Modeling Air Passengers' Ground Access Mode Choice a Case Study of IKIA. *International Journal of Modeling and Optimization*, Vol. 2, No. 2, 2012, pp. 147–152.
65. Javid, R. J., M. Salari, and R. J. Javid. Environmental and Economic Impacts of Expanding Electric Vehicle Public Charging Infrastructure in California′ s Counties. *Transportation Research Part D: Transport and Environment*, Vol. 77, 2019, pp. 320–334.
66. Javid, R., and E. Sadeghvaziri. Investigating the Relationship Between Access to Intercity Bus Transportation and Equity. *Transportation Research Record*, 2022, p. 03611981221088218. https://doi.org/10.1177/03611981221088218.

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8. APPENDIX A. PRE SURVEY

1. What is your gender?
   a) Male
   b) Female

2. What is your age group?
   a) 15 to 24
   b) 25 to 34
   c) 35 to 44
   d) 45 to 54
   e) 55 to 64
   f) More than 65

3. What is your annual Household Income?
   a) Less than $19,999
   b) $20,000 to $49,999
   c) $50,000 to $79,999
   d) $80,000 to 109,999
   e) More than $110,000

4. What is the highest level of education you have completed? If you are currently enrolled in school, please indicate the highest degree you have.
   a) Less than high school graduate
   b) High school graduate, including GED
   c) Some college or Associate's Degree
   d) Bachelor's Degree
   e) Graduate or professional degree

5. What is your race?
   a) American Indian, or Alaskan Native
   b) Asian
   c) Black or African American
   d) Hispanic or Latino
   e) Native Hawaiian or Other Pacific Islander
   f) White

6. Are you Hispanic, Latino, or Spanish origin?
   a) Yes
   b) No

7. Are you currently employed?
   a) No
   b) Yes, Full-time
   c) Yes, Part-time

8. What type of Driver’s License do you have?
   a) Permanent License for regular vehicles class C
   b) Permanent License for all types of vehicles class B
   c) Permanent License for all types of vehicles class A
   d) Learner's Permit
   e) Do not have a driver's license

9. Do you use any distraction prevention technologies (such as "Do not Disturb While Driving" or any other apps) while driving?
   a) Yes
   b) No

10. If you said yes to the previous question, please specify which technology or app do you use? (If your answer was "No", please type N/A.)

9. APPENDIX B. POST SURVEY

1. When the Do not Disturb While Driving mode was activated, you were?
   a) Feeling safe
   b) Attentive
   c) Distracted
   d) Did not like it

2. If you answered "did not like it" to the previous question, would you answer why? (If you answered "No", please type N/A.)

3. After this experience, do you think you will use distraction prevention technologies (such as "Do not Disturb While Driving" or any other apps) to drive safely?
   a) Yes
   b) No

There are several smartphone apps that pay their users not to use their phone while driving.

Users get paid for every mile they do not text and drive and can refer their friends to get compensated for them as well. The money earned can then be used for Cash Cards, Gas Cards, Gift Cards, Travel Deals, Sports Contests and Much, Much More...

You can simply keep your phone locked while driving to earn! Passengers get rewarded as well.

The following are some apps that will pay you to drive safely:

- *On my way*

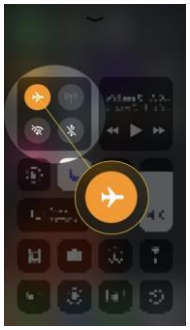
- *Safe2Save*

- *This app saves lives*

- *LifeSaver*

4. According to the above information and your driving experience, which option do you like to use for preventing distraction while driving?

a) Putting my phone on flight mode



b) Use my phone's build-in driving mode (e.g. Do not Disturb while driving)

c) Use above mentioned app that pay to drive safe

d) Use other distraction prevention apps (e.g. DriveMode or Apple CarPlay)

e) I will not use any distraction prevention technologies while driving.

5. If you use any other distraction prevention technologies or ways to prevent distraction while driving, please describe them below.

10. APPENDIX C. IRB

Institutional Review Board (IRB)

August 25, 2022

Dr. Mansoureh Jeihani
School of Engineering
Urban Infrastructure Studies
Morgan State University

RE: IRB #22/09-0169

Dear Dr. Jeihani,

Following expedited review of the amendment materials submitted to the IRB with respect to the study being conducted in collaboration with Eazaz Sadehvaziri and Ramina Javid titled *"Educating the Public about Distracted Driving and Evaluating Distraction-Preventing Technologies"*, I am pleased to inform you that **IRB Approval** is hereby granted for the project.

Please note that this **approval** is for a one-year period from the date of this letter. If the research extends beyond the expiration date, it is the responsibility of the principal investigator to obtain renewal of approval prior to the expiration date. Also, note that it is your responsibility to inform the IRB promptly should there be a substantive change in the study methodology.

Do not hesitate to contact me at benjamin.welsh@morgan.edu, or Dr. Isuk at X3447 should you have any questions.

Sincerely,

MORGAN STATE UNIVERSITY
IRB
APPROVED
Signature: *Benjamin H. Welsh*
Date: 9/20/2022
Void one year from date above

Benjamin Welsh, Ph.D.
IRB Chairperson

Cc: Dr. Edet Isuk, IRB Administrator

11. APPENDIX D. CONSENT FORM

INFORMED CONSENT FORM

You are invited to participate in a study of the Distracted Driving Prevention Technologies. The study is being conducted by Dr. Mansoureh Jeihani of Morgan State University. You were selected as a possible participant in this study because you kindly responded to our invitation and accepted to participate.

If you decide to participate, we will ask you to fill out two survey questionnaire forms. You will be trained how to drive the simulator. It will take no more than 15 minutes. When you drive the simulator, you may feel dizzy in the first few experiments until you get used to it. There is no risk of driving the simulator, you just may feel dizzy or fatigue or get headache. You may find it fun to drive the simulator and have some experiences such as crashes that are dangerous in the real world.

Your decision whether or not to participate will not prejudice your future relation with the Morgan State University. If you decide to participate, you are free to discontinue participation at any time without prejudice.

Any information that is obtained in connection with this study and that can be identified with you will remain confidential and will be disclosed only with your permission.

If you have any questions, please do not hesitate to contact us. If you have any additional questions later about the study, please contact Dr. Mansoureh Jeihani at 443-885-1873 who will be happy to answer them. If you have further administrative questions, you may contact the MSU IRB Administrator, Dr. Edet Isuk, at 443-885-3447.

You will be offered a copy of this form to keep.

You are making a decision whether or not to participate. Your signature indicates that you have read the information provided above and have decided to participate. You may withdraw at any time without penalty or loss of any benefits to which you may be entitled after signing this form should you choose to discontinue participation in this study.

_____ _____

Signature **Date**

_____ _____

Signature of Parent/Legal Guardian (If necessary) **Date**

_____ _____

Signature of Witness (If appropriate) **Signature of Investigator**