Report No. K-TRAN: KU-19-2 ▪ FINAL REPORT ▪ January 2021

Effectiveness of Entertaining, Non-Traffic-Related Messages on Dynamic Message Signs

Alexandra Kondyli, Ph.D.
Steven D. Schrock, Ph.D, P.E., F.ITE
Irtiza Rafid Khan

The University of Kansas

Kansas Department of Transportation

1 Report No. K-TRAN: KU-19-2	**2 Government Accession No.**	**3 Recipient Catalog No.**
4 Title and Subtitle Effectiveness of Entertaining, Non-Traffic-Related Messages on Dynamic Message Signs		**5 Report Date** January 2021 **6 Performing Organization Code**
7 Author(s) Alexandra Kondyli, Ph.D. Steven D. Schrock, Ph.D, P.E., F.ITE Irtiza Rafid Khan		**8 Performing Organization Report No.**
9 Performing Organization Name and Address The University of Kansas Department of Civil, Environmental & Architectural Engineering 1530 West 15th St Lawrence, Kansas 66045-7609		**10 Work Unit No. (TRAIS)** **11 Contract or Grant No.** C2123
12 Sponsoring Agency Name and Address Kansas Department of Transportation Bureau of Research 2300 SW Van Buren Topeka, Kansas 66611-1195		**13 Type of Report and Period Covered** Final Report August 2018–January 2020 **14 Sponsoring Agency Code** RE-0753-01
15 Supplementary Notes For more information write to address in block 9.		

16 Abstract

This research used a fixed-base driving simulator to determine the effects of dynamic message signs (DMSs) on driver behavior. A DMS notifies drivers with safety, weather, incident, or traffic condition messages. Recently, however, state Departments of Transportation (DOTs) display safety messages with entertaining content. The Kansas DOT (KDOT) wanted to assess how these entertaining messages affect driving behavior. Therefore, this research evaluated the effect of DMS content on driver behavior using a combination of surveys and driver behavior data obtained from a fixed-base driving simulator.

Existing literature was reviewed to determine similar studies. Based on the literature, which included results of DMS modeling in driving simulators and DMS effects on driver behavior, a research methodology was developed. One hundred participants were recruited and screened using an online survey questionnaire that included messages currently displayed on DMS; feedback on their perceived effectiveness was requested. The second data collection was done via a driving simulator experiment. The simulator was prepared for the study, the DMS was set, and events were designed to capture changes in driver behavior and awareness. A total of 60 participants with diverse demographics drove by several DMSs that displayed a variety of messages. Participants completed a survey at the end of the experiment, and their responses were compared to responses of the online survey. Behavioral data (speeds, accelerations, gazes, etc.) were then reduced, and statistical analyses were performed, including hypothesis testing and analysis of variance, to evaluate to what extent the message content affected driver behavior. The study identified potential messages that were found to effectively affect driver behavior.

17 Key Words Dynamic Message Signs, Driver Behavior, Questionnaires, Variable Message Signs, Digital Simulation		**18 Distribution Statement** No restrictions. This document is available to the public through the National Technical Information Service www.ntis.gov.	
19 Security Classification (of this report) Unclassified	**20 Security Classification (of this page)** Unclassified	**21 No. of pages** 66	**22 Price**

Form DOT F 1700.7 (8-72)

This page intentionally left blank.

Effectiveness of Entertaining, Non-Traffic-Related Messages on Dynamic Message Signs

Final Report

Prepared by

Alexandra Kondyli, Ph.D.
Steven D. Schrock, Ph.D, P.E., F.ITE
Irtiza Rafid Khan

The University of Kansas

A Report on Research Sponsored by

THE KANSAS DEPARTMENT OF TRANSPORTATION
TOPEKA, KANSAS

and

THE UNIVERSITY OF KANSAS
LAWRENCE, KANSAS

January 2021

PREFACE

The Kansas Department of Transportation's (KDOT) Kansas Transportation Research and New-Developments (K-TRAN) Research Program funded this research project. It is an ongoing, cooperative and comprehensive research program addressing transportation needs of the state of Kansas utilizing academic and research resources from KDOT, Kansas State University and the University of Kansas. Transportation professionals in KDOT and the universities jointly develop the projects included in the research program.

NOTICE

The authors and the state of Kansas do not endorse products or manufacturers. Trade and manufacturers names appear herein solely because they are considered essential to the object of this report.

This information is available in alternative accessible formats. To obtain an alternative format, contact the Office of Public Affairs, Kansas Department of Transportation, 700 SW Harrison, 2nd Floor – West Wing, Topeka, Kansas 66603-3745 or phone (785) 296-3585 (Voice) (TDD).

DISCLAIMER

The contents of this report reflect the views of the authors who are responsible for the facts and accuracy of the data presented herein. The contents do not necessarily reflect the views or the policies of the state of Kansas. This report does not constitute a standard, specification or regulation.

Abstract

This research used a fixed-base driving simulator to determine the effects of dynamic message signs (DMSs) on driver behavior. A DMS notifies drivers with safety, weather, incident, or traffic condition messages. Recently, however, state Departments of Transportation (DOTs) display safety messages with entertaining content. The Kansas DOT (KDOT) wanted to assess how these entertaining messages affect driving behavior. Therefore, this research evaluated the effect of DMS content on driver behavior using a combination of surveys and driver behavior data obtained from a fixed-base driving simulator.

Existing literature was reviewed to determine similar studies. Based on the literature, which included results of DMS modeling in driving simulators and DMS effects on driver behavior, a research methodology was developed. One hundred participants were recruited and screened using an online survey questionnaire that included messages currently displayed on DMS; feedback on their perceived effectiveness was requested. The second data collection was done via a driving simulator experiment. The simulator was prepared for the study, the DMS was set, and events were designed to capture changes in driver behavior and awareness. A total of 60 participants with diverse demographics drove by several DMSs that displayed a variety of messages. Participants completed a survey at the end of the experiment, and their responses were compared to responses of the online survey. Behavioral data (speeds, accelerations, gazes, etc.) were then reduced, and statistical analyses were performed, including hypothesis testing and analysis of variance, to evaluate to what extent the message content affected driver behavior. The study identified potential messages that were found to effectively affect driver behavior.

Acknowledgments

The authors of this report thank KDOT project monitor Chris Bortz for his guidance and suggestions.

Table of Contents

List of Tables

List of Figures

Chapter 1: Introduction

1.1 Background

Many transportation agencies throughout the United States use dynamic message signs (DMSs) to display traffic-related information such as travel times, lane closures, traffic updates, roadwork warnings, traffic crashes, and inclement weather information to motorists. Several state Departments of Transportation (DOTs) have recently implemented behavioral traffic safety messages to attract motorists' attention, raise awareness, and change driver behavior. These often-entertaining messages focus on seat belt use, distracted driving, and aggressive driving, as well as reinforce driving rules. For example, Massachusetts exploited the regional dialect to display "Use yah blinkah" and "Make yah ma proud, wear yah seatbelt." Utah displayed "That seat belt looks good on you," and one of Tennessee's popular messages is "Texting and driving, oh cell no." Iowa and Missouri DOTs are displaying messages such as "Exit to text it," or "Get your head out of your apps." To raise safety awareness, some DOTs hold contests in which the public is asked to contribute entertaining messages. Although these messages have gained public approval, no study has evaluated how effective these messages are in raising public awareness, changing behavior, and promoting safety.

1.2 Objectives

The objectives of this project were to investigate whether entertaining non-traffic-related messages influence driver behavior and to specifically identify which messages are most effective.

Chapter 2: Review of Current Practice

A thorough literature review was conducted to identify existing research related to DMS messaging. Several publications, theses, and books were obtained using resources from the University of Kansas Library and online library databases such as Google Scholar, Transportation Research International Documentation (TRID), ScienceDirect, DBPIA, JSTOR, and IEEE Xplore Digital Library.

2.1 Effect of DMS Messages on Driver Behavior

The number of state transportation agencies posting safety messages on DMS has increased over the last few years. Several studies have proven that these safety messages potentially change driver behavior, including small samples of traffic data analysis that show speed changes when drivers approach an active DMS. Although the overall findings from these reports support the use of DMS to disseminate highway safety messages, more research is needed to validate perceptions noted in the surveys, and more field studies are necessary to confirm long-term impacts of DMS use to convey safety messages about driver behavior and traffic safety.

On February 9, 2006, the Federal Highway Administration (FHWA) issued a policy memorandum that allows driver-safety-focused messages to be displayed on a DMS. The memorandum recommended that messages should be kept current and related to a specific campaign, and the period that a specific message is displayed for a safety campaign should be limited to a few weeks. More recently, DMSs have been used in public campaigns to raise awareness of safe driving behavior and promote roadway safety. Messages are typically focused on five common, dangerous behaviors: drowsiness, distractions, aggression, alcohol or drug impairment, and unrestrained driving. More recently, the displayed messages also included the state-specific number of traffic fatalities year-to-date.

A recent study by Mitran, Cummins, and Smithers (2018) reviewed the literature and documented the existing practice of placing safety campaign messages on DMSs to determine if they effectively influence driver behavior and provide safety benefits to the public. The authors reviewed reports from states that currently utilize safety message campaigns and display these messages on DMSs. The findings were based on surveys that were administered to the general public and solicited their input on the effectiveness of specific messages. Although the report is not detailed and specific data on the sample sizes or detailed survey questionnaires are missing, the authors claimed that, overall, the use of DMSs for safety campaigns effectively changed driver behavior. In addition, the results suggested that drivers most often read and process DMS messages with informative, text-only content with assertive, cautionary language. However, once installed, the researchers warned, DMSs should be treated as one of many communication channels, meaning DMSs are likely to be underutilized if they are used only for safety campaigns.

Simulation studies have also been used to evaluate the effect of DMS messages in a controlled environment. Vaughn, Abdel-Aty, Kitamura, and Jovanis (1992) performed a study using a PC-based simulation program to investigate how route choice decisions are affected by Advanced Traveler Information Systems displayed on DMSs. Results showed that males are more likely to follow advice provided by the system, and drivers are more willing to obey the system for a route change if the route includes a freeway. Similarly, a study by Adler and Kalsher (1994) used a simulator program called FASTCARS to investigate the effects of traffic advisory and route guidance information on en-route behavior and travel performance. Information on simulated traffic speeds and route guidance was provided, and driver travel speeds were collected. Their findings showed that providing subjects with guidance information resulted in decreased travel times because drivers did not have to utilize trial-and-error practices.

Benson (1996) evaluated motorist attitudes regarding the content of DMS messages, revealing that respondents preferred DMS messages that are simple, reliable, and useful. Messages with exact locations of crashes and time-tagging traffic information received high levels of response. Using theoretical calculations and motorists' experiences, the results showed that a DMS should not use more than two message screens. Other researchers have discovered that a single message screen is preferable and that incorrect information can have negative consequences on DMS effectiveness (Miller, Smith, Newman, & Demetsky, 1995).

DMSs have been incorporated into many metropolitan cities worldwide in the hope that the information provided by these signs will alter driver behavior in a positive manner (Emmerink, Nijkamp, Rietveld, & Van Ommeren, 1996). In 2001, results of a European study on the comprehension of pictograms for DMSs demonstrated the difficulty of finding images that could be readily understood (Luoma & Rämä, 2001). Another study investigated the effectiveness of safety campaign messages, such as "Watch Your Speed," that were randomly displayed on DMSs throughout the United Kingdom's motorway network (Jamson & Merat, 2007). The study focused on the effects of individual messages and how their presence influences driver behavior towards more critical tactical incident messages (TIMs) that warn of imminent hazards. The study used the University of Leeds Driving Simulator, which recorded eye gazes via a Seeing Machines faceLAB v4 eye tracker within the simulator to determine if drivers read the message. Research results suggested that, although DMSs with safety campaign messages did not significantly affect driver behavior, they still produced safety benefits. When used sporadically, they improved driver alertness and acted as favorable reminders of safe driving practices. Evidence in this study also suggested that responses to TIMs are timelier if drivers are accustomed to reading such messages on DMSs; if not, drivers tend to ignore them.

Tay and de Barros (2008) studied driver perceptions of DMS safety messages. Focus group discussions with transportation engineers and road safety experts were conducted, and qualitative analysis was followed by a questionnaire survey of two samples of drivers to examine opinions of DMS displays and self-reported reactions to several safety messages related to speeding. In addition to standard demographic and driving information, the survey gathered data on the respondents' exposure to various types of messages displayed on a DMS, and the respondents were asked to identify all the types of messages they recalled seeing on the DMS.

The first sample, which totaled 94 participants, primarily consisted of students in transportation engineering courses at the University of Calgary, with friends and colleagues of the research team comprising a small proportion of participants. The second sample consisted of 163 drivers who stopped at the Gasoline Alley, a popular stopover point on Highway 2 between Calgary and Edmonton, cities in Alberta, Canada. Reports were prepared based on driver attention and reactions to messages displayed on DMSs along the highway. Most drivers (85.8%) responded that they looked at the displayed messages, and 69.9% reported that they thought about the displayed messages. These encouraging results show that drivers are aware of the messages and contemplate them, indicating that DMS is an effective communication device. Coupled with earlier findings that most drivers support the display of other non-traffic-related information, the conclusion was made that displaying non-traffic-related information does not negatively impact the effectiveness of displayed traffic-related information.

Most participants added that the current messages are very "soft" and thus not likely to grab the attention of drivers. They suggested that "hard-hitting" messages are harder to ignore. Several participants also suggested that messages should be more current and specific, such as "xx people were killed this year" or "xx% of the drivers today are speeding." A few participants also suggested relevant messages such as "your speed is xxx km/h - slow down" or "you are following too closely." Most participants felt that direct, immediate warnings more effectively grab drivers' attention than general "soft-soft" messages. The study also found that most drivers looked at the displayed messages and could recall many of the previous messages.

Tay and de Barros (2010) also examined the effectiveness of anti-speeding messages on driver attitudes and traffic speed on an inter-city highway. "Speeding will catch up to you" and "Don't save time, save lives" messages were used to measure driver behavior. A questionnaire survey, developed, and administrated to 97 drivers, gathered information on driver exposure to and recollection of the various types of information displayed on DMSs; driver attitudes towards the messages were recorded using a standard 5-point Likert scale. The authors also performed an on-road test, based on a simple quasi-experimental design methodology, that provided valid interference on the effect of a particular message by measuring and comparing traffic speeds when drivers were exposed to the message and when they were not exposed to the message. This study showed that the messages had a relatively small, albeit beneficial effect on driver behavior and on-road traffic speed.

2.2 Mechanics of Driving Simulators

Driving simulators virtually represent the dynamics of a vehicle and surrounding environment without physically jeopardizing test subjects (Capustiac & Napoca, 2011). The goal of the driving simulator is to immerse drivers into a virtual environment generated by computer rendering. While driving in a particular scenario, the virtually generated environment moves with respect to the vehicle, creating a perception of motion. Several vehicle manufacturers and educational institutions use driving simulators to research driver behavior, body position, human-vehicle interactions, roadway geometrics, and driver assistance systems. Because they pose no physical threat to individuals, simulators can efficiently determine driving risks.

Driving simulators are generally categorized in terms of cost and number of degrees of freedom (DOFs), or the direction in which motion is free to occur. For example, a simulator with three DOFs can demonstrate motion in three planes: x-axis, y-axis, and z-axis. As the number of DOFs increases, the driving experience becomes more realistic, but the cost of the driving simulator also increases. Simulators are typically classified as low level, mid-level, or high-level; low-level simulators are usually fixed-based (FB) simulators (Slob, 2008).

Driving simulators have existed since the early 1950s when vehicle manufacturers started designing simulators to test designs. In the early 1970s, Volkswagen built their first driving simulator with a 3-DOF (yaw, roll, and pitch) motion system (Slob, 2008). Mazda was the next vehicle manufacturer to develop a 4-DOF (yaw, roll, pitch, and surge) system in 1985. Around the same period, Daimler-Benz introduced a 6-DOF system with a 180-degree view in a hydraulic hexapod (Slob, 2008). Ford Motor Company introduced their 6-DOF simulator, Virttex, in 1994. In addition to yaw, roll, and pitch, Ford's simulator could also sway, heave, and surge. Renault implemented a similar system in 2004 (Slob, 2008). Kookmin University in South Korea developed a 6-DOF system in a single-seat simulator, and in 2001, the system was replaced with a full-car chassis and a 2-DOF motion platform. The Kookmin University Simulator can also generate effects such as rumble strips and speed bumps (Lee, Sung, Lee, Kim, & Cho, 2007).

Highly sophisticated simulators (high-level simulators), such as the Toyota Driving Simulator at the Higashi-Fuji Technical Center in Susono, Japan, and the National Advanced Driving Simulator (NADS) at the University of Iowa in the United States, provide realistic, immersive driving experiences. Both Toyota and NADS simulators have 13 DOFs with a fully enclosed hexapod and a 360° horizontal view (Slob, 2008).

Compared to high-level simulators, low-level simulators are not fully capable of delivering realistic immersion into a virtual driving environment. In addition, low-level simulators are more prone to effects such as simulator sickness, which occurs because the simulator lacks motion cues. Humans perceive motion through skin pressure and balance organs in the ear (Capustiac & Napoca, 2011). When the human body is subject to a simulator, however, the eyes register visual cues, but the ears and skin do not register any movement (motion cues), leading to a lack of motion perception. The most common symptoms of simulator sickness are nausea, headaches, vomiting, and sweating. Therefore, Kemeny and Panerai (2003) recommended a minimum horizontal field of view (FOV) of 120° for drivers to accurately perceive speed with respect to moving images in a driving simulator.

Chapter 3: Methodology

This research used surveys and driving simulator experiments to evaluate the effectiveness of non-traffic-related messages for changing driver behavior and promoting safety. Participants recruited for the driving simulator at the University of Kansas (KU) were given a screening questionnaire that gathered information regarding their demographics and driving behavior. Simulator scenarios were created, including selecting and setting up DMS messages, and, following completion of the draft scenario, pilot testing was carried out to detect any discrepancies missed by the designer. Figure 3.1 highlights the main tasks performed in this study.

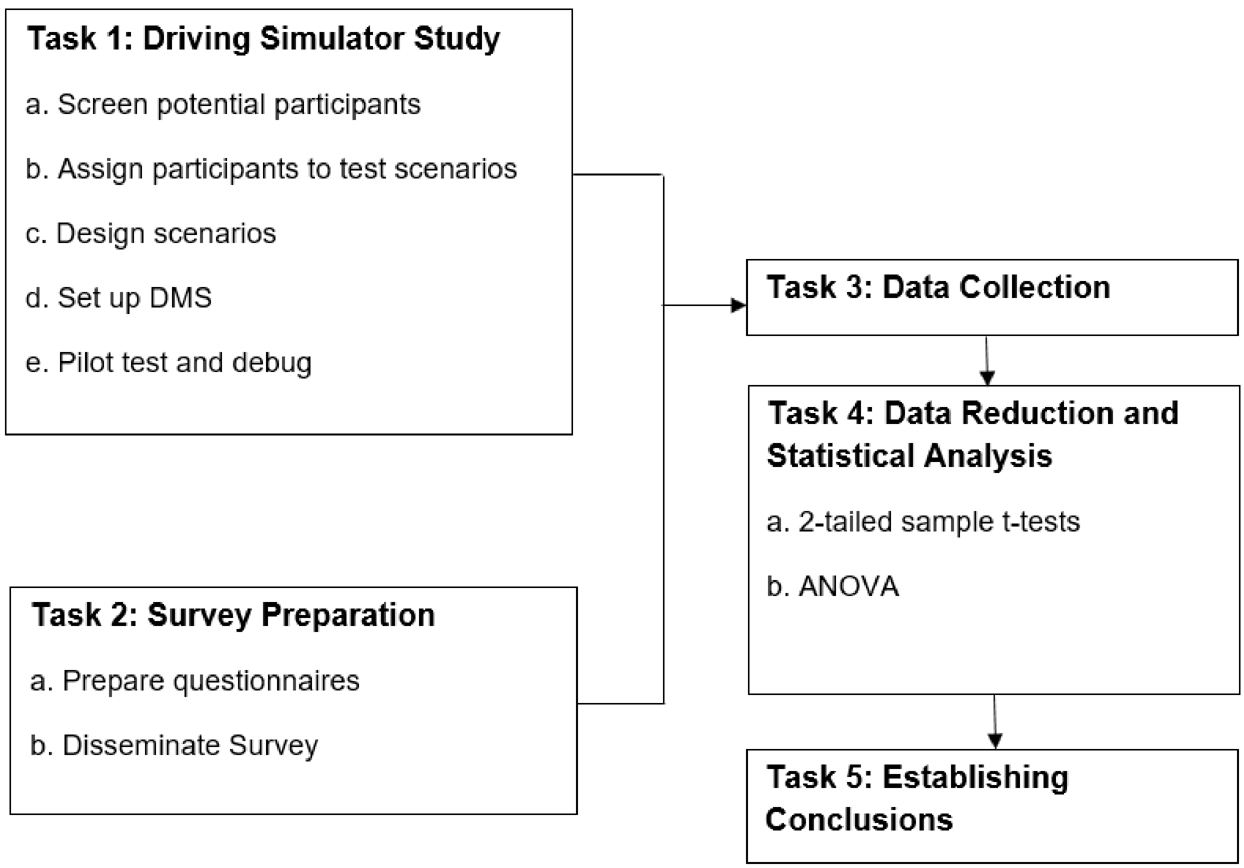


Figure 3.1: Study Tasks

Two additional surveys were developed to gauge drivers' preferences regarding the DMS and perceived effectiveness of specific messages. The first survey was given online, and the second survey was administered after the driving simulator study was completed. Data were analyzed using the statistical package for social sciences (SPSS) software (IBM, 2011), and data analysis included paired t-tests and analysis of variance (ANOVA).

3.1 Online and Simulator Surveys

This study utilized two surveys to examine driver perceptions of DMS use and self-reported reactions to the displayed messages. One survey was given to 120 participants online via social media. The other survey was administered to 60 drivers after they finished simulated driving. Both surveys included the same questions (Appendix A).

Table 3.1 shows the profile of respondents from the online and driving simulator surveys. As shown in the table, 65 (54.2%) of the 120 respondents in the online survey were male and 55 (45.8%) were female. In addition, results showed that drivers aged 18–49 years were overrepresented, and the sample consisted of a higher proportion of drivers with more than 10 years of driving experience. Of the 60 respondents in the driving simulator survey, 31 (51.70%) were male and 29 (48.3%) were female. Again, drivers aged 18–50 years were overrepresented in the total sample, which also consisted of a higher proportion of drivers with more than 10 years of driving experience.

Table 3.1: Profile of Survey Respondents

	Online Survey	Driving Simulator Survey
Gender		
Male	54.2%	51.7%
Female	45.8%	48.3%
Age (yrs)		
18–25	43.3	41.7
26–49	39.2	41.7
50+	19.2	16.7
Driving Experience (yrs)		
1–5	33.3	36.7
6–10	16.7	16.7
>10	50.0	46.7

3.2 Driving Simulator Experiment

The KU driving simulator is a fixed-based simulator in an Acura MDX chassis (half cab). As shown in Figure 3.2 and Figure 3.3, the simulator provides a 170° horizontal FOV, with three forward screens and one rear screen. The rear screen renders the view of both sideview mirrors and the rearview mirror, providing an immersive driving experience. The simulation run and respective data were recorded on the MiniSim (NADS, 2015) computer, while the video of each participant's drive was captured on a video-capture computer. Eye-tracking equipment was used to collect eye-tracking data from the participants, and the eye-tracking and simulation data were synchronized.

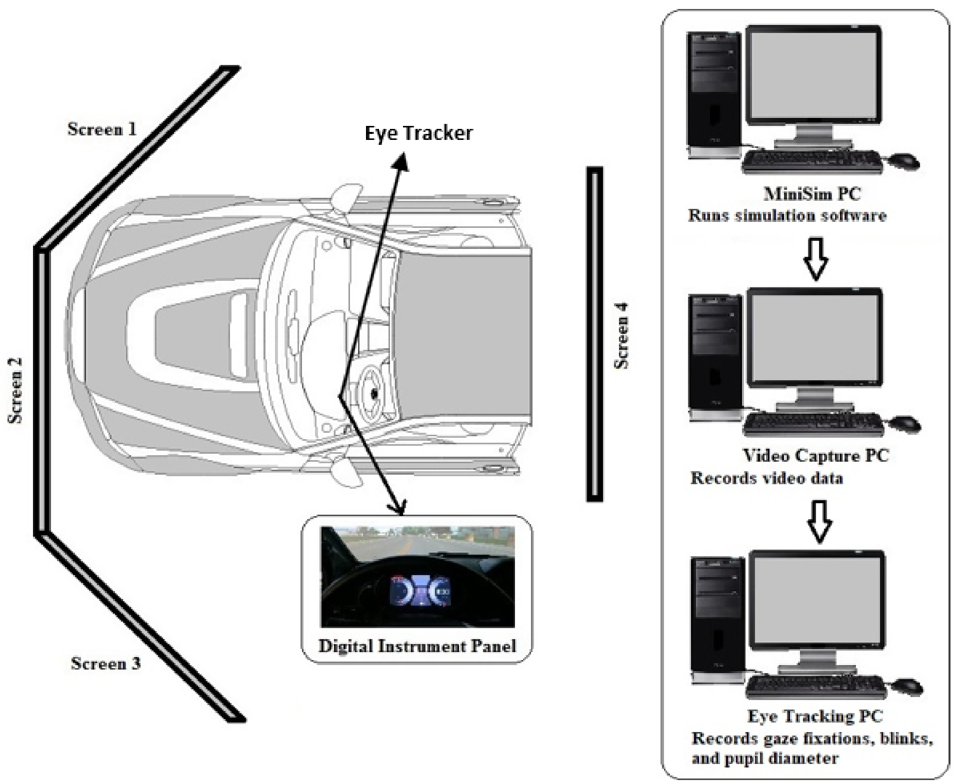


Figure 3.2: Layout of KU Driving Simulator

Figure 3.3: KU Driving Simulator in Action

3.2.1 Participation Recruitment

Outlets such as advertisements at KU, the Lawrence Public Library, the Department of Motor Vehicles (DMV), churches, and social media platforms (Facebook and LinkedIn) were used to distribute the survey to the general public in Kansas. In addition, requests for participation were sent to people who had previously participated in human factors-related research. A web-based prescreening questionnaire collected demographics and information pertaining to current driving habits from perspective participants. The driving simulator study and related material were approved by the University of Kansas Human Research Protection Program (HRPP). A total of 201 participants showed interest in participating in the driving simulator study, and 60 participants were invited to participate. The selected participants' database is shown in Table 3.2.

3.2.2 Designing Roadway Geometry

This study utilized the tile mosaic tool (TMT) to generate roadway alignments and render the virtual environment (NADS, 2016). The program used square tiles with dimensions of 660 ft by 660 ft, consisting of virtual environment features such as pavement, shoulder, vegetation, markings, and geometry. The square tiles could be combined to form a continuous roadway layout; a four-lane divided highway with a grass median, 70 mph speed limit, and several DMSs were created for this study. The virtual driving scenario consisted of a typical freeway with straight and curved segments. The total length of the freeway, including two interchanges, was approximately 60 miles.

Table 3.2: Participant Database

No.	ID	Age	Gender	No.	ID	Age	Gender
1	V001	28	M	31	V039	32	M
2	V002	19	F	32	V040	21	M
3	V003	29	M	33	V042	20	F
4	V004	18	M	34	V043	54	M
5	V005	26	F	35	V044	42	F
6	V007	22	M	36	V045	18	M
7	V008	19	F	37	V046	21	M
8	V011	28	M	38	V047	62	M
9	V012	24	F	39	V048	56	F
10	V016	20	M	40	V049	46	M
11	V017	28	M	41	V051	37	F
12	V018	42	F	42	V052	77	M
13	V019	21	M	43	V053	21	F
14	V020	38	F	44	V054	31	F
15	V021	46	M	45	V055	20	F
16	V022	26	F	46	V056	21	M
17	V023	23	M	47	V057	64	F
18	V024	21	M	48	V058	21	M
19	V025	34	F	49	V059	24	F
20	V027	39	F	50	V060	25	M
21	V028	24	F	51	V061	18	F
22	V029	21	F	52	V062	26	M
23	V030	50	F	53	V063	55	F
24	V031	18	M	54	V064	21	F
25	V033	37	M	55	V065	34	F
26	V034	60	M	56	V066	34	F
27	V035	28	M	57	V067	18	M
28	V036	28	M	58	V068	31	F
29	V037	30	M	59	V069	50	F
30	V038	50	F	60	V070	29	M

3.2.3 Experiment Procedure

The research team used NADS-ISAT and NADS-MiniSim software programs to create simulated scenarios of roadways with DMSs that displayed specific non-traffic-related content. KDOT determined the exact content of the displayed messages in order to test messages that were thought to specifically influence driver behavior. Each DMS was spaced approximately 3 miles apart, and drivers drove past approximately 20 DMSs throughout the simulation. The entire duration of the experiment was approximately 60 min.

In the first part of the roadway network, drivers underwent a 5-minute practice session that resembled experimental motorway conditions. No DMS was present during the practice drive so participants could acclimate to the driving simulator and the driving process. Screening for simulation sickness was also carried out, and participants with severe symptoms were excluded from the study. In the second part of the network, DMSs were introduced into the simulated network, and driver data such as speed control, lane changing, and gap acceptance were collected to investigate the impact of message content on driving behavior. The four general DMS message categories were texting and driving, move-over law, car-following event, and anti-speeding messages. A total of 14 messages were selected, and most were repeated at least twice to determine if message repetition changed driver behavior. Since some of the selected messages were related to texting while driving, participants were provided with the Messenger app that was installed on a cellphone and placed inside the car. Messages were sent to them from a laptop, and participants were advised to attempt to reply to the text messages if they felt comfortable while driving the simulator. The displayed messages are shown in Table 3.3.

Table 3.3: Messages Shown in the Driving Simulator

Type of Message	Message
Texting	Steering Wheel: Not A Hands-Free Device
	Pay Attention and Just Drive
	Drive Like Your Life Depends on It
	Get Your Head out of Your Apps
	One Text or Call Could Wreck It All
	Even Texting Drivers Hate Texting Drivers
	No Text Is Worth A Life
	What's More Important, Your Text or Your Life?
	Don't Let Texting Blind You
	Texting & Driving—It Can Wait
Tailgating	Give Space, Don't Tailgate
Move-Over Law	Move Over for Law Enforcement and Maintenance Workers
Speeding	Speeding Kills
	Slow Down

In each driving scenario, participants had to drive from the starting point to the end point. The distance from the starting point to the first DMS location was approximately 1,500 m, which allowed drivers to accelerate to typical driving speeds. In addition, to make the driving scenarios more realistic, several vehicles were modeled as ambient traffic. Because the research team hypothesized that drivers would change their behavior once they read the message signs, statistically significant differences in driver speed, acceleration, and gaps were investigated before and after drivers looked at (and read) the message signs. Upon completion, participants were asked to answer questions regarding the usefulness and perceived effectiveness of the DMS content. Figure 3.4 and Figure 3.5 show final scenarios from the NADS-ISAT and NADS-MiniSim software programs, respectively.

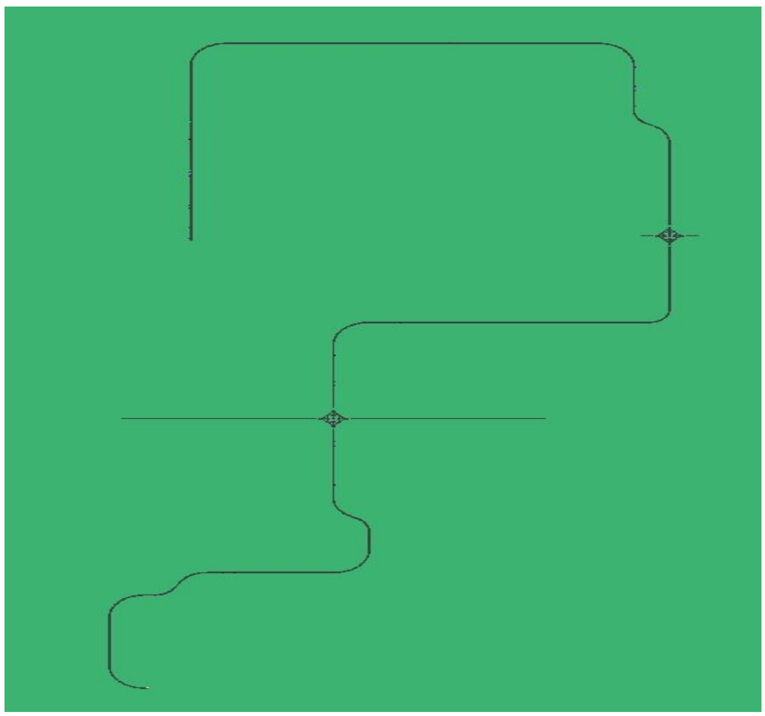


Figure 3.4: Final Scenario in NADS-ISAT

Figure 3.5: Final Scenario with DMS in NADS-MiniSim

3.2.4 Pilot Testing

Following the initial scenario design, three test participants with no prior exposure to the simulator were invited to drive the scenarios. Based on their feedback, modifications were made to the events within the scenario, such as changing traffic speed, adjusting distances between vehicles, and fixing unnoticed graphics bugs in the simulated environment.

3.2.5 Data Collection, Reduction, and Statistical Analysis

The scenarios were run using the NADS MiniSim software, which directly linked to hardware inputs such as steering wheel, accelerator pedal, brake pedal, and gear selector (NADS, 2015). All data collection outputs were stored in a data acquisition file, accessible through MATLAB (The MathWorks, Inc., 1996). A MATLAB plugin, the data acquisition viewer, provided by NADS, was used to select required data variables from each scenario. Filtered and sorted data included variables such as vehicle speed, lateral position, distance to lead vehicle, deceleration rate, and video data. After extracting the required variables, data were exported to Microsoft Excel for further sorting into individual events. Each event was uniquely numbered in ISAT between 1 and 20, allowing easy identification during sorting. The data variables were then organized by participant ID and age group.

The surveys and driving simulator data were used to assess whether drivers believed that the message content had affected their behavior and whether the message content had affected their driving behavior and improved safety awareness. Statistical tests were used for assessment. For statistical analysis, the null hypothesis was that there was no significant difference between driver behavior and awareness of individuals driving before and after seeing the DMS message, as verified by a 2-tailed paired sample t-test at a confidence level of 95%. ANOVA was also conducted to identify significant differences in data variables between age groups or genders.

Chapter 4: Survey Data Analysis

4.1 Driving Simulator Survey Data Analysis

4.1.1 Awareness of DMS Messages

Upon completion of the driving simulator experiments, participants were asked to complete a survey pertaining to the perceived effectiveness of DMS messages. In addition to standard demographics and driving information, the survey gathered data on the respondents' exposure to various types of DMS messages. Participants were asked to indicate all the types of messages they recalled seeing on a DMS. As shown in Figure 4.1, most respondents remembered seeing safety-related messages; in fact, the positive response rate was 89%, followed by construction-related information (42%), crash information (40%), travel-time information (36%), and weather-related messages (21%). These results may reflect the relative amount of exposure or number of times these messages were displayed. Overall, most drivers recalled seeing the DMS messages, which indicates that DMS is an effective communication device.

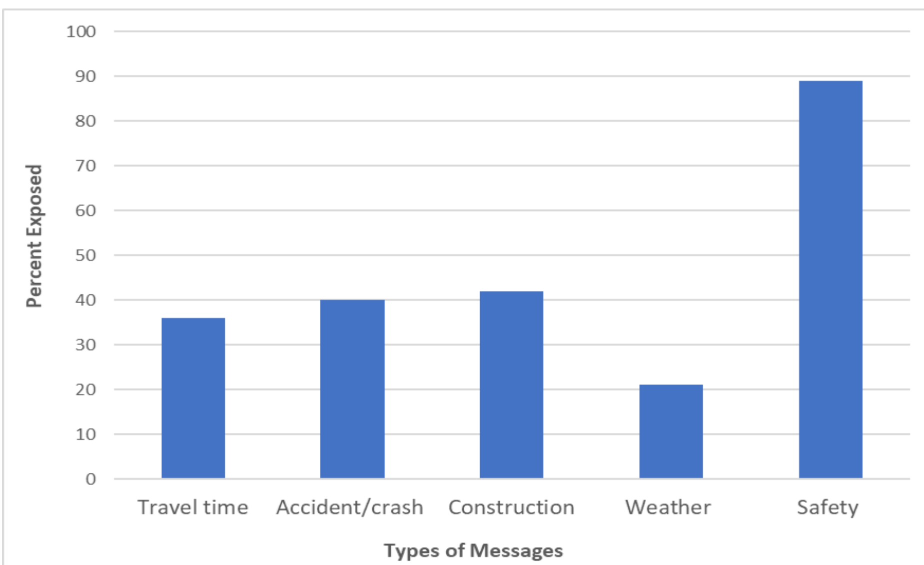


Figure 4.1: Exposure to DMS Messages (Driving Simulator Survey)

4.1.2 Uses of DMS

A standard 5-point Likert scale was used to elicit drivers' opinions on the various displayed messages. As shown in Table 4.1, most respondents appreciated the display of information regarding weather, real-time traffic, reminders not to tailgate, general safety messages, and reminders of driver courteousness. Their opinions on anti-speeding messages, however, were somewhat neutral.

Table 4.1: Driver Responses for Displayed DMS Messages (Driving Simulator Survey)

Driver Responses to DMS	SD (%)	D (%)	N (%)	A (%)	SA (%)	Mean (1–5)
It is a good idea to remind drivers….						
not to follow too closely on the road.	0.00	1.67	28.33	50.00	20.00	3.88
to be courteous on the road.	1.67	8.33	26.67	50.00	13.33	3.65
of hazardous weather conditions.	0.00	0.00	3.33	30.00	66.67	4.63
It is a good idea to display….						
general safety messages on highway message boards.	1.67	6.67	25.00	41.67	25.00	3.82
anti-speeding messages on highway message boards.	1.67	10.00	36.67	35.00	16.67	3.55
drunk-driving messages on highway message boards.	5.00	5.00	18.33	50.00	21.67	3.78
anti-texting-and-driving messages on highway message boards.	1.67	5.00	15.00	41.67	36.67	4.07
seat belt-use messages on highway message boards.	0.00	6.67	20.00	43.33	30.00	3.97
weather-warning messages.	1.67	3.33	5.00	40.00	50.00	4.33

Note: Mean calculated using strongly disagree (SD) = 1, disagree (D) = 2, neutral (N) = 3, agree (A) = 4, and strongly agree (SA) = 5

4.1.3 Display of Road Safety Messages

In order to evaluate the effectiveness of the DMS for changing driver behavior, drivers initially were asked about the attention they paid to the messages. Second, in order to gauge behavioral change, examples of more specific types of messages were presented to survey respondents to determine changes in driving behavior. Table 4.2 reports the results of drivers' attention and reactions to the messages. Most drivers (88.3%) reported that they looked at the displayed messages, and 85% reported that they thought about the displayed messages. Moreover, since a majority of the respondents agreed that road safety messages should be displayed but were not overly enthusiastic about anti-speeding messages, displaying other safety messages may be more effective than displaying anti-speeding messages.

Table 4.2: Driver Reactions to Displayed Messages

Respond to the Following Statements:	**SD (%)**	**D (%)**	**N (%)**	**A (%)**	**SA (%)**	**Mean (1–5)**
I look at the information on highway message boards when it is displayed.	0.00	3.33	8.33	51.67	36.67	4.22
I think about the information displayed on highway message boards.	0.00	0.00	15.00	50.00	35.00	4.20
Behavioral Effects of Road Safety Messages						
Remind me to check my following distance	3.33	13.33	33.33	40.00	10.00	3.40
Reduce my likelihood of speeding	3.33	13.33	31.67	36.67	15.00	3.47
Remind me not to text while driving	3.33	6.67	20.00	50.00	20.00	3.77
Remind me not to drive after consuming alcohol	10.00	3.33	18.33	40.00	28.33	3.73
Remind me to pay more attention while driving	3.33	3.33	16.67	55.00	21.67	3.88
Remind me to always use the seat belt while driving	3.33	8.33	13.33	50.00	25.00	3.85
Remind me to move over for law enforcement or maintenance workers	3.33	3.33	11.67	46.67	35.00	4.07

Note: Mean calculated using strongly disagree (SD) = 1, disagree (D) = 2, neutral (N) = 3, agree (A) = 4, and strongly agree (SA) = 5

4.1.4 Driver Perception of DMS Messages

4.1.4.1 Messages Shown in Simulator (M1-M14)

Upon completion of the experiment, participants were surveyed regarding their thoughts about the 14 messages shown on the DMS during the simulator experiment. The message codes are shown in Table 4.3.

To confirm these survey responses, drivers' opinions were elicited using a standard 5-point Likert scale. As shown in Table 4.4 and Figure 4.2, most participants (90%) thought that the message "Move Over for Law Enforcement and Maintenance Workers" was most effective, followed by "Give Space, Don't Tailgate" (81.67%) and "No Text Is Worth A Life" (80%).

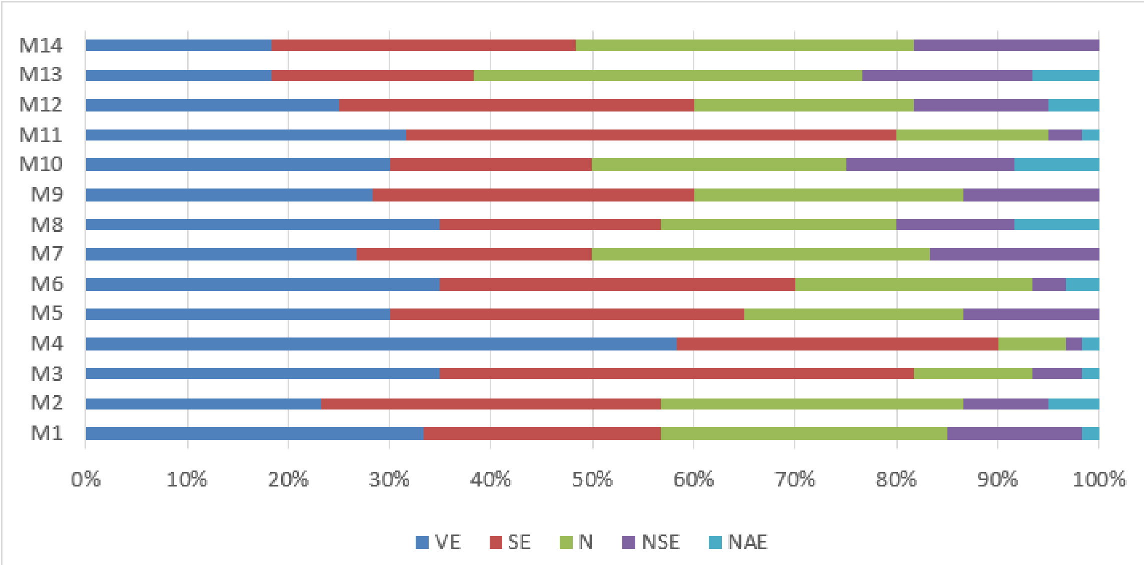
Table 4.3: Message Codes on DMS

Code	Messages
M1	Steering Wheel: Not A Hands-Free Device
M2	Pay Attention and Just Drive
M3	Give Space, Don't Tailgate
M4	Move Over for Law Enforcement and Maintenance Workers
M5	Speeding Kills
M6	Slow Down
M7	Drive Like Your Life Depends on It
M8	Get Your Head out of Your Apps
M9	One Text or Call Could Wreck It All
M10	Even Texting Drivers Hate Texting Drivers
M11	No Text Is Worth A Life
M12	What's More Important, Your Text or Your Life?
M13	Don't Let Texting Blind You
M14	Texting & Driving—It Can Wait

Table 4.4: Driver Perceptions of DMS Messages M1–M14 (Simulator Survey)

Messages	NAE (%)	NSE (%)	N (%)	SE (%)	VE (%)	Mean (1–5)
Steering Wheel: Not a Hands-Free Device	1.67	13.33	28.33	23.33	33.33	3.73
Pay Attention and Just Drive	5	8.33	30	33.33	23.33	3.62
Give Space, Don't Tailgate	1.67	5	11.67	46.67	35	4.08
Move Over for Law Enforcement and Maintenance Workers	1.67	1.67	6.67	31.67	58.33	4.43
Speeding Kills	0	13.33	21.67	35	30	3.82
Slow Down	3.33	3.33	23.33	35	35	3.95
Drive Like Your Life Depends on It	0	16.67	33.33	23.33	26.67	3.60
Get Your Head out of Your Apps	8.33	11.67	23.33	21.67	35	3.63
One Text or Call Could Wreck It All	0	13.33	26.67	31.67	28.33	3.75
Even Texting Drivers Hate Texting Drivers	8.33	16.67	25	20	30	3.47
No Text Is Worth A Life	1.67	3.33	15	48.33	31.67	4.05
What's More Important, Your Text or Your Life?	5	13.33	21.67	35	25	3.62
Don't Let Texting Blind You	6.67	16.67	38.33	20	18.33	3.27
Texting & Driving—It Can Wait	0	18.33	33.33	30	18.33	3.48

Note: Mean calculated using not-at-all effective (NAE) = 1, not-so effective (NSE) = 2, neutral (N) = 3, somewhat effective (SE) = 4, and very effective (VE) = 5



Note: VE: very effective, SE: somewhat effective, N: neutral, NSE: not so effective, NAE: not at all effective

Figure 4.2: Driver Perceptions of DMS Messages M1–M14 (Simulator Survey)

4.1.4.2 Other Messages

Participants were also asked about the effectiveness of 13 messages that were not shown in the simulator study. The message codes (M15–M27) are shown in Table 4.5.

Table 4.5: Message Codes Not Shown on DMS

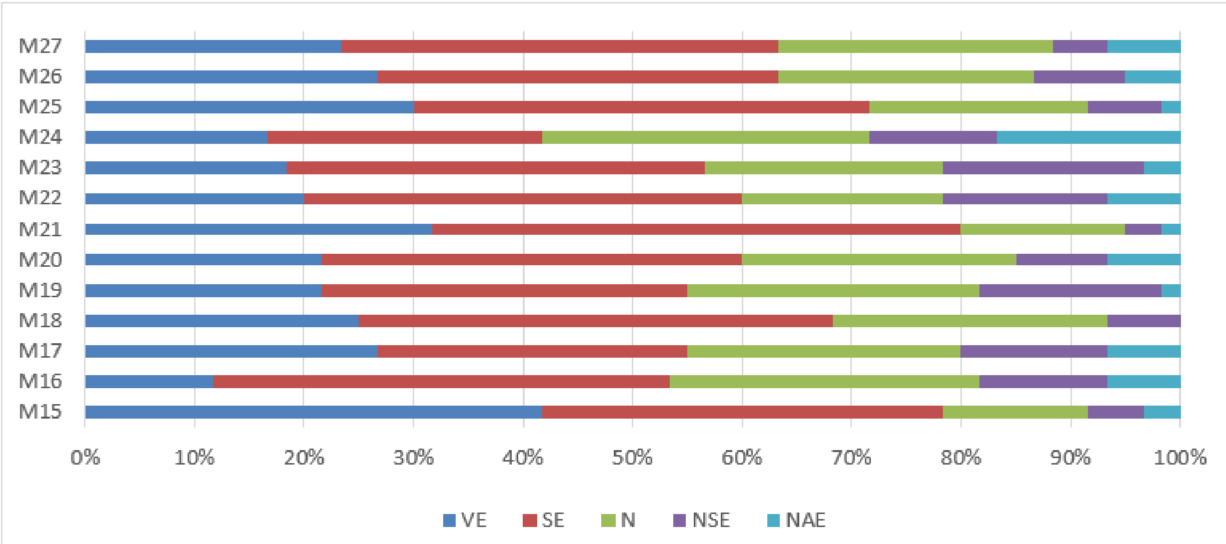
Code	Messages
M15	Click It or Ticket
M16	Click It, Don't Risk It
M17	Buckle Up, Every Trip, Every Time
M18	Head Up Phone Down
M19	A Steering Wheel Is Not A Hands-Free Device
M20	Slow Down, Ride Like Your Life Depends on It
M21	Speeding Kills—Arrive Alive
M22	Tomorrow Is the Reward for Safe Driving
M23	Don't Text and Drive, It Can Wait
M24	Just Drive
M25	You Drink. You Drive. You Lose.
M26	Drunk Driving—Don't Let Cheers Turn into Tears
M27	Drive High Get a DUI

As with the first messages, drivers' opinions about the messages were elicited using a standard 5-point Likert scale. As shown in Table 4.6 and Figure 4.3, most participants (80%) thought that the message "Speeding Kills—Arrive Alive" was most effective, followed by "Click it or Ticket" (78.33%) and "You Drink. You Drive. You Lose." (71.67%).

Table 4.6: Driver Perceptions of DMS Messages M15–M27 (Simulator Survey)

Messages	NAE (%)	NSE (%)	N (%)	SE (%)	VE (%)	Mean (1–5)
Click It or Ticket	3.33	5	13.33	36.67	41.67	4.08
Click It, Don't Risk It	6.67	11.67	28.33	41.67	11.67	3.40
Buckle Up, Every Trip, Every Time	6.67	13.33	25	28.33	26.67	3.55
Head Up Phone Down	0	6.67	25	43.33	25	3.87
A Steering Wheel Is Not A Hands-Free Device	1.67	16.67	26.67	33.33	21.67	3.57
Slow Down, Ride Like Your Life Depends on It	6.67	8.33	25	38.33	21.67	3.60
Speeding Kills—Arrive Alive	1.67	3.33	15	48.33	31.67	4.05
Tomorrow Is the Reward for Safe Driving	6.67	15	18.33	40	20	3.52
Don't Text and Drive, It Can Wait	3.33	18.33	21.67	38.33	18.33	3.50
Just Drive	16.67	11.67	30	25	16.67	3.13
You Drink. You Drive. You Lose.	1.67	6.67	20	41.67	30	3.92
Drunk Driving—Don't Let Cheers Turn into Tears	5	8.33	23.33	36.67	26.67	3.72
Drive High Get A DUI	6.67	5	25	40	23.33	3.68

Note: Mean calculated using not-at-all effective (NAE) = 1, not-so effective (NSE) = 2, neutral (N) = 3, somewhat effective (SE) = 4, and very effective (VE) = 5



Note: VE: very effective, SE: somewhat effective, N: neutral, NSE: not-so effective, NAE: not-at-all effective

Figure 4.3: Driver Perceptions of DMS Messages M15–M27 (Simulator Survey)

4.2 Online Survey Data Analysis

4.2.1 Awareness of DMS Messages

The online survey gathered data on the respondents' exposure to various messages displayed on DMSs. As shown in Figure 4.4, most respondents (85%) reported that they had seen safety-related messages displayed on DMSs. Subsequently, 45% of respondents reported seeing crash-related information, 40% reported seeing construction messages, 33% had seen travel-time information, and only 25% remembered seeing weather-related messages. Since traffic incidents and adverse weather reports are relatively infrequent, it is not surprising that more drivers recalled seeing safety messages. Therefore, in terms of awareness and recall, most drivers recalled seeing DMS messages.

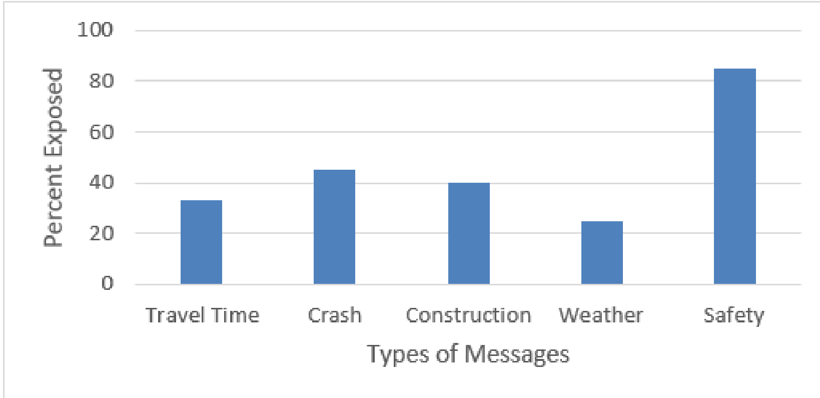


Figure 4.4: Exposure to DMS Messages (Online Survey)

4.2.2 Uses of DMS

As shown in Table 4.7, most survey respondents recognized the benefits of displaying information regarding weather, real-time traffic, reminders not to tailgate, general safety messages, and reminders of driver courteousness. Similar to the results obtained after the simulation study, respondents' opinions on the display of anti-speeding messages, however, were somewhat neutral. These results show that most drivers support the use of DMS for the display of other types of messages besides traffic information.

4.2.3 Display of Road Safety Messages

Table 4.8 reports the results of drivers' attention and reactions to road safety messages on DMSs. Most drivers (89%) indicated that they look at displayed messages, and 85% reported that they think about the displayed messages. These results reveal that a DMS is an effective communication device and that displaying non-traffic-related information does not negatively impact the effectiveness of traffic-related information. Since most respondents appreciated the display of road safety messages but were not overly enthusiastic about anti-speeding messages, displaying other safety messages may be more effective than displaying anti-speeding messages.

Table 4.7: Driver Responses to Displayed DMS Messages (Online Survey)

Driver Responses to DMS	SD (%)	D (%)	N (%)	A (%)	SA (%)	Mean (1–5)
It is a good idea to remind drivers….						
not to follow too closely on the road.	1.67	1.67	25.83	50.00	20.83	3.87
to be courteous on the road.	1.67	7.50	25.00	50.83	15.00	3.70
of hazardous weather conditions.	0.00	0.00	3.33	28.33	68.33	4.65
It is a good idea to display….						
general safety messages on highway message boards.	1.67	5.83	23.33	43.33	25.83	3.86
anti-speeding messages on highway message boards.	2.50	10.00	39.17	33.33	15.00	3.48
drunk-driving messages on highway message boards.	5.00	5.00	16.67	50.00	23.33	3.82
anti-texting and driving messages on highway message boards.	0.83	4.17	14.17	42.50	38.33	4.13
seat belt-use messages on highway message boards.	0.83	3.33	20.83	45.83	29.17	3.99
weather-warning messages.	1.67	4.17	5.00	40.00	49.17	4.31

Note: Mean calculated using strongly disagree (SD) = 1, disagree (D) = 2, neutral (N) = 3, agree (A) = 4, and strongly agree (SA) = 5

Table 4.8: Driver Reactions to Displayed Messages

Respond to the Following Statements:	SD (%)	D (%)	N (%)	A (%)	SA (%)	Mean (1–5)
I look at the information on highway message boards when it is displayed.	0.83	2.50	7.50	51.67	37.50	4.23
I think about the information displayed on highway message boards.	0.83	1.67	12.50	51.67	33.33	4.15
Behavioral Effects of Road Safety Messages						
Remind me to check my following distance	4.17	12.50	32.50	41.67	9.17	3.39
Reduce my likelihood of speeding	2.50	14.17	30.83	35.83	16.67	3.50
Remind me not to text while driving	2.50	5.00	19.17	52.50	20.83	3.84
Remind me not to drive after consuming alcohol	6.67	3.33	19.17	41.67	29.17	3.83
Remind me to pay more attention while driving	3.33	2.50	15.83	57.50	20.83	3.90
Remind me to always use the seat belt while driving	4.17	6.67	11.67	53.33	24.17	3.87
Remind me to move over for law enforcement or maintenance workers	4.17	4.17	12.50	45.83	33.33	4.00

Note: Mean calculated using strongly disagree (SD) = 1, disagree (D) = 2, neutral (N) = 3, agree (A) = 4, and strongly agree (SA) = 5

4.2.4 Driver Perception of DMS Messages

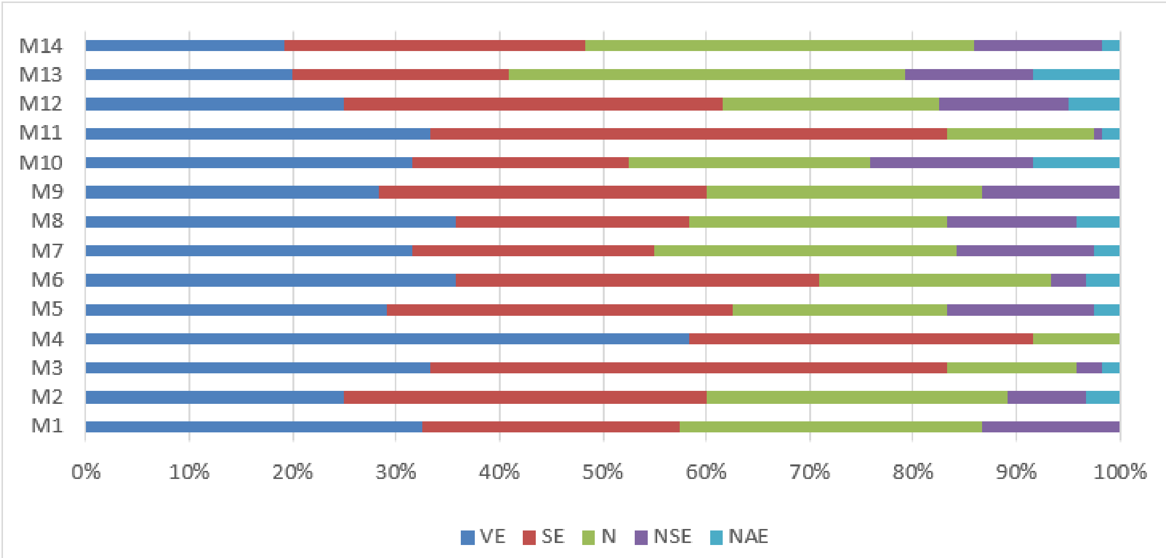
4.2.4.1 Messages Shown in Simulator (M1–M14)

The 14 DMS messages coded M1–M14 (Table 4.3) were also used in the online survey. To confirm survey responses, drivers' opinions on various displayed messages were elicited using a standard 5-point Likert scale. As shown in Table 4.9 and Figure 4.5, most participants (91.67%) thought that "Move Over for Law Enforcement and Maintenance Workers" was the most effective message, followed by "No Text Is Worth A Life" (83.33%) and "Give Space, Don't Tailgate" (83.3%).

Table 4.9: Driver Perceptions of DMS Messages M1–M14 (Online Survey)

Messages	NAE (%)	NSE (%)	N (%)	SE (%)	VE (%)	Mean (1–5)
Steering Wheel: Not A Hands-Free Device	0	13.33	29.17	25	32.5	3.77
Pay Attention and Just Drive	3.33	7.5	29.17	35	25	3.71
Give Space, Don't Tailgate	1.67	2.5	12.5	50	33.33	4.11
Move Over for Law Enforcement and Maintenance Workers	0	0	8.33	33.33	58.33	4.50
Speeding Kills	2.5	14.17	20.83	33.33	29.17	3.73
Slow Down	3.33	3.33	22.5	35	35.83	3.97
Drive Like Your Life Depends on It	2.5	13.33	29.17	23.33	31.67	3.68
Get Your Head out of Your Apps	4.17	12.5	25	22.5	35.83	3.73
One Text or Call Could Wreck It All	0	13.33	26.67	31.67	28.33	3.75
Even Texting Drivers Hate Texting Drivers	8.33	15.83	23.33	20.83	31.67	3.52
No Text Is Worth A Life	1.67	0.83	14.17	50	33.33	4.12
What's More Important, Your Text or Your Life?	5	12.5	20.83	36.67	25	3.64
Don't Let Texting Blind You	8.33	12.5	38.33	20.83	20	3.32
Texting & Driving—It Can Wait	1.67	12.5	37.5	29.17	19.17	3.52

Note: Mean calculated using not-at-all effective (NAE) = 1, not-so effective (NSE) = 2, neutral (N) = 3, somewhat effective (SE) = 4, and very effective (VE) = 5



Note: VE: very effective, SE: somewhat effective, N: neutral, NSE: not-so effective, NAE: not-at-all effective

Figure 4.5: Driver Perceptions of DMS Messages M1–M14 (Online Survey)

4.2.4.2 Other Messages

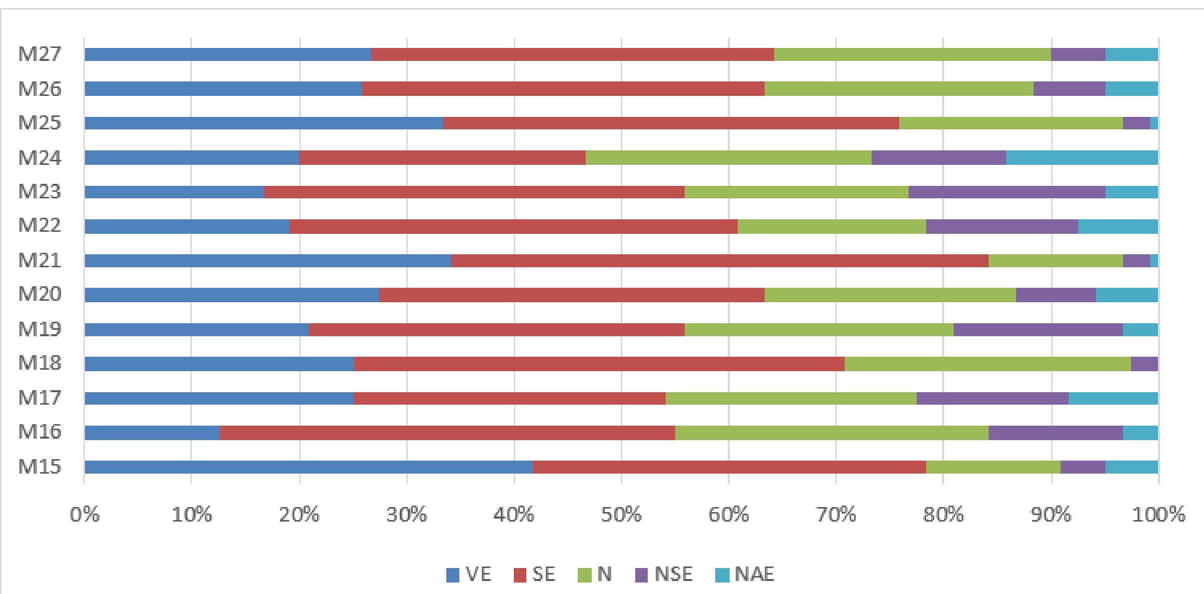
The online survey also included questions regarding the effectiveness of 13 messages coded M15–M27 (Table 4.5). Drivers' opinions on the various displayed messages were also elicited using the standard 5-point Likert scale. As shown in Table 4.10 and Figure 4.6, most participants (84.17%) thought that "Speeding Kills—Arrive Alive" was the most effective message, followed by "Click It or Ticket" (78.33%) and "You Drink. You Drive. You Lose." (75.83%).

Most survey participants recommended displaying suggestions for safer driving behavior and other road safety messages, including warnings about driver fatigue, drunk driving, tailgating, and speeding. Most participants also affirmed the effectiveness of displaying non-traffic-related information.

Table 4.10: Driver Perceptions of DMS Messages M15–M27 (Online Survey)

Messages	NAE (%)	NSE (%)	N (%)	SE (%)	VE (%)	Mean (1–5)
Click It or Ticket	5	4.17	12.5	36.67	41.67	4.06
Click It, Don't Risk It	3.33	12.5	29.17	42.5	12.5	3.48
Buckle Up, Every Trip, Every Time	8.33	14.17	23.33	29.17	25	3.48
Head Up Phone Down	0	2.5	26.67	45.83	25	3.93
A Steering Wheel Is Not A Hands-Free Device	3.33	15.83	25	35	20.83	3.54
Slow Down, Ride Like Your Life Depends on It	5.83	7.5	23.33	35.83	27.5	3.72
Speeding Kills—Arrive Alive	0.83	2.5	12.5	50	34.17	4.14
Tomorrow Is the Reward for Safe Driving	7.5	14.17	17.5	41.67	19.17	3.51
Don't Text and Drive, It Can Wait	5	18.33	20.83	39.17	16.67	3.44
Just Drive	14.17	12.5	26.67	26.67	20	3.26
You Drink. You Drive. You Lose.	0.83	2.5	20.83	42.5	33.33	4.05
Drunk Driving—Don't Let Cheers Turn into Tears	5	6.67	25	37.5	25.83	3.72
Drive High Get A DUI	5	5	25.83	37.5	26.67	3.76

Note: Mean calculated using not-at-all effective (NAE) = 1, not-so effective (NSE) = 2, neutral (N) = 3, somewhat effective (SE) = 4, and very effective (VE) = 5

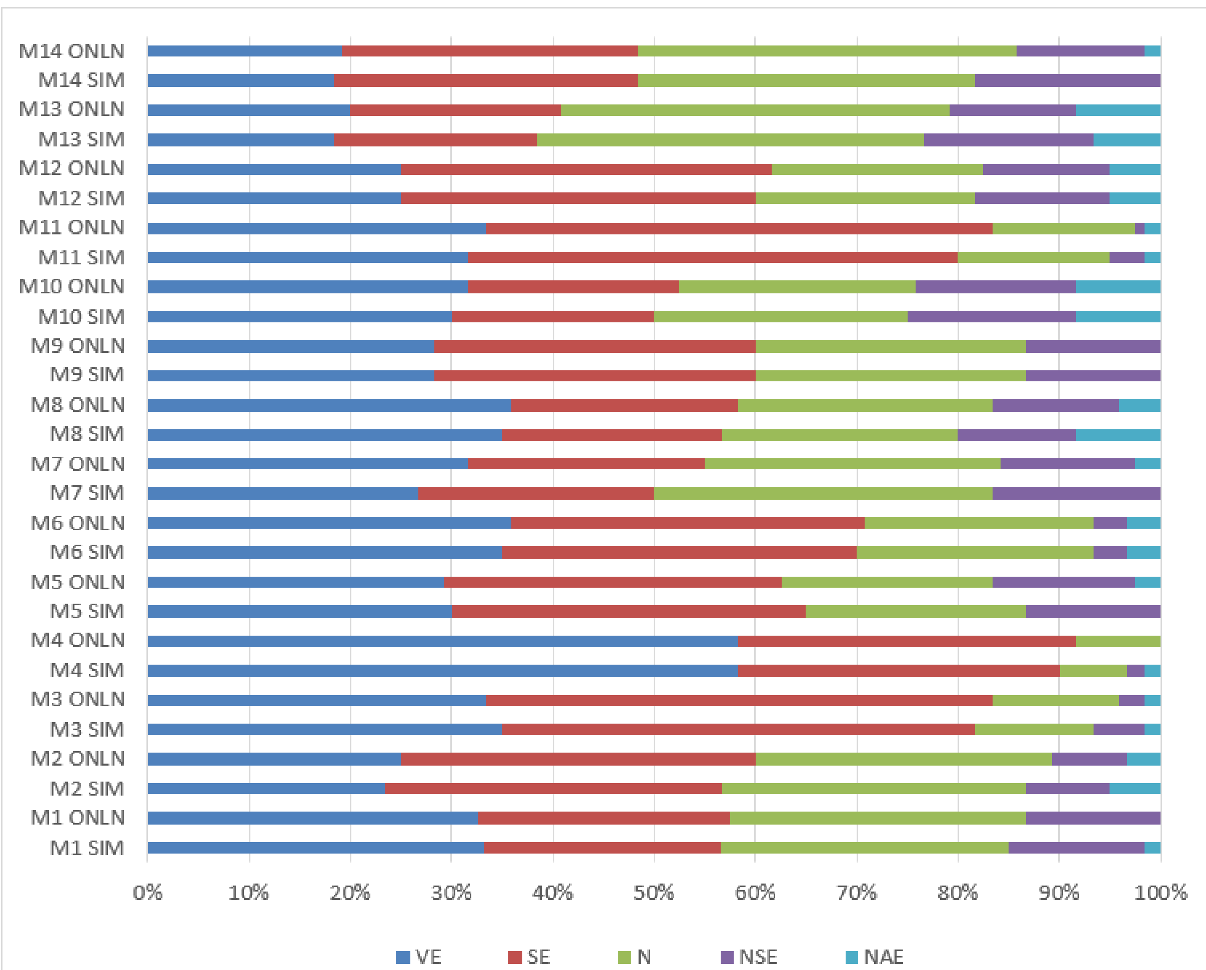


Note: VE: very effective, SE: somewhat effective, N: neutral, NSE: not-so effective, NAE: not-at-all effective

Figure 4.6: Driver Perceptions of DMS Messages M15–M27 (Online Survey)

4.3. Combined Analysis

Based on preliminary analysis, the results obtained from the two DMS display surveys were very similar even though they were administered to different sample populations. Therefore, the two samples were combined to report aggregated results. Figure 4.7 displays the combined results of the two surveys for questions M1–M14. Visual assessment of Figure 4.7 and Figure 4.8 reveals that the participants responded similarly across the two surveys; therefore, the difference between the two surveys was minimal, and the conclusion was made that the simulator drivers and online survey participants had comparable perceptions regarding the messages.



Note: VE: very effective, SE: somewhat effective, N: neutral, NSE: not-so effective, NAE: not-at-all effective

Figure 4.7: Driver Perceptions of DMS Messages M1–M14 (Combined Results)

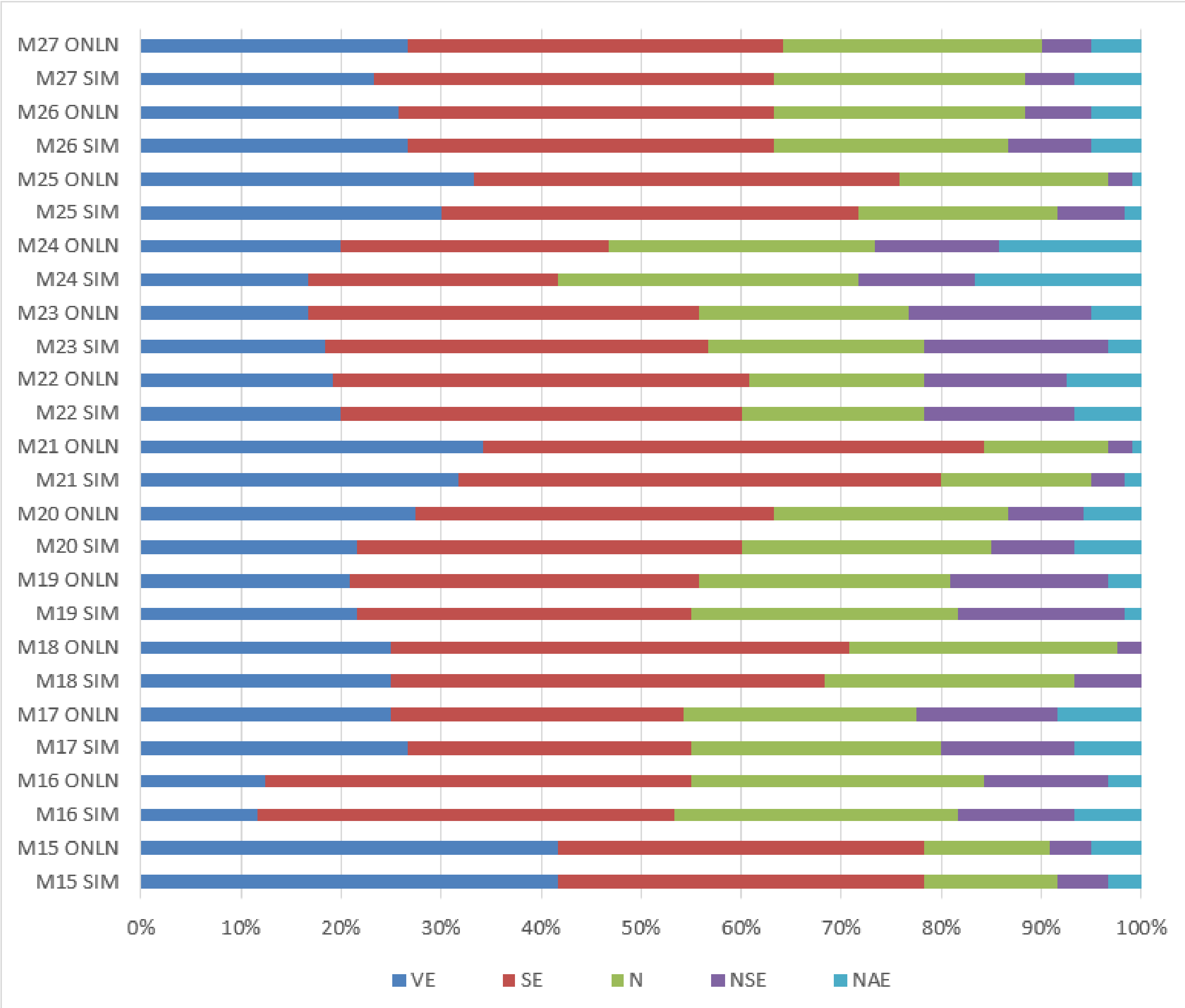


Figure 4.8: Driver Perceptions of DMS Messages M15–M27 (Combined Results)

After combining the two survey results (Table 4.11), most survey participants (91.11%) thought that "Move Over for Law Enforcement and Maintenance Workers" was the most effective message, followed by "Give Space, Don't Tailgate" (82.78%), "Speeding Kills—Arrive Alive" (82.77%), and "No Text Is Worth A Life" (82%).

Table 4.11: Driver Perceptions (Combined) of Messages Displayed on DMS in Simulator

Code	Messages	NAE (%)	NSE (%)	N (%)	SE (%)	VE (%)	Mean (1–5)
M1	Steering Wheel: Not A Hands-Free Device	0.56	13.33	28.89	24.44	32.78	3.76
M2	Pay Attention and Just Drive	3.89	7.78	29.44	34.44	24.44	3.68
M3	Give Space, Don't Tailgate	1.67	3.33	12.22	48.89	33.89	4.10
M4	Move Over for Law Enforcement and Maintenance Workers	0.56	0.56	7.78	32.78	58.33	4.48
M5	Speeding Kills	1.67	13.89	21.11	33.89	29.44	3.76
M6	Slow Down	3.33	3.33	22.78	35.00	35.56	3.96
M7	Drive Like Your Life Depends on It	1.67	14.44	30.56	23.33	30.00	3.66
M8	Get Your Head out of Your Apps	5.56	12.22	24.44	22.22	35.56	3.70
M9	One Text or Call Could Wreck It All	0.00	13.33	26.67	31.67	28.33	3.75
M10	Even Texting Drivers Hate Texting Driver	8.33	16.11	23.89	20.56	31.11	3.50
M11	No Text Is Worth A Life	1.67	1.67	14.44	49.44	32.78	4.10
M12	What's More Important, Your Text or Your Life?	5.00	12.78	21.11	36.11	25.00	3.63
M13	Don't Let Texting Blind You	7.78	13.89	38.33	20.56	19.44	3.30
M14	Texting & Driving—It Can Wait	1.11	14.44	36.11	29.44	18.89	3.51
M15	Click It or Ticket	4.44	4.44	12.78	36.67	41.67	4.07
M16	Click It, Don't Risk It	4.44	12.22	28.89	42.22	12.22	3.46
M17	Buckle Up, Every Trip, Every Time	7.78	13.89	23.89	28.89	25.56	3.51
M18	Head Up Phone Down	0.00	3.89	26.11	45.00	25.00	3.91
M19	A Steering Wheel Is Not a Hands-Free Device	2.78	16.11	25.56	34.44	21.11	3.55
M20	Slow Down, Ride Like Your Life Depends on It	6.11	7.78	23.89	36.67	25.56	3.68
M21	Speeding Kills—Arrive Alive	1.11	2.78	13.33	49.44	33.33	4.11
M22	Tomorrow Is the Reward for Safe Driving	7.22	14.44	17.78	41.11	19.44	3.51
M23	Don't Text and Drive, It Can Wait	4.44	18.33	21.11	38.89	17.22	3.46
M24	Just Drive	15.00	12.22	27.78	26.11	18.89	3.22
M25	You Drink. You Drive. You Lose.	1.11	3.89	20.56	42.22	32.22	4.01
M26	Drunk Driving—Don't Let Cheers Turn into Tears	5.00	7.22	24.44	37.22	26.11	3.72
M27	Drive High Get A DUI	5.56	5.00	25.56	38.33	25.56	3.73

Note: Mean calculated using not-at-all effective (NAE) = 1, not-so effective (NSE) = 2, neutral (N) = 3, somewhat effective (SE) = 4, and very effective (VE) = 5

Chapter 5: Driver Behavior Data Analysis

Data collected via the driving simulator were used to identify changes in driver behavior due to DMS messages. The statistical analysis involved 2-tailed paired t-tests. A 95% confidence interval was assumed for the t-tests.

5.1 Speeding Messages

Two DMS speeding messages were used in the simulator scenario to assess whether driver behavior changed after drivers saw and read these messages. Average speeds before the displayed message and average speeds after the message was displayed were extracted from the simulator. In addition, to ensure that drivers read the DMS message, the exact point that drivers initially looked at the DMS was obtained using eye-tracking equipment.

5.1.1 "Slow Down" Message

The average speed for each driver was calculated by averaging the point speed recorded at a frequency of 60 Hz. The average speed was calculated during two separate events. The "before" event included driving along the roadway for approximately 1.5 miles upstream of the DMS and before participants identified and read the DMS message. The "after" event included looking at and reading the message on the DMS and driving along the roadway for approximately 1.5 miles. Drivers' eye gazes were recorded using the eye-tracking device. Figure 5.1 shows the average speeds per gender for three age groups during the two events when the message "Slow Down" (M6) was shown in the DMS.

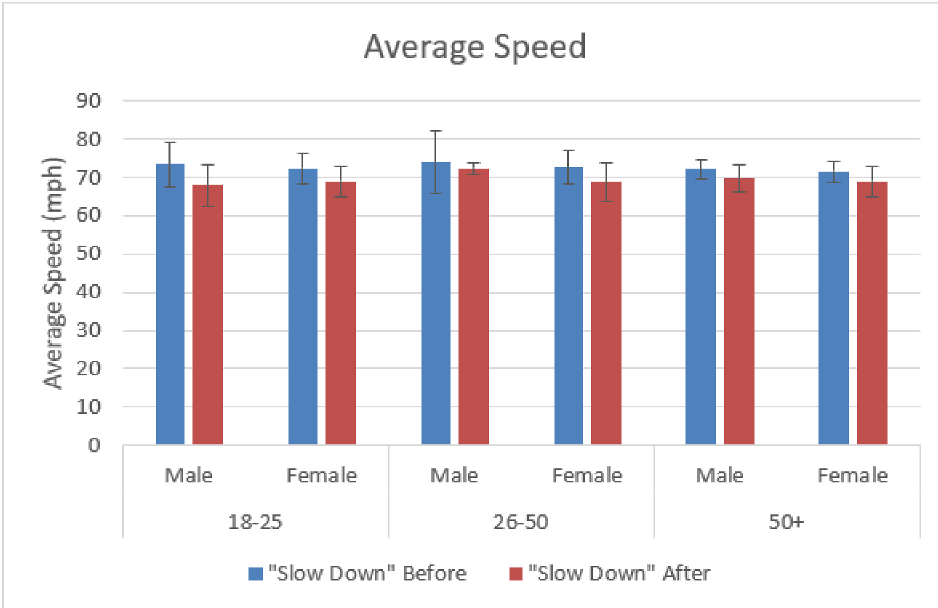


Figure 5.1: Average Speeds and Standard Deviations for the "Slow Down" Message

Table 5.1 provides descriptive statistics of average speed measurements for the "Slow Down" message. A comparison of the means among the 60 participants in the paired t-test resulted in a p-value of 0.0001 (Table 5.2). The obtained p-value indicated a significant difference between the means of the two phases of the drive. Therefore, the "Slow Down" DMS message significantly affected driving speeds.

Table 5.1: Descriptive Statistics for Avg Speed (Slow Down)

Avg Speed	Mean	N	Std. Deviation	Std. Error Mean
Before	72.9305	60	5.36635	.69279
After	69.5352	60	5.98157	.77222

Table 5.2: Significance in 2-Tailed T-Test for Avg Speed (Slow Down)

Mean Speed Difference	Std. Dev	Std. Error Mean	95% CI of the Difference		t	df	p-value
			Lower	Upper			
3.39533	4.29701	0.55474	2.28530	4.50537	6.121	59	0.0001

In addition, a paired t-test was conducted to evaluate if the message affected certain age groups or genders. Based on results shown in Table 5.3, a p-value of 0.0002 and 0.0041 (less than 0.025) was obtained for males and females, respectively, indicating that the speed of both male and female drivers significantly changed after reading the message.

Table 5.3: T-Test Results for Avg Speed "Slow Down" Message by Gender Group

Gender	Mean Speed Difference	Std. Dev	Std. Error Mean	95% CI of the Difference		t	df	p-value
				Lower	Upper			
Male	4.47774	4.49217	0.80682	2.83000	6.12548	5.550	30	0.0002
Female	2.23828	3.82128	0.70959	0.78474	3.69181	3.154	28	0.0041

Average speed changes were also evaluated for three age groups (18–25, 26–50, and over 50 years old). As shown in the statistical results in Table 5.4, the DMS message significantly affected driving speeds of the 18–25 and 26–50 age groups (p-values = 0.0003 and 0.0011, respectively) but did not impact the older age group (over 50 years old), where the p-value was greater than 0.025.

Table 5.4: T-Test Results for Avg Speed "Slow Down" Message by Age Group

Age Group	Mean Speed Difference	Std. Dev	Std. Error Mean	95% CI of the Difference		t	df	p-value
				Lower	Upper			
18–25	4.48320	5.07487	1.01497	2.38840	6.57800	4.417	24	0.0003
26–50	2.73680	3.75747	0.75149	1.18579	4.28781	3.642	24	0.0011
50+	2.32200	2.99066	0.94573	0.18261	4.46139	2.455	9	0.0363

5.1.2 "Speeding Kills" Message

Figure 5.2 shows the average speeds before and after study participants read the DMS message "Speeding Kills" (M5).

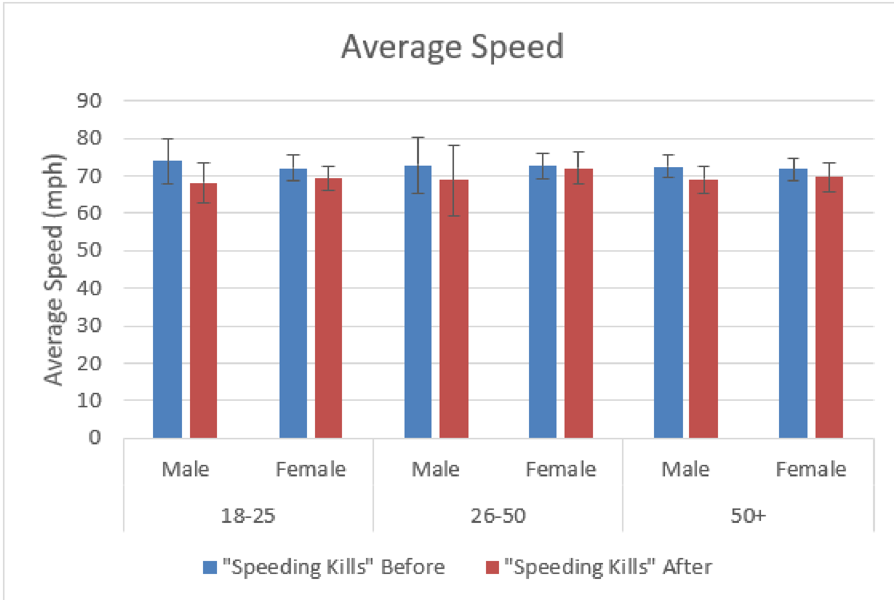


Figure 5.2: Average Speeds and Standard Deviations for the "Speeding Kills" Message

Table 5.5 lists the descriptive statistics of the average speeds before and after the "Speeding Kills" message was displayed. A comparison of the means among the 60 participants in the paired t-test resulted in a p-value of 0.0003 (Table 5.6). The obtained p-value indicated a significant difference between the means of the two phases of the driving test.

Table 5.5: Descriptive Statistics for Avg Speed (Speeding Kills)

Avg Speed	Mean	N	Std. Deviation	Std. Error Mean
Before	71.3872	60	5.25022	0.67780
After	67.4317	60	5.74255	0.74136

Table 5.6: Significance in 2-Tailed T-Test for Avg Speed (Speeding Kills)

Mean Speed Difference	Std. Dev	Std. Error Mean	95% CI of the Difference		t	df	p-value
			Lower	Upper			
3.24750	3.89572	0.50294	2.24113	4.25387	6.457	59	0.0003

Based on the paired t-test, a p-value less than 0.025, shown in Table 5.7, was obtained for male and female participants, respectively, which indicates a significant difference between the means.

Table 5.7: T-Test Results for Avg Speed "Speeding Kills" Message by Gender Group

Gender	Mean Speed Difference	Std. Dev	Std. Error Mean	95% CI of the Difference		t	df	p-value
				Lower	Upper			
Male	4.60097	4.56666	0.82020	2.92590	6.27603	5.610	30	0.0001
Female	1.80069	2.33220	0.43308	0.91357	2.68781	4.158	28	0.0003

In Table 5.8, the paired t-test results show that the youngest age group (18–25) demonstrated a significant change in their speeding behavior after the "Speeding Kills" message was displayed. For the other two age groups (26–50 and over 50), however, no significant difference was found between the means of the speed during the two phases of the driving test.

Table 5.8: T-Test Results for Avg Speed "Speeding Kills" Message by Age Group

Age Group	Mean Speed Difference	Std. Dev	Std. Error Mean	95% CI of the Difference		t	df	p-value
				Lower	Upper			
18–25	4.47400	4.17941	0.83588	2.74882	6.19918	5.352	24	<0.0001
26–50	2.37840	6.04536	1.20907	-0.11700	4.87380	1.967	24	0.0614
50+	2.54700	3.10135	0.98073	0.32843	4.76557	2.597	9	0.0293

5.2 Car-Following Event

During the car-following event, measurements of a preferred gap (distance in ft) to the lead vehicle were recorded. Gaps were collected every 60 Hz (1/60 s). The average gap value from the beginning to the end of the car-following event was calculated for each participant. Slow-moving cars were modeled in the simulator during this event to see if drivers altered their car-following behavior after they saw the DMS message "Give Space, Don't Tailgate" (M3). Figure 5.3 presents the average gaps for all participants, based on age and gender groups, before and after seeing this message while they were driving.

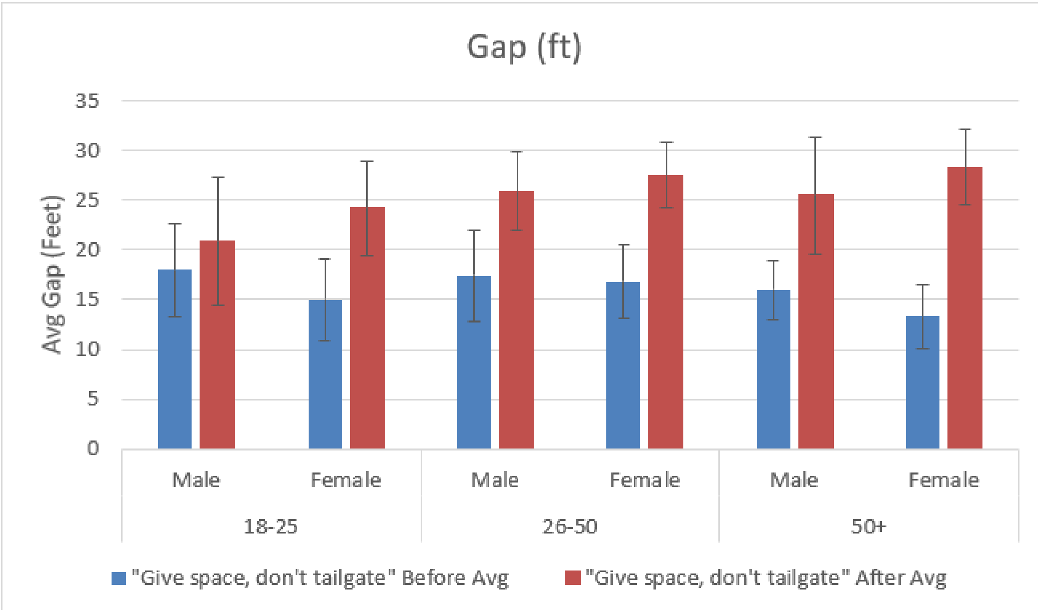


Figure 5.3: Average Gap for the "Give Space, Don't Tailgate" Message

Preferred gap distance provides an insight into risky driver behavior. As shown in Figure 5.3, after the DMS was displayed, most drivers chose to follow longer gaps. Table 5.9 provides descriptive statistics of average gaps for this message. Statistical analysis (Table 5.10) resulted in a p-value of <0.0001, indicating a significant difference in the mean gaps of the two phases of the driving test.

Table 5.9: Descriptive Statistics for Avg Gap (Give Space, Don't Tailgate)

Avg Gap	Mean	N	Std. Deviation	Std. Error Mean
Before	16.5000	60	4.24863	0.54850
After	24.9667	60	5.29140	0.68312

Table 5.10: Significance in 2-Tailed T-Test for Avg Gap (Give Space, Don't Tailgate)

Mean Gap Difference	Std. Dev	Std. Error Mean	95% CI of the Difference		t	df	p-value
			Lower	Upper			
-8.46667	5.53408	0.71445	-9.89627	-7.03706	-11.851	59	<0.0001

Maximum speed data were also recorded during the car-following event. Results showed that maximum speeds were higher before the DMS message was displayed (mean velocity of 65.5 mph), compared to maximum speeds recorded after the DMS message was displayed (mean velocity of 57.5 mph). On average, a 12.2% reduction in maximum speed was observed after the DMS was displayed. Figure 5.4 and Table 5.11 show the resulting descriptive statistics and variation of maximum speeds by gender and age group.

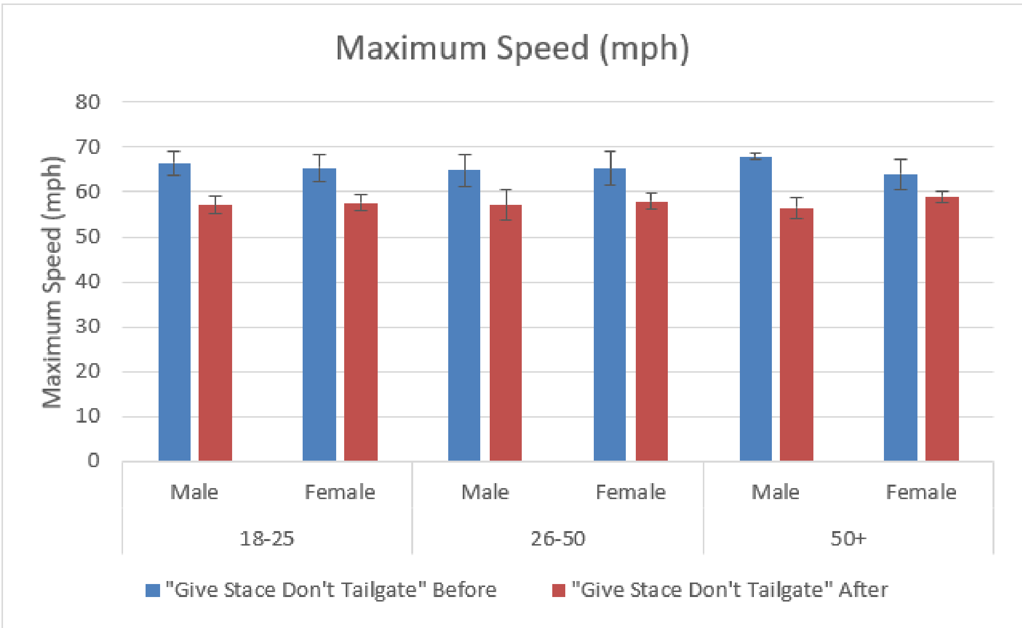


Figure 5.4: Maximum Speeds and Standard Deviations for the "Give Space, Don't Tailgate" Message

Table 5.11: Descriptive Statistics for Maximum Speed (Give Space, Don't Tailgate)

Max Speed	Mean	N	Std. Deviation	Std. Error Mean
Before	65.5167	60	3.16491	0.40859
After	57.5333	60	1.85460	0.23943

Statistical comparison between the average maximum speeds for this message showed that participants changed their preferred speeds after seeing the "Give Space, Don't Tailgate" message (Table 5.12).

Table 5.12: Significance in 2-Tailed T-Test for Maximum Speed (Give Space, Don't Tailgate)

Mean Speed Difference	Std. Dev	Std. Error Mean	95% CI of the Difference		t	df	p-value
			Lower	Upper			
7.98333	3.93374	0.50784	6.96714	8.99953	15.720	59	0.0003

5.3 Move-Over Law

Each designed scenario contained three locations where the message "Move Over for Law Enforcement and Maintenance Workers" (M4) could be observed. A value of 1 was assigned each time participants moved over after reading the message. A maximum number of three observed locations per scenario could be achieved by each participant. A value of zero was recorded if participants did not move over at a location. Figure 5.5 shows the move-over events per age and gender group before and after the message was displayed, and Table 5.13 shows the descriptive statistics of those events.

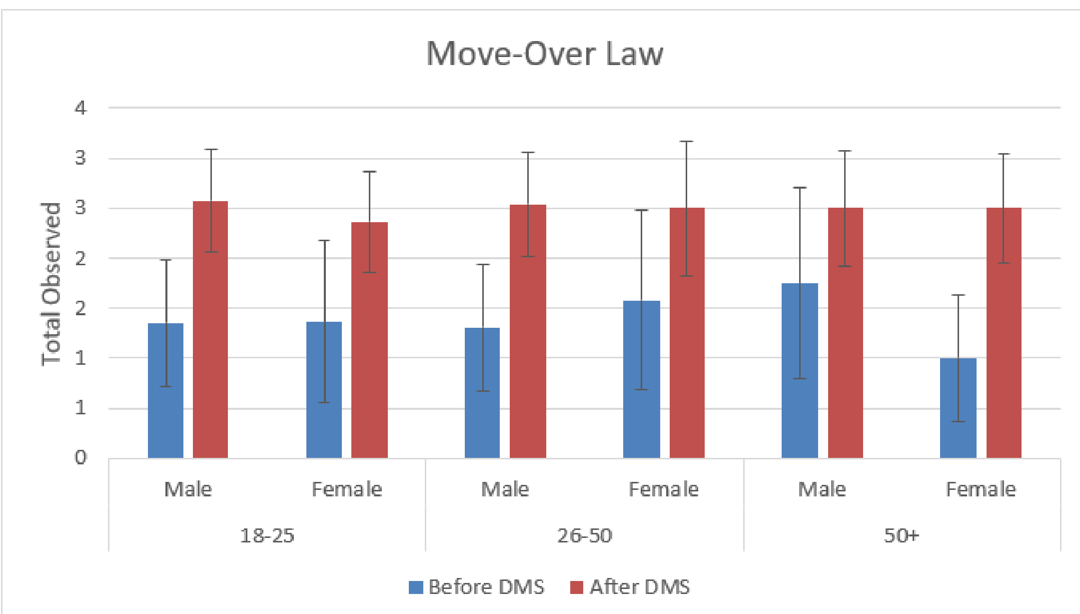


Figure 5.5: Move-Over Events Observed for the "Move Over for Law Enforcement" Message

Table 5.13: Descriptive Statistics for Move-Over Law

Events	Mean	N	Std. Deviation	Std. Error Mean
Before	1.38	60	0.739	0.095
After	2.50	60	0.537	0.069

The paired t-test (Table 5.14) resulted in a p-value of 0.0001, which is less than 0.025, indicating that the data obtained from the sample population succeeded in rejecti ng the null hypothesis, thereby showing significant difference in driving behavior when the move-over DMS was displayed.

Table 5.14: Significance in 2-Tailed T-Test for Move-Over Law

Move-Over Events Difference	Std. Dev	Std. Error Mean	95% CI of the Difference		t	df	p-value
			Lower	Upper			
-1.117	0.783	0.101	-1.319	-0.914	-11.045	59	0.0001

5.4 Anti-Texting Messages

In this study, 10 text-related DMS messages were displayed in the driving scenario, with the primary aim of discouraging texting while driving. Each driver received five text messages on a cellphone when no DMSs were present on the roadway and five text messages after they had been exposed to DMS messages. The numbers of text messages that the drivers responded to before and after seeing the DMS were recorded, and then the number of text message responses was further analyzed to evaluate which DMS message most effectively discouraged drivers from texting. Table 5.15 lists the anti-texting DMS messages with their respective code numbers. Table 5.16 shows the descriptive statistics of texting responses for all 10 messages.

Table 5.15: Anti-Texting DMS Messages

Code	Messages
M1	Steering Wheel: Not A Hands-Free Device
M2	Pay Attention and Just Drive
M7	Drive Like Your Life Depends on It
M8	Get Your Head out of Your Apps
M9	One Text or Call Could Wreck It All
M10	Even Texting Drivers Hate Texting Drivers
M11	No Text Is Worth A Life
M12	What's More Important, Your Text or Your Life?
M13	Don't Let Texting Blind You
M14	Texting & Driving—It Can Wait

Table 5.16: Descriptive Statistics for Anti-Texting Messages

Code		Mean No. of Texts	N	Std. Deviation	Std. Error Mean
M1	BEFORE	3.92	60	1.094	0.141
	AFTER	1.02	60	1.242	0.160
M2	BEFORE	4.18	60	1.017	0.131
	AFTER	3.77	60	1.155	0.149
M8	BEFORE	3.70	60	1.280	0.165
	AFTER	0.60	60	0.942	0.122
M9	BEFORE	3.72	60	1.277	0.165
	AFTER	2.17	60	1.729	0.223
M10	BEFORE	3.88	60	1.043	0.135
	AFTER	3.33	60	1.323	0.171
M11	BEFORE	4.02	60	1.049	0.135
	AFTER	1.35	60	1.505	0.194
M12	BEFORE	3.87	60	1.033	0.133
	AFTER	2.33	60	1.602	0.207
M13	BEFORE	3.72	60	1.027	0.133
	AFTER	3.58	60	1.197	0.155
M14	BEFORE	3.75	60	1.068	0.138
	AFTER	3.30	60	1.139	0.147
M7	BEFORE	3.63	60	1.041	0.134
	AFTER	3.35	60	1.162	0.150

Table 5.17 shows the results of the statistical comparison of the number of text messages sent by the participants before and after seeing the anti-texting DMS messages. As shown in the table, the p-value in the paired t-test was greater than 0.025 for messages M2, M10, M13, M14, and M7. However, for messages M1, M8, M9, M11, and M12, the paired t-test p-values were less than 0.025. Therefore, the most effective messages for altering drivers' texting behavior were "Steering Wheel: Not A Hands-Free Device," "Get Your Head out of Your Apps," "One Text or Call Could Wreck It All," "No Text Is Worth A Life," and "What's More Important, Your Text or Your Life?"

Table 5.17: Significance in 2-Tailed T-Tests for Anti-Texting Messages

Code	Mean Difference	Std. Dev	Std. Error Mean	95% CI of the Difference		t	df	p-value
				Lower	Upper			
M1	2.900	1.623	0.210	2.481	3.319	13.841	59	0.0002
M2	0.417	1.544	0.199	0.018	0.815	2.091	59	0.0410
M8	3.100	1.298	0.168	2.765	3.435	18.500	59	0.0004
M9	1.550	2.143	0.277	0.997	2.103	5.604	59	0.0002
M10	0.550	1.534	0.198	0.154	0.946	2.777	59	0.0730
M11	2.667	1.847	0.238	2.189	3.144	11.182	59	0.0001
M12	1.533	1.789	0.231	1.071	1.996	6.637	59	0.0000
M13	0.133	1.420	0.183	-0.233	0.500	0.727	59	0.4700
M14	0.450	1.610	0.208	0.034	0.866	2.166	59	0.0340
M7	0.283	1.519	0.196	-0.109	0.676	1.445	59	0.1540

5.5 Summary of Results

Table 5.18 summarizes all messages that were evaluated in the driving simulator experiment. Statistical analysis showed that 10 of the 14 messages were statistically significant for affecting driver behavior.

Table 5.18: Significance in 2-Tailed T-Test for DMS Messages

DMS Message	Variable	Phase	Mean	p-value	Rejected Null Hypothesis
Slow Down	Average Speed (mph)	Before	72.93	0.0001	Yes
		After	69.54		
Speeding Kills	Average Speed (mph)	Before	71.39	0.0003	Yes
		After	67.43		
Give Space, Don't Tailgate	Gap (feet)	Before	16.5	<0.0001	Yes
		After	24.97		
	Maximum Speed (mph)	Before	65.52	0.0003	Yes
		After	57.53		
Move Over for Law Enforcement	Total Observed	Before	1.38	0.0001	Yes
		After	2.5		
Steering Wheel: Not A Hands-Free Device	Text Message Responded	Before	3.92	0.0002	Yes
		After	1.02		
Pay Attention and Just Drive	Text Message Responded	Before	4.18	0.0410	No
		After	3.77		
Get Your Head out of Your Apps	Text Message Responded	Before	3.7	0.0004	Yes
		After	0.6		
One Text or Call Could Wreck It All	Text Message Responded	Before	3.72	0.0002	Yes
		After	2.17		
Even Texting Drivers Hate Texting Drivers	Text Message Responded	Before	3.88	0.0730	No
		After	3.33		
No Text Is Worth A Life	Text Message Responded	Before	4.02	0.0001	Yes
		After	1.35		
What's More Important, Your Text or Your Life?	Text Message Responded	Before	3.87	<0.0001	Yes
		After	2.33		
Don't Let Texting Blind You	Text Message Responded	Before	3.72	0.4700	No
		After	3.58		
Texting & Driving—It Can Wait	Text Message Responded	Before	3.75	0.0340	No
		After	3.3		
Drive Like Your Life Depends on It	Text Message Responded	Before	3.63	0.1540	No
		After	3.35		

Chapter 6: Conclusions and Recommendations

6.1 Summary

The objective of this project was to investigate the effectiveness of entertaining, non-traffic-related messages in influencing driver behavior. To accomplish this objective, two main data collection efforts were undertaken. The first data collection effort included an online survey questionnaire that was administered to 100 participants. The questionnaire included several messages currently displayed on DMSs and requested feedback on their perceived effectiveness. The second data collection was done via a driving simulator experiment, during which 60 participants (31 males and 29 females) of diverse demographics drove past several DMSs that displayed a variety of messages. These messages were categorized as speeding (2 messages), car-following (1 message), move-over law (1 message), and anti-texting (10 messages). Participants were surveyed at the end of the experiment, and their responses were compared with responses from the online survey. Behavioral data (speeds, gaps, gazes, etc.) were extracted from the driving simulator experiment and then reduced. Statistical analyses were performed to evaluate to what extent the message content affected the driving behavior of the study participants.

6.2 Conclusions

The following conclusions were obtained from the analysis:

- Significant differences were found in the study between some of the collected variables. Participants drove at significantly lower average speeds after seeing the two speeding-related DMS messages ("Speeding Kills" and "Slow Down") in all the events configured to capture this variable.
- The gap was significantly lower after showing the DMS message "Give Space, Don't Tailgate," proving that this message helped reduce tailgating.
- A significant increase in maintaining the move-over law was observed after the "Move Over for Law Enforcement" message was displayed.
- Not all anti-texting messages yielded significant changes in drivers' texting behavior. Of the 10 displayed messages, only 5 effectively changed drivers' texting behavior. Those messages were "Steering Wheel: Not A Hands-Free

Device," "Get Your Head out of Your Apps," "One Text or Call Could Wreck It All," "No Text Is Worth A Life," and "What's More Important, Your Text or Your Life?"

- Based on the survey results, 91% of the drivers stated that the "Move Over for Law Enforcement" was an effective message to show on a DMS.
- In addition, the following effective messages were identified: "Give Space, Don't Tailgate," "Speeding Kills—Arrive Alive," and "No Text Is Worth A Life" (82%); "Click It or Ticket" (78.34%); "You Drink. You Drive. You Lose." (74.44%); "Slow Down" and "Head Up Phone Down" (70%).

6.3 Recommendations and Future Research

The following recommendations and steps for future work are proposed:

- The effects of DMS on tired/fatigued drivers should be assessed to provide key insights into the role of DMS for changing driving behavior.
- Future research should investigate the possible effects of DMS on distraction, using longer messages in more challenging driving environments.
- Drivers in this study used a different phone and some were not familiar with using their phones for text messaging. It is possible that drivers' familiarity and adeptness at using another phone may have attenuated any differences in texting behaviors.
- A separate study could investigate the effects of DMS on drivers who typically text too much while driving. In the current study, older drivers were less comfortable with texting than younger drivers, and some drivers preferred not to use their phones at all while driving.
- Based on the survey, drivers thought some messages that were not used in the simulator study would be effective. A follow-up research could evaluate the effectiveness of those unused messages.

- Drinking and driving is a serious safety issue, and while drivers thought it would be a good idea to show anti-drinking and driving messages, the effects of those messages are difficult to study with a driving simulator. Future studies could evaluate the impact of anti-drinking and driving campaigns.
- The duration of the driving simulator experiments was 60 min. Some drivers felt exhausted after driving the simulator for 30 min, and most participants suggested a drive duration of 20–25 min.

References

Adler, J. L., & Kalsher, M. J. (1994). Human factors studies to investigate driver behavior under in-vehicle information systems: An interactive microcomputer simulation approach. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting, 38*(9), 461–465.

Adler, J. L., Recker, W. W., & McNally, M. G. (1993). A conflict model and interactive simulator (FASTCARS) for predicting enroute driver behavior in response to real-time traffic condition information. *Transportation, 20*, 83–106.

Benson, B. G. (1996). Motorist attitudes about content of variable-message signs. *Transportation Research Record, 1550*, 48–57.

Capustiac, N. A., & Napoca, C. (2011). *Development and application of smart actuation methods for vehicle simulators* [Doctoral dissertation]. University of Duisburg-Essen, Duisburg, Germany.

Emmerink, R., Nijkamp, P., Rietveld, P., Van Ommeren, J. (1996). Variable message signs and radio traffic information: An integrated empirical analysis of drivers' route choice behavior. *Transportation Research Part A: Policy and Practice, 30*(2), 135–153.

IBM. (2011). *IBM SPSS Statistics 20 Core System User's Guide*. IBM Corporation.

Jamson, H. (2000). Driving simulator validity: Issues of field of view and resolution. In *Proceedings of the Driving Simulation Conference, DSC 2000, Paris, France* (pp. 57–64).

Jamson, A. H., & Merat, N. (2007). The effectiveness of safety campaign VMS messages – A driving simulator investigation. In *Proceedings of the Fourth International Driving Symposium on Human Factors in Driver Assessment, Training and Vehicle Design, July 9-12, 2007, Stevenson, Washington* (pp. 459–465). Retrieved from https://doi.org/10.17077/drivingassessment.1277

Kemeny, A., & Panerai, F. (2003). Evaluating perception in driving simulation experiments. *Trends in Cognitive Sciences, 7*(1), 31–37.

Lee, W. S., Sung, D. H., Lee, J. Y., Kim, Y. S., & Cho, J. H. (2007). Driving simulation for evaluation of driver assistance systems and driving management systems. *DSC North America – Iowa City – September 2007*.

Levine, O., & Mourant, R. (1995). A driving simulator based on virtual environments technology *(Paper No. 950269)*. Presented at the *74th Annual Meeting of the Transportation Research Board, Washington, D.C.*

Luoma, J., & Rämä, P. (2001). Comprehension of pictograms for variable message signs. *Traffic Engineering & Control, 42*(2), 53-58.

Miller, J. S., Smith, B. L., Newman, B. R., & Demetsky, M. J. (1995). Effective use of variable message signs: Lessons learned through development of users' manuals. *Transportation Research Record, 1495*, 1–8.

Mitran, E., Cummins, D., & Smithers, A. (2018). *Traffic safety messages on dynamic message signs (DMS)* (Report No. FHWA/LA.18/17-01TA-SA). Baton Rouge, LA: Louisiana Transportation Research Center.

National Advanced Driving Simulator (NADS). (2015). *MiniSim user's guide* (Document version 19). Iowa City, IA: The University of Iowa.

National Advanced Driving Simulator (NADS). (2016). *TMT user's guide*. Iowa City, IA: The University of Iowa.

Slob, J. J. (2008). *State-of-the-art driving simulators, a literature survey* (DCT 2008.107). Eindhoven, Netherlands: Eindhoven University of Technology.

Tay, R., & de Barros, A. G. (2008). Public perceptions of the use of dynamic message signs. *Journal of Advanced Transportation, 42*(1), 95–110.

Tay, R., & de Barros, A. G. (2010). Effectiveness of road safety messages on variable message signs. *Journal of Transportation Systems Engineering and Information Technology, 10*(3), 18–23.

The MathWorks, Inc. (1996). *MATLAB language reference manual* (Version 5). Natick, MA: Author.

Vaughn, K. M., Abdel-Aty, M. A., Kitamura, R., & Jovanis, P. P. (1992). *Experimental analysis and modeling of sequential route choice under ATIS in a simple traffic network*. Berkeley, CA: California Partners for Advanced Transit and Highways (PATH), UC Berkeley.

Appendix A: Survey Questionnaire

1. What types of messages do you usually notice when driving on the highways? (Check all that apply)

a. Travel time-related messages
b. Crash related messages
c. Construction-related messages
d. Weather-related messages
e. Safety-related messages

2. Respond to the following statements

	Strongly Disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
It`s a good idea to…					
Remind drivers not to follow too closely on the road					
Remind drivers to be courteous on the road					
Remind drivers of hazardous weather conditions					
Display general safety messages on the highway message boards					
Display anti-speeding messages on the highway message boards					
Display drunk driving messages on the highway message boards					
Display anti-texting and driving messages on the highway message boards					
Display seat belt messages on the highway message boards					
Display weather warning messages					
I look at the information on highway message boards when they are displayed					
I think about the information displayed on highway message board					
In general, safety-related messages…					
remind me to check my following distance					
reduce my likelihood of speeding					
remind me not to text while driving					
remind me not to drive after consuming alcohol					
remind me to pay more attention while driving					
remind me to always use the seat belt while driving					
remind me to move over for law enforcement or maintenance workers					

3. Rate these messages in terms of their effectiveness

Messages	Effectiveness				
	Very effective	Somewhat effective	Neutral	Not so effective	Not at all effective
Click it or Ticket					
Click it, Don’t Risk It					
Buckle Up, Every Trip, Every Time					
Head Up Phone Down					
A Steering Wheel is Not a Hands-Free Device					
Slow Down, Ride Like Your Life Depends on It					
Speeding Kills – Arrive Alive					
Tomorrow is the Reward for Safe Driving					
Don’t Text and Drive, It Can Wait					
Just Drive					
You Drink You Drive You Lose					
Drunk Driving – Don’t Let Cheers Turn into Tears					
Drive High Get a DUI					

4. Rate these messages in terms of their effectiveness

Messages	Effectiveness				
	Very effective	Somewhat effective	Neutral	Not so effective	Not at all effective
Steering Wheel: Not a hands-free device					
Pay Attention and Just Drive					
Give space, don`t tailgate					
Move Over for Law Enforcement and Maintenance Workers					
Speeding Kills					
Slow Down					
Drive like your life depends on it					
Get your head out of your apps					
One text or call-Could wreck it all					
Even Texting Drivers Hate Texting Drivers					
No text is worth a life					
What's more important, your text or your life?					
Don't let texting blind you					
Texting & driving- it can wait					

K-TRAN

KANSAS TRANSPORTATION RESEARCH AND NEW-DEVELOPMENT PROGRAM

AD ASTRA PER ASPERA

Kansas

Department of Transportation