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Educating Older Drivers To Improve Acceptance and Utilization of CAV Technologies

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Yi, Ping; Marovic, Claudia; and Whittenberger, Renee, "Educating Older Drivers To Improve Acceptance and Utilization of CAV Technologies" (2023). Report No. UA-CETran 2023-04.
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CENTER FOR CONNECTED AND AUTOMATED TRANSPORTATION

Report No. UA-CETran 2023-04

August 2023

Project Start Date: May 2022

Project End Date: July 2023

Educating Older Drivers

To Improve Acceptance and Utilization of CAV Technologies

by

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Funding for this research was provided by the Center for Connected and Automated Transportation under Grant No. 69A3551747105 of the U.S. Department of Transportation, Office of the Assistant Secretary for Research and Technology (OST-R), University Transportation Centers Program. The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the information presented herein. This document is disseminated under the sponsorship of the Department of Transportation, University Transportation Centers Program, in the interest of information exchange. The U.S. Government assumes no liability for the contents or use thereof.

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Technical Report Documentation Page

1. Report No. UA-CETran 2023-04	**2. Government Accession No.**	**3. Recipient's Catalog No.**
4. Title and Subtitle Educating Older Drivers to Improve Acceptance and Utilization of CAV Technologies		**5. Report Date** July 25, 2023 **6. Performing Organization Code**
7. Author(s) Ping Yi, https://www.uakron.edu/engineering/CE/profile.dot?u=pyi ORCID: 0000-0003-3761-7162 Claudia Marovic: ORCID: 0009-0007-8075-9912 Reneé Whittenberger, P.E., RSP1 ORCID: 0009-0004-0186-1088		**8. Performing Organization Report No.** **UA-CETran 2023-04**
9. Performing Organization Name and Address Center for Connected and Automated Transportation University of Michigan Transportation Research Institute 2901 Baxter Road Ann Arbor, MI 48109 Department of Civil Engineering Auburn Science and Engineering Center, Room 210 The University of Akron Akron, Ohio 44325-3905		**10. Work Unit No.** **11. Contract or Grant No.** Contract No. 69A3551747105
12. Sponsoring Agency Name and Address U.S. Department of Transportation Office of the Assistant Secretary for Research and Technology 1200 New Jersey Avenue, SE Washington, DC 20590		**13. Type of Report and Period Covered** Final Report (May 2022 – July 2023) **14. Sponsoring Agency Code** OST-R
15. Supplementary Notes Conducted under the U.S. DOT Office of the Assistant Secretary for Research and Technology's (OST-R) University Transportation Centers (UTC) program.		

16. Abstract

As the population of older drivers continues to grow, there is an increasing need to enhance their awareness and understanding of Connected and Automated Vehicles (CAVs). This study utilized an education program aimed at improving the knowledge and awareness of older drivers about CAVs, thereby preparing them to utilize the safety features of these technologies while effectively meeting the challenges that come with them. Through data collection and analysis from study participants, the research provides valuable insights for transportation agencies and technology developers to design and develop more adaptive technologies and associated education for older drivers. The findings from this research will contribute to promoting the acceptance of CAVs among older drivers, thereby improving their social equity among technology users. Overall, this research provides an important contribution to the field of transportation and technology and provides insights for policymakers, researchers, and practitioners.

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17. Key Words		18. Distribution Statement	
Older Drivers, Education and Survey, Safety Features of Vehicles,= CAV technologies, Older Driver Safety		No restrictions.	
19. Security Classif. (of this report)	**20. Security Classif. (of this page)**	**21. No. of Pages**	**22. Price**
Unclassified	Unclassified	53	

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

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I. INTRODUCTION

As the world population ages, transportation safety and accessibility for older adults have become increasingly pressing issues. In particular, older drivers' declining perceptual, cognitive, and motor abilities make them more vulnerable to crashes, injuries, and fatalities. Connected and automated vehicle (CAV) technologies have the potential to reduce human-error related accidents and enhance the safety and mobility of all drivers. However, the uptake of CAVs by older drivers has been hindered by their limited awareness, understanding, and acceptance of the features and functions of these technologies. As a result, older drivers may not reap the benefits of CAVs and continue to face disproportionate safety risks on the road.

To address this issue, this research project aims to design, implement, and evaluate an education intervention for older drivers about CAVs. The primary purpose of the intervention is to increase older drivers' awareness and knowledge of CAV technologies, their safety benefits, and potential challenges. By doing so, the intervention aims to improve older drivers' acceptance and adoption of CAVs, enhance their driving safety and mobility, and contribute to the overall societal goal of reducing traffic crashes and fatalities. The secondary purpose of the intervention is to generate insights and recommendations for transportation agencies, vehicle manufacturers, and other stakeholders to design more user-friendly and accessible CAV technologies that meet the diverse needs and preferences of older drivers.

To achieve these objectives, the intervention has been conducted in the form of on-site training and surveys with older drivers attending senior activity centers in the northeast Ohio area.

By providing empirical evidence of the effectiveness and feasibility of the education intervention for older drivers, this research project contributes to the academic literature and practice of transportation safety, aging, and technology adoption. Furthermore, this project aligns with the broader social, economic, and policy goals

of promoting equitable access to transportation and enhancing the quality of life for older adults.

II. PURPOSE AND NEED

It is well-known that older drivers experience a gradual decline in perception, reaction ability, motor and coordination skills, and that aging can accelerate this process. This can lead to serious consequences at intersections with a stop-sign control where older drivers have a higher crash rate than other age groups due to poor gap selection. They are also more likely to be involved in a collision when making turns than going straight. According to the National Safety Council, number of motor-vehicle deaths involving drivers and other road users age 65 and older increased 15%, from 7,902 in 2020 to 9,102 in 2021. The increased frailty of older drivers makes them more likely to be killed or injured in a collision than other age groups, with the total number of deaths increasing 34% over the last decade.

The primary objective of CAV technology applications is to improve traffic safety by reducing human-factor related traffic accidents, with the technology advancement expected to provide direct benefits to those who would need them the most, such as older drivers. To address the disconnect between older drivers' needs and their lack of understanding of CAV technologies, this education study for older drivers investigates and mitigates the challenges and opportunities in operating newer vehicle models with different levels of automation functions.

III. PROJECT TIMELINE

The education study was completed in 13 months, beginning in April 2022 with the selection of researchers. The timetable and activities of the project are outlined below.

Program and Survey Development
May 2022 – September 2022
Research on existing practices, current trends with older drivers, and the range of CAV technologies as safety features present in vehicles today. Strategies were developed to reach, engage, and educate older drivers. Before and After surveys were developed to assess the knowledge, understanding, current use, and acceptance of CAV technologies via vehicle safety features. A presentation was created to introduce, define, describe, and demonstrate (through manufacturer and informational videos) certain key features.

Training Presentations and Data Collection
October 2022 – June 2023

Researchers coordinated with senior gathering locations to schedule and deliver presentations. Data was collected via the Before and After surveys.

Results and Analysis
April 2023 – July 2023
Data was analyzed, findings were assessed, and the project was documented herein.

IV. PROGRAM DEVELOPMENT

The program development phase of the research project involved a thorough investigation of available safety features in vehicles manufactured in 2022 and prior. After extensive research, 29 features were selected to be used in the training, data collection, and assessments. These features were categorized into 8 groups based on their safety objectives and use categories, which include Collisions Prevention and Mitigation, Speed and Cruise control, Braking and Anti-Rollover Assistance, Tire Temperature and Terrain, Hill Assist, Parking Assistance, Lane and Side Assistance, and Driver Communication.

Collisions Prevention and Mitigation: These safety features aim to prevent or reduce the impact of collisions. They include forward collision warning, automatic emergency braking, and pedestrian detection. The purpose of these features is to alert the driver to potential collisions and intervene if necessary to prevent or minimize impact. They typically use sensors such as cameras, radar, or lidar to detect other vehicles or objects in the car's path.

Speed and Cruise Control: These features help drivers to maintain a safe and steady speed while driving. They include adaptive cruise control, which adjusts the speed of the vehicle to maintain a safe distance from the vehicle ahead, and speed limit recognition, which alerts the driver when they exceed the speed limit. The objectives of these features are to reduce the risk of accidents caused by speeding and to improve fuel efficiency by maintaining a consistent speed.

Braking and Anti-Rollover Assistance: These features help to improve braking performance and prevent rollover accidents. They include electronic stability control, which uses sensors to detect if the car is losing control and applies the brakes to prevent rollover, and anti-lock braking system (ABS), which prevents the wheels from locking up during hard braking. The objectives of these features are to improve the safety and stability of the vehicle during emergency maneuvers and to prevent accidents caused by loss of control.

Tire, Temperature and Terrain: These features provide information about tire pressure, temperature, and road conditions to improve safety and

performance. They include tire pressure monitoring systems, which alert the driver if tire pressure is too low, and hill descent control, which helps the driver to maintain a safe speed when driving downhill. The purpose of these features is to improve safety and performance by providing the driver with important information about the vehicle and road conditions.

Hill Assist: Hill assist features help drivers to start on an incline without rolling backwards. They include hill start assist, which automatically applies the brakes when the driver releases the brake pedal, and hill hold control, which maintains brake pressure when the vehicle is stationary on an incline. The objectives of these features are to improve safety and convenience when driving on hills.

Parking Assistance: Parking assistance features help drivers to park more safely and easily. They include rearview cameras, which provide a view of the area behind the vehicle, and parking sensors, which alert the driver to obstacles when parking. The purpose of these features is to reduce the risk of accidents while parking and to make parking easier and more convenient.

Lane and Side Assistance: Lane and side assistance features help drivers to stay in their lane and avoid collisions with other vehicles. They include lane departure warning, which alerts the driver if the vehicle drifts out of its lane, and blind spot monitoring, which alerts the driver if there is a vehicle in the blind spot. The objectives of these features are to improve safety and reduce the risk of collisions caused by drifting out of the lane or failing to detect other vehicles.

Driver Communication: Driver communication features provide information and alerts to the driver to improve safety and convenience. They include voice control, which allows the driver to control certain functions using voice commands, and heads-up display, which displays important information such as speed and navigation directions on the windshield. The purpose of these features is to provide the driver with important information while minimizing distractions and improving convenience.

Each of the 29 features were carefully named and defined, and videos were located from educational websites such as MyCarDoesWhat.org, manufacturer's websites, National Highway Traffic Safety Administration (NHTSA), American Association of Retired Persons (AARP), and other safety-focused entities.

A presentation was created to be given during trainings that introduced the project and its purpose, the background, presence, and purpose of CAV features as safety features in current vehicles, the benefits of the safety features for the

audience and other drivers, and information about where to learn more about the safety features in their vehicle.

The presentation identified each individual feature with the following items:

- Name,
- Icon,
- Purpose,
- if the feature is an alert, an assist, or a partial takeover of driving, and
- how use of the feature is accomplished.

Links to online videos created by other sources were also included for at least one feature in each grouping.

The presentation was designed to be used as a PowerPoint slide deck projected to the audience. In cases where this technology was not provided, a show-and-tell version of the presentation was created as 11x17 printed sheets that the presenter could hold up and discuss.

Researchers contacted many senior centers, cultural centers, and neighborhood centers to schedule training sessions in the coming months. Many Program Leaders responded enthusiastically as they themselves were curious about their own vehicle safety features. A total of 16 training sessions (includes one with no after surveys) were scheduled all over northeast Ohio. At each training session, a Before survey was administered, followed by the presentation, and then an After survey. The surveys were printed and stapled sheets of 8.5x11 paper.

Upon completion of 16 trainings and collection of enough Before and After surveys to appropriately represent the population, the data was analyzed.

V. SURVEY DEVELOPMENT

Survey Development was a critical component of the study design and data collection process. The purpose of this section is to detail the development of the Before and After surveys, which were designed to assess the impact of the education intervention on older drivers' knowledge and acceptance of safety features in their vehicles.

The survey development process included the selection of 29 safety features, which were named, defined, and discussed in the educational presentation. The Before and After surveys were designed to be similar in structure to allow for more direct comparisons between pre- and post-presentation results.

First Edition of Surveys August 10, 2022

Demographic information was gathered without direct personal identification, including age, gender, career/profession, frequency and objectives of vehicle use, location of residence, and make, model, and year of the vehicle most used. These questions were on both the Before and After surveys to allow assessments and comparisons of presentation impacts based on certain characteristics such as age, make of vehicle, typical driving purposes, etc.

Email addresses were also collected to enable follow-up surveys to assess the use, acceptance, and preference of specific features in the weeks after the presentation.

The surveys asked the same question about the 29 specific features to discern knowledge, understanding, current use, and likelihood of use of the feature. The name and definition of the features were shown along with up to three different icons.

The Before survey questions assessed familiarity and previous or current use. The respondent had six choices available:

(1) I am unfamiliar with this feature.
(2) I am familiar with this feature but do not use it.
(3) I am familiar with this feature and have used it sometimes.
(4) I am familiar with this feature and would have used it if available.
(5) I already use this feature every time I drive.
(6) I would use this feature if available every time I drive.

See Figure 1 for an example of an individual feature question on the Before Survey.

The After survey questions assessed understanding and willingness to use the feature if available. The respondent had five choices available:

(1) I do not understand this feature.
(2) I understand this feature but will not use it.
(3) I understand this feature and would like to try to use it sometimes.
(4) I plan to use this feature regularly.
(5) I will continue to use this feature regularly.

See Figure 2 for an example of an individual feature question on the After Survey.

Rear Cross Traffic Alert - Warns you if one or more vehicles are about to enter your backing path.

- ☐ I am unfamiliar with this feature.
- ☐ I am familiar with this feature but do not use it.
- ☐ I am familiar with this feature and have used it sometimes.
- ☐ I am familiar with this feature and would have used it if available.
- ☐ I already use this feature every time I drive.
- ☐ I would use this feature if available every time I drive.

Figure 1 - Example of Before Survey question about an individual safety feature.

Forward Collision Warning - Alerts you of an impending collision with a slower moving or stationary car in front of you.

- ☐ I do not understand this feature.
- ☐ I understand this feature but will not use it.
- ☐ I understand this feature and would like to try to use it sometimes.
- ☐ I plan to use this feature regularly.
- ☐ I will continue to use this feature regularly.

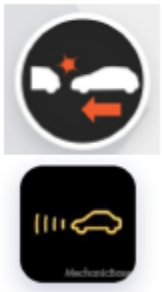

Figure 2 - Example of After Survey question about an individual safety feature.

In addition to the individual feature questions, the 29 features were grouped into eight categories based on similar safety objectives and/or use categories. For the final eight questions in the surveys, if the respondent did not use a specific feature, they were asked to provide reasons for their decision. The respondent had 13 choices available, including a fill in:

(1) I do not have these features on my vehicle.
(2) I do not know how to turn these features on.
(3) I do not want to spend the time to learn about these features.
(4) The alerts are distracting.
(5) The alerts are startling,
(6) The alers do not work.
(7) I am confident in my driving ability without these features.
(8) I am afraid I may cause disruption in my vehicle's electronic system.
(9) I do not believe that these features will always work when I need them to.
(10) I think these features will make me a less alert driver.
(11) The icons are too small to read.
(12) I use most of these.
(13) Other:_____

See Figure 3 for an example of a grouping question to discern reasons for disuse.

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- ☐ I do not have these features on my vehicle.
- ☐ I do not know how to turn these features on.
- ☐ I do not want to spend the time to learn about these features.
- ☐ The alerts are distracting.
- ☐ The alerts are startling.
- ☐ The alerts do not work.
- ☐ I am confident in my driving ability without these features.
- ☐ I am afraid I may cause disruption in my vehicle's electronic system.
- ☐ I do not believe that the features will always work when I need them to.
- ☐ I think these features will make me a less alert driver.
- ☐ The icons are too small to read.
- ☐ I use most of these.

Other: _____

Figure 3 - Example of Feature Group question to determine reasons for disuse.

The surveys were 19 pages long, printed in large font, with up to three questions per page after the initial demographic questionnaire portion. This detailed survey development process provided critical data on the impact of the educational intervention on older drivers' knowledge and acceptance of safety features in newer vehicle models.

The researchers completed four scheduled presentations using the First Edition surveys. This resulted in extensive time consumption before the presentation could begin. With a large group, nearly 45 minutes of the scheduled time was spent in order for all attendees to complete the Before survey. It was not anticipated that the respondents would read each question and every multiple-choice answer for all 37 questions, despite the repetition. Once the presentation was complete, the same time frame was required to complete the After surveys. Many expressed frustration that the surveys appeared the same. Some respondents chose not to complete an After survey. A few completed the survey

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but skipped pages or rushed through with cynical responses. Some respondents voiced annoyance at the request for an email address as many of them did not use email, did not want to be contacted, or did not want their email put into a system. Researchers found that some respondents were persuaded to complete the After surveys if offered a small token of appreciation, such as a pen or container of personal hand sanitizer.

Second Edition of Surveys November 18, 2022

In order to improve the After survey response rate and quality as well as the respondent attitude, the surveys were reformatted as a table with column responses. This was to reduce the need to repeatedly read the same question with multiple answers 29 times. The same questions with multiple choice answers were used as in the first version of the Survey such that data analysis could be performed without the obstruction of different questions across locations. See Figure 4 for an example page of the Second Edition Before survey with columns for check mark answers.

The demographic questionnaire portion and the final eight grouping questions to discern reasons for disuse remained unchanged in the Second Edition. The page count was reduced to 13.

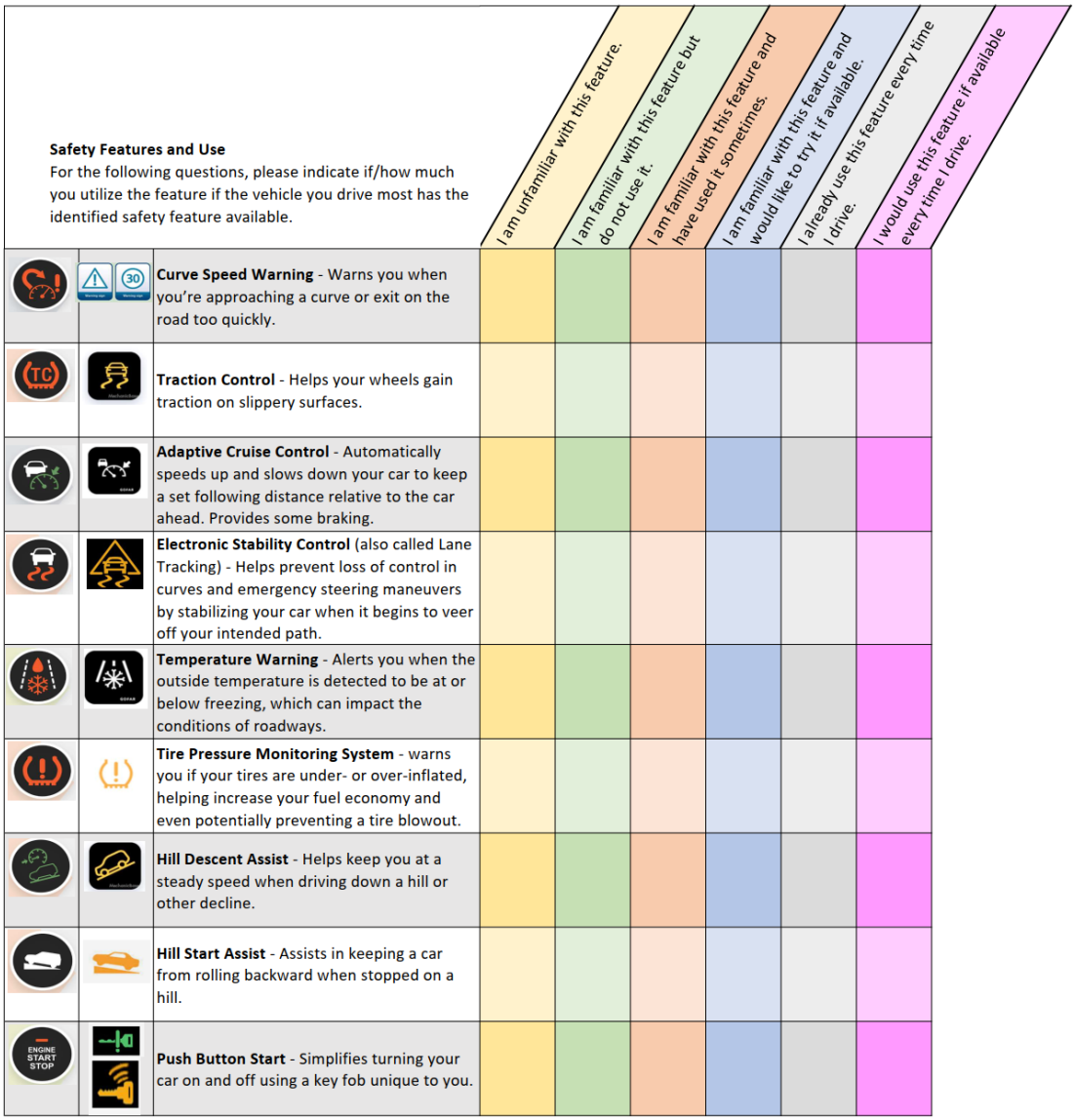

Figure 4 - Example page of Second Edition Before Survey with columns for check mark answers.

The Second Edition surveys did reduce the time spent taking surveys, however, the improvement was not significant enough to obtain enough participation in the After survey. One presentation location received a 0% After survey response rate as the scheduled time had ended and the attendees abandoned the presentation in favor of lunchtime.

Third Edition of Surveys January 10, 2023

The research team detected that the length of the surveys was a potential barrier to obtaining a statistically valuable number of comparable surveys. The main driver of the survey length was the 29 questions about individual safety features

plus eight additional questions repeating those features in groupings. Although it was most desirable to discern how the respondents felt towards each individual feature, the researchers recognized that this approach was not feasible given the length of the surveys and the fortitude of the respondents in completing them.

To address this issue, the surveys were reformatted such that the features were grouped in the same categories as previously used and each grouping presented on a single page with one question, one sub-question, and multiple-choice answers. This reduced the survey length to only seven pages.

The demographic questionnaire portion was removed from the After surveys to avoid time and morale spent on repeated questions. To achieve a means of connecting a single respondent's Before and After surveys, the surveys were numbered such that each person received the same number on both the Before and After survey. The request for an email address was removed from the demographics portion.

On the After survey, the demographic questionnaire page was replaced with a page of four questions with fill-in answer blanks to assess the respondents' opinion on the efficacy of the presentation and their desire for more information. Their email addresses could be provided if they wished to receive follow-up communication.

Although the Third Edition surveys lost some of the information that could have been gleaned from the previous two editions, the response rate improved significantly, with a response rate of 94.3%. This is in comparison to the first version with a response rate of 73.1% and the second version with 73.0%. The team determined that this approach was the best solution to obtain a meaningful number of responses while still gathering valuable information on the safety features.

See Figure 5 and Figure 6 for example pages of grouped features with a single page for multiple choice answers on the Before and After surveys, respectively.

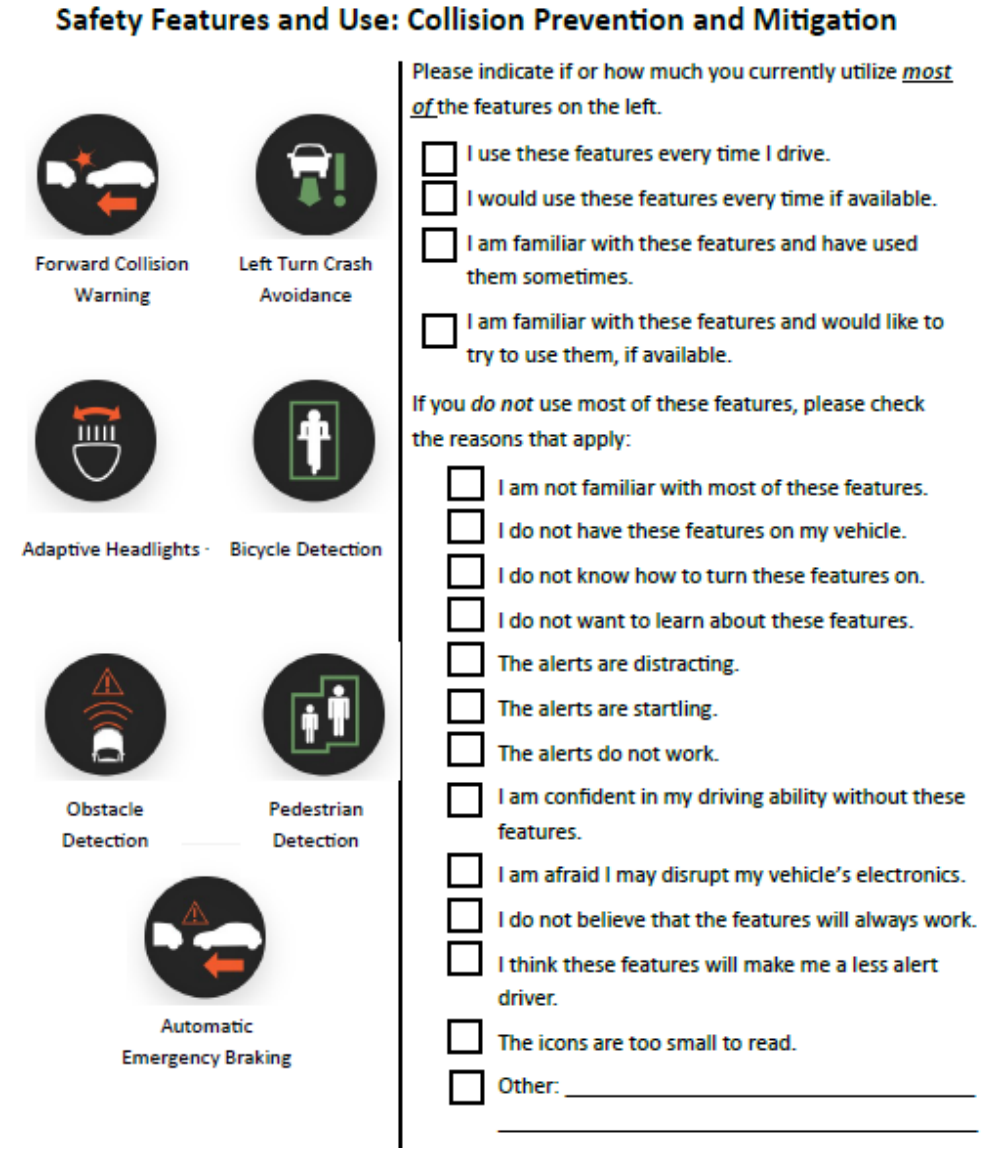

Figure 5 - Example of Grouped Features with Single Page for Multiple Choice Answers on the Before Survey

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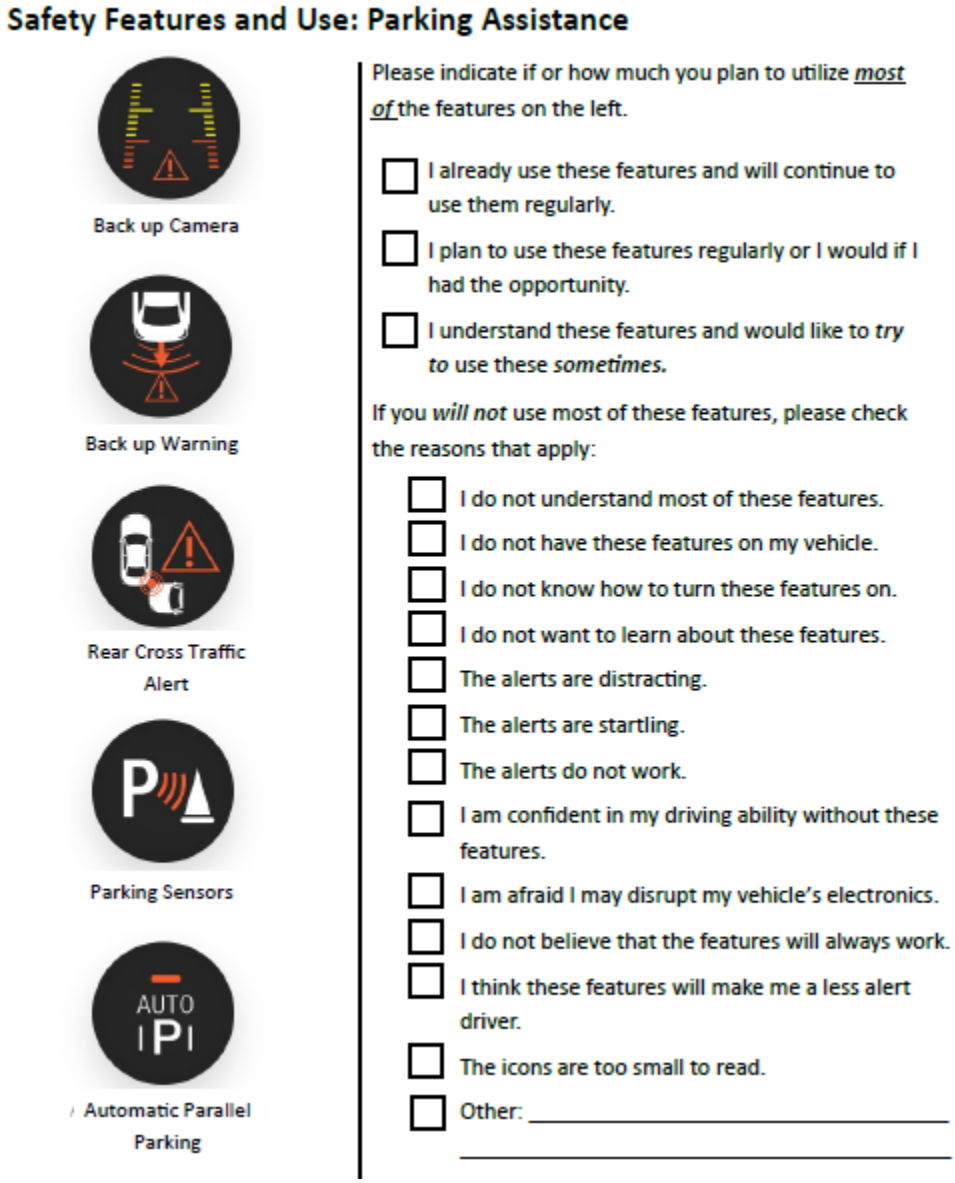

Figure 6 - Example of Grouped Features with Single Page for Multiple Choice Answers on the After Survey

VI. RESPONDENTS

Demographic information was gathered without direct personal identification, including age, gender, career/profession, amount and objectives of vehicle use, location of residence, and make, model, and year of the vehicle most used. This nominal data, as provided by the respondents, is aggregated and illustrated in the following figures. Note that some respondents did not respond to all questions on the survey and therefore the proportions are only indicative of answers provided.

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The survey respondents in this study hailed from a diverse range of 50 distinct cities or towns in northeast Ohio. Figure 7 shows the locations of the presentations given. The locations listed from northeast to southwest are Ashtabula County, Painesville, Eastlake, Middlefield, Greater Cleveland, Portage County, Austintown, Patterson Park (Akron), German Center (Akron), Salem, Kenmore (Akron), New Franklin (Akron), Wadsworth, Medina, and Avon. Figure 8 shows a heat map based on the zip codes that the respondents wrote for their place of residence, which aligns with the locations of the education sessions.

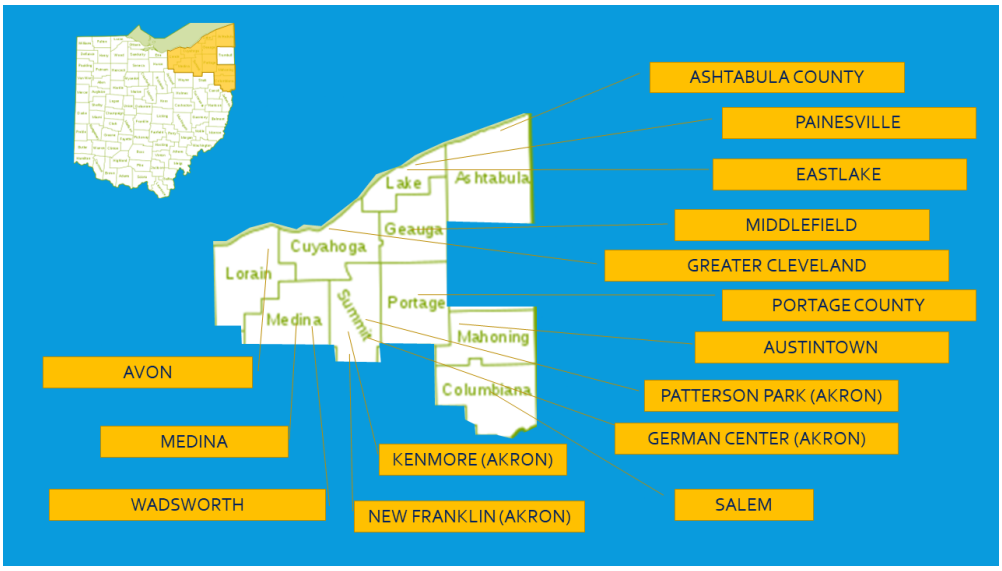

Figure 7 - Learning Session Locations

Figure 8 - Heat map of respondents' residential zip codes.

The respondents selected a range for their current age. Of the total, 72% of the participants were older than 70, 16% were between 66 and 70, 9% were between

61 and 65, 2% were between 56 and 60, and 1% were under 50 years old. See Figure 9.
Among the surveyed individuals, 77% were female, while 23% were male. See Figure 10.

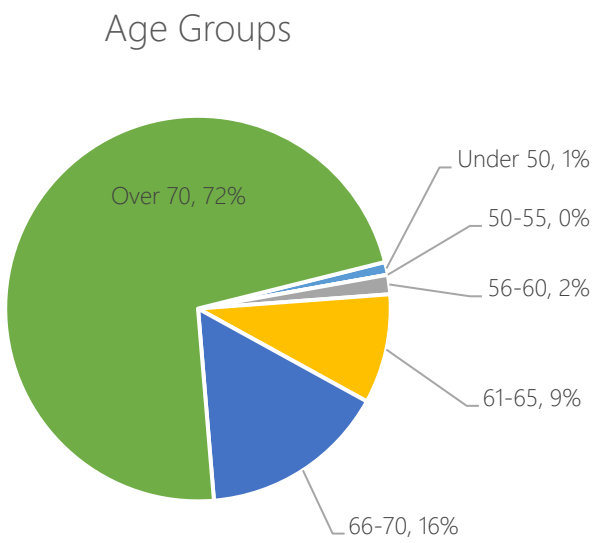

Figure 9 - Age groups of survey respondents.

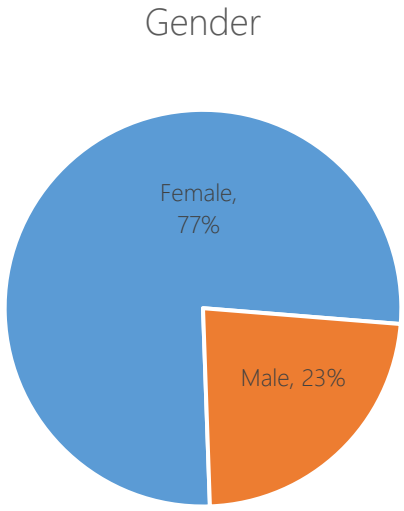

Figure 10 - Gender proportions of survey respondents.

Survey respondents indicated the year, make, and model of the vehicle they drive most. Figure 11 shows that a majority of vehicles were made after 2014,

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indicating that many of the respondents' vehicles did have various safety features installed.

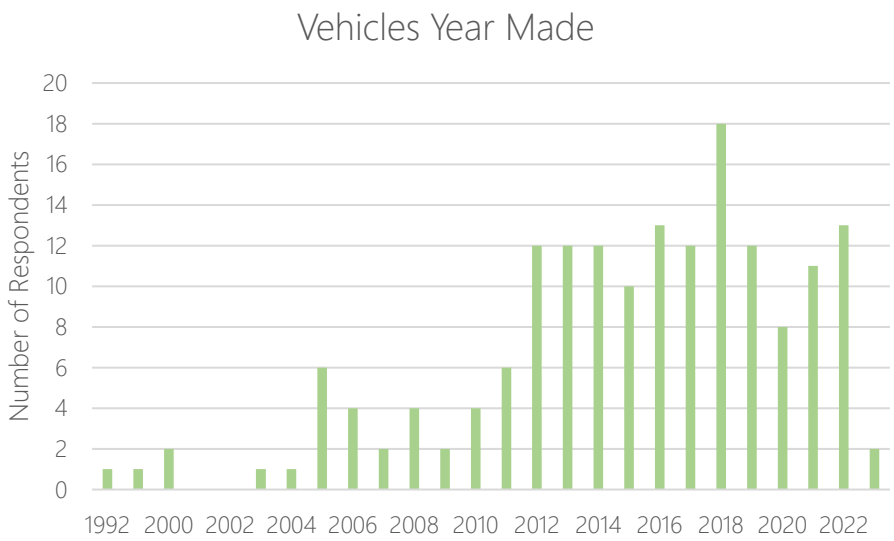

Figure 11 - Manufacture year of vehicle driven most by respondents.

Among the survey respondents, the data revealed their preferences for car manufacturers. Participants were asked to indicate the manufacturer of the car they drive. The responses were analyzed to determine the distribution of car manufacturer preferences among the participants. The results are summarized in Figure 12.

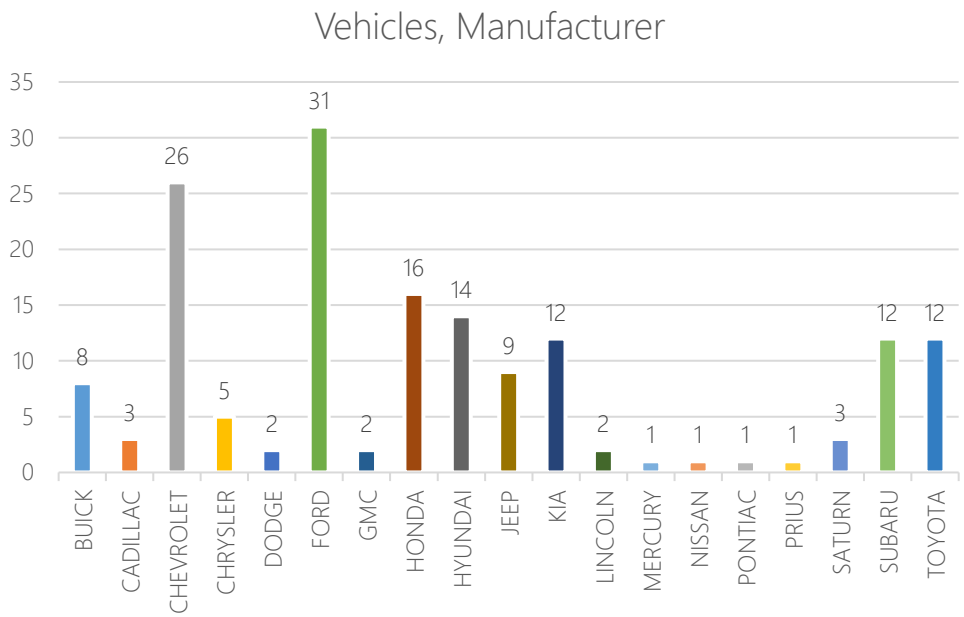

Figure 12 - Manufacturer of vehicle driven by respondents.

This data may provide insight into the preference of car manufacturers among the surveyed individuals. Among the survey participants, Ford had the highest number of respondents with 31, representing 12.4% of the total responses. Chevrolet followed closely with 26 respondents, accounting for 10.4% of the total responses. Other manufacturers such as Honda, Toyota, Hyundai, Jeep, and Kia also had notable representation among the participants.

A notable observation can be made regarding the correlation between the most represented car manufacturers, such as Ford and Chevrolet, and the characteristics of the survey respondents. Most of the survey participants were located in northeast Ohio, an area historically associated with industries like steel manufacturing. It is worth noting that Ford and Chevrolet have a strong presence as American car manufacturers, and their vehicles have been traditionally associated with this region due to their production in nearby manufacturing plants. This regional influence and affinity towards American-made vehicles may explain the relatively higher representation of Ford and Chevrolet among the survey respondents.

Furthermore, it is important to highlight that the survey respondents were predominantly from the Baby Boomer generation, which is characterized by individuals born between 1946 and 1964. This generational cohort has witnessed the rise and prominence of American car manufacturers throughout their lives. Given their age and familiarity with these brands, it is not surprising to observe a higher proportion of survey participants who owned cars from manufacturers

such as Ford and Chevrolet, which have a longstanding presence in the market and have catered to the preferences of previous generations.

These factors, the regional influence of northeast Ohio's industrial history and the prevalence of the Baby Boomer generation among the respondents, likely contribute to the higher representation of American car manufacturers like Ford and Chevrolet in the survey data. However, it is important to acknowledge that these findings are specific to the surveyed population and may not be reflective of broader trends in car manufacturer preferences or regional distributions in other areas.

The participants were given a range of options to indicate the number of trips they drove per week, reflecting various levels of driving frequency. The distribution of responses is as follows: 4% reported driving zero trips per week, 7% reported driving one trip per week, 34% reported driving between one and five trips per week, 32% reported driving between six and ten trips per week, and 23% reported driving more than ten trips per week. These findings provide valuable insights into the range of driving behaviors and highlight the diversity in participants' weekly trip frequency. See Figure 13.

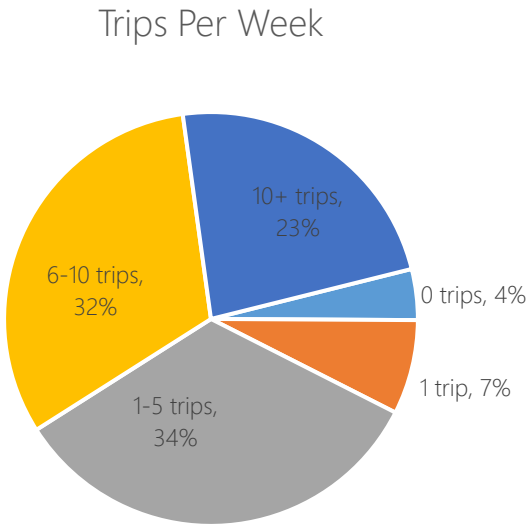

Figure 13 - Range of driving trips taken per week.

The occupations written by the respondents exhibited a significant range and are represented in Figure 14 as a word cloud. The most common response was “Retired”, the second most common was “Manager”, and the third most common was “Teacher”.

Figure 14 - Current or former occupations as written by respondents.

VII. FINDINGS

Figure 15 through Figure 20 show the comparison of respondents' willingness to use or try safety features, grouped by category.

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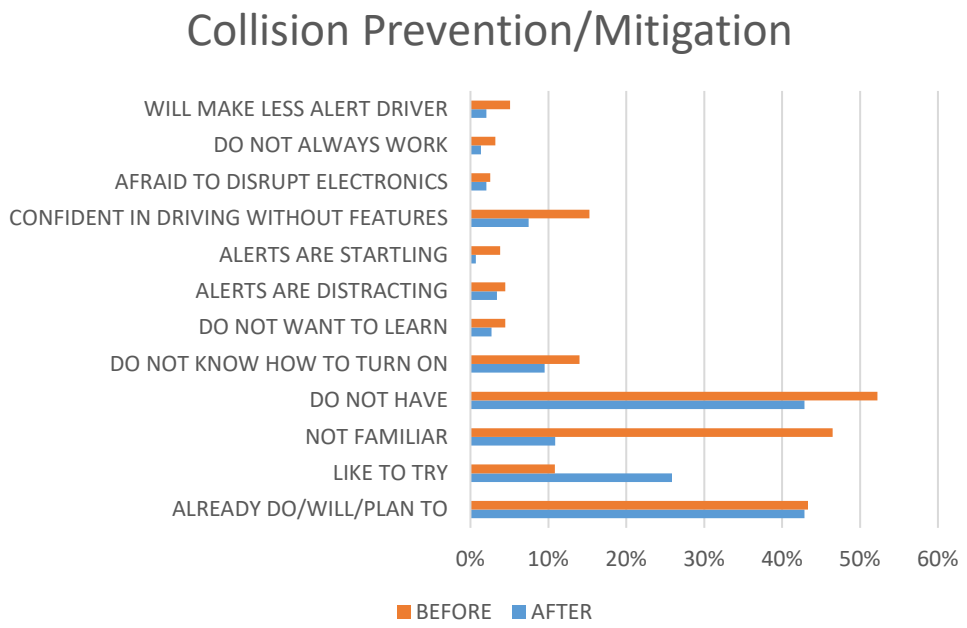

Figure 15 - Comparison of Before/After Responses to willingness to use or try Collision Prevention or Mitigation safety features.

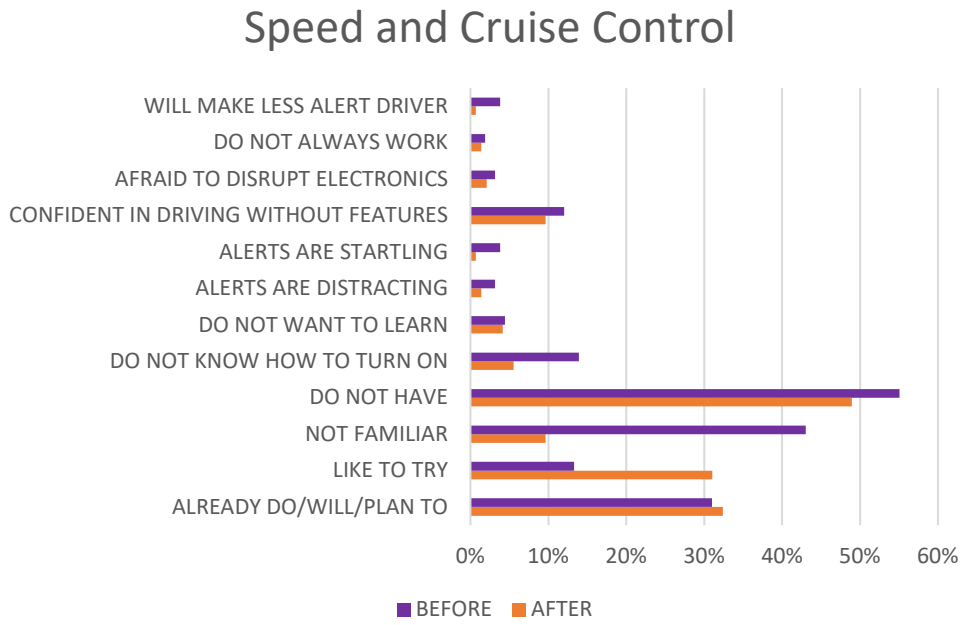

Figure 16 - Comparison of Before/After Responses to willingness to use or try Speed and Cruise Control safety features.

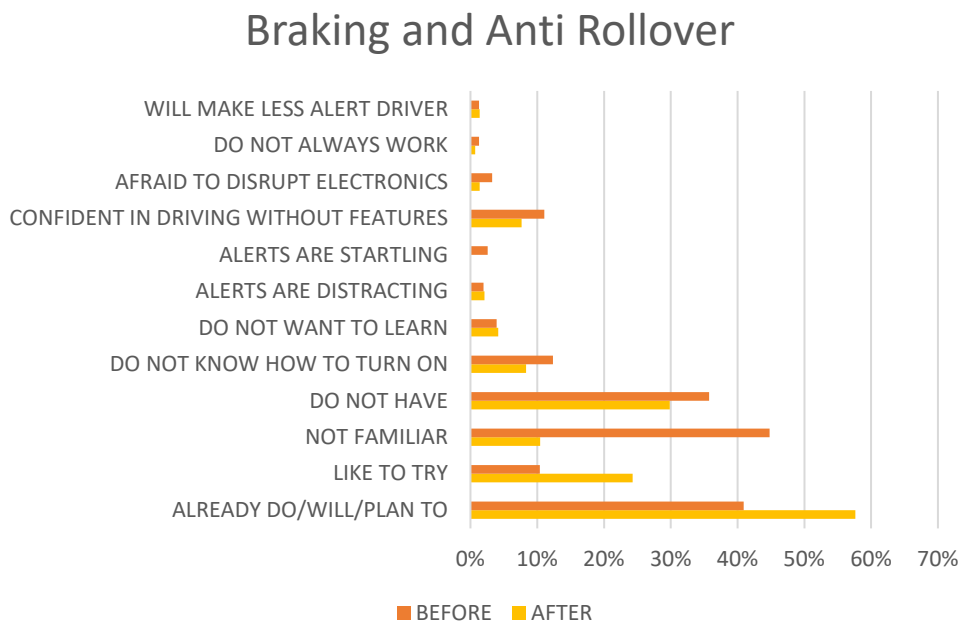

Figure 17 - Comparison of Before/After Responses to willingness to use or try Braking and Anti Rollover safety features.

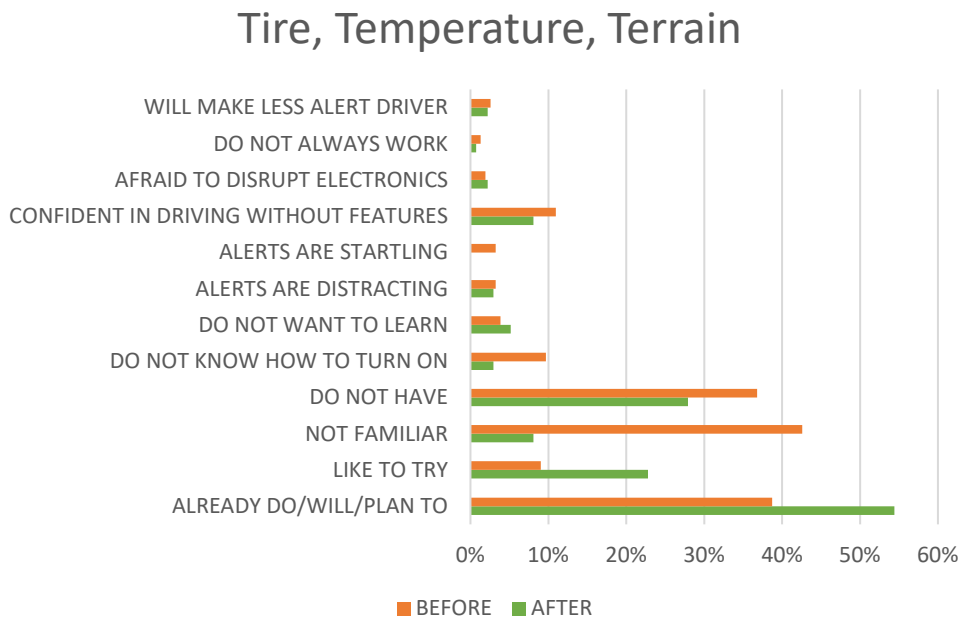

Figure 18 - Comparison of Before/After Responses to willingness to use or try Tire, Temperature, and Terrain safety features.

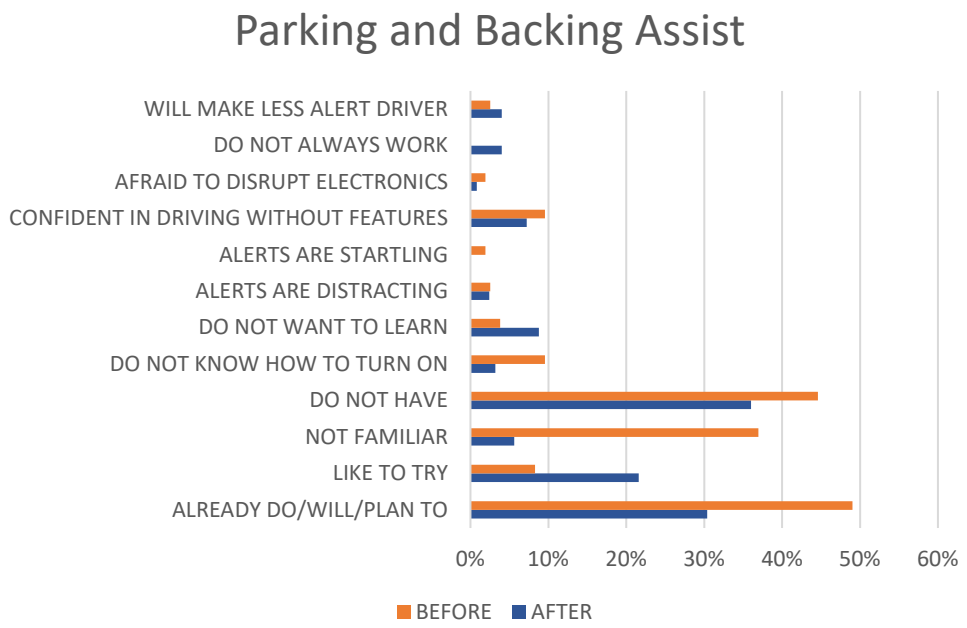

Figure 19 - Comparison of Before/After Responses to willingness to use or try Parking and Backing Assist safety features.

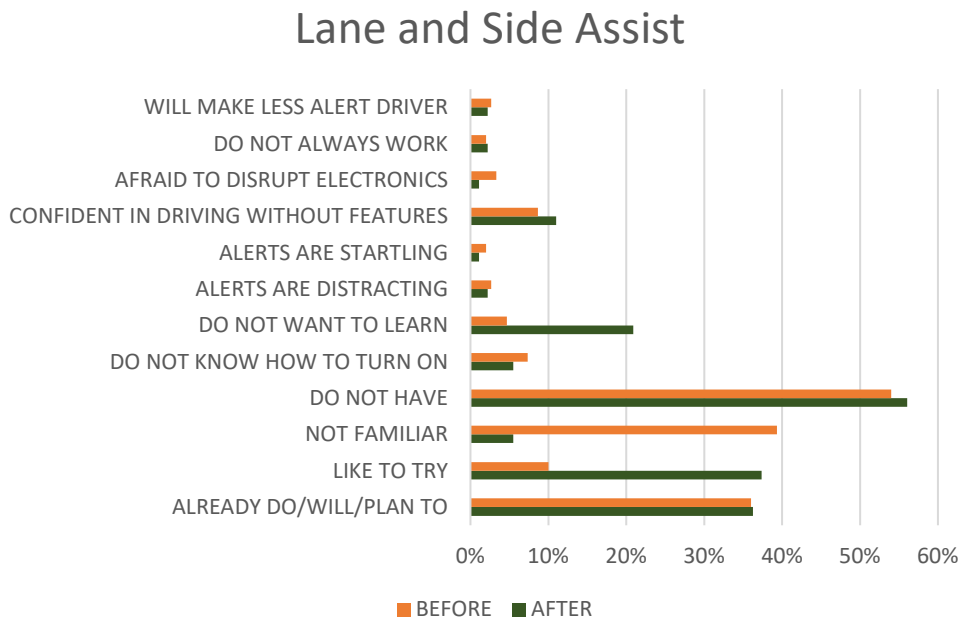

Figure 20 - Comparison of Before/After Responses to willingness to use or try Lane and Side Assist safety features.

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Since nominal and ordinal data were collected in this study, the chi-square test of independence was used to test whether there were relationships between test variables and the outcome variable of change in attitude (positive or neutral) towards vehicle technologies. A paired-samples, one-tailed t-test was also used to determine whether changes in participants' acceptance (willingness to use) of vehicle technologies after learning about them was statistically significant. A 0.05 level of significance was used to decide whether to reject, or to fail to reject the null hypothesis for both tests.

For the chi-square test of independence, the null hypothesis was a prediction of no relationship between test variables and the outcome. The alternative hypothesis was a prediction of a relationship between test variables and the outcome. The seventeen test variables were a collection of stated and derived values. Gender was the only variable with a p-value less than 0.05. See Table 1 for all chi-square test variable results and p-values.

Table 1 – Chi-square Test Variable Results

n = 143 chi-square test variable	df	value	p-value
AGE65	2	0.0166	0.9917
AGE70	2	0.2223	0.8948
AGEBRACKET	4	0.4413	0.979
CITYTOWN	45	55.4491	0.1367
COUNTY	12	22.043	0.037
DOMVSFOR_NONEREMOVED	1	0.6767	0.4107
DOMVSFOR	2	5.6242	0.0601
GENDER_NONEREMOVED	1	7.9766	0.0047
GENDER	2	8.026	0.0166
MAKEOFVEHICLE	20	22.9726	0.2901
MODELOFVEHICLE	69	73.3356	0.3379
OCCUPATION	89	104.4031	0.1265
OCCUPATIONCATEGORY	10	7.8411	0.6444
PURPOSES	4	6.3033	0.1776
TRIPSWEEK	4	5.0853	0.2787
YEAR	23	29.4715	0.1652
ZIPCODE	51	57.86	0.2369

The Before survey collected data about current use of safety features. The After survey collected data about plans to use and/or to try to use safety features. Changes in acceptance of vehicle technologies were quantified by comparing

differences between current use and future use plans. For the left-tailed t-test, the null hypothesis was a prediction of equal means before and after the workshop. The alternative hypothesis was a prediction of a greater mean after the workshop. The test was completed for each of the 6 groupings of safety features as presented in the surveys. Each of the groupings had t-values greater than the t-critical value of 1.6575. The p-values are significantly less than the 0.05 level of significance. The t-test was also completed with all safety features combined for the before and after conditions. It also resulted in a t-value greater than the t-critical value, and a p-value significantly less than 0.05. See Table 2 – t-Test Results for mean and variance changes and the resulting t- and p-values.

Table 2 – t-Test Results

Collision Prevention and Mitigation
t-Test: Paired Two Sample for Means

	Variable 1	*Variable 2*
Mean	0.54020979	2.1002331
Variance	1.167826012	8.347472559
Observations	143	143
df	142	
t Stat	-6.290605828	
P(T<=t) one-tail	1.83931E-09	
t Critical one-tail	1.655655173	

Speed and Cruise Control
t-Test: Paired Two Sample for Means

	Variable 1	*Variable 2*
Mean	0.475524476	1.48951049
Variance	0.814537575	2.448832857
Observations	143	143
df	142	
t Stat	-7.679972832	
P(T<=t) one-tail	1.17911E-12	
t Critical one-tail	1.655655173	

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Braking and Anti-Rollover

t-Test: Paired Two Sample for Means

	Variable 1	*Variable 2*
Mean	0.879370629	1.688811189
Variance	1.721701714	3.622549985
Observations	143	143
df	142	
t Stat	-4.73117271	
P(T<=t) one-tail	2.66691E-06	
t Critical one-tail	1.655655173	

Tire, Temp, Terrain

t-Test: Paired Two Sample for Means

	Variable 1	*Variable 2*
Mean	0.786713287	1.741258741
Variance	1.801019403	3.74860263
Observations	143	143
df	142	
t Stat	-5.963065248	
P(T<=t) one-tail	9.35786E-09	
t Critical one-tail	1.655655173	

Parking

t-Test: Paired Two Sample for Means

	Variable 1	*Variable 2*
Mean	0.601398601	1.917482517
Variance	1.283660002	6.003002068
Observations	143	143
df	142	
t Stat	-7.106097419	
P(T<=t) one-tail	2.66015E-11	
t Critical one-tail	1.655655173	

Lane and Side Assist
t-Test: Paired Two Sample for Means

	Variable 1	*Variable 2*
Mean	0.56993007	1.946853147
Variance	1.308455629	5.739127352
Observations	143	143
df	142	
t Stat	-7.222142902	
P(T<=t) one-tail	1.4282E-11	
t Critical one-tail	1.655655173	

Overall
t-Test: Paired Two Sample for Means

	Variable 1	*Variable 2*
Mean	3.853146853	10.88414918
Variance	19.49236679	136.405283
Observations	143	143
Pearson Correlation	0.287462754	
Hypothesized Mean Diffe	0	
P(T<=t) one-tail	3.47767E-12	
t Critical one-tail	1.655655173	

The chi-square test of independence for gender (male/female) resulted in a p-value of 0.0047. The null hypothesis that there is no relationship between gender and outcome is rejected. This study found that the variables are related, and whether an individual has a positive or neutral change in attitude towards the vehicle technologies is related to their gender.

The paired t-tests resulted in p-values of 1.83931E-09 (Collision Prevention and Mitigation), 1.17911E-12 (Speed and Cruise Control), 2.66691E-06 (Braking and Anti-Rollover), 9.35786E-09 (Tire, Temp, Terrain), 2.66015E-11 (Parking), 1.4282E-11 (Lane and Side Assist), and 3.47767E-12 (Overall). The null hypothesis that the population means are equal is rejected. There is sufficient evidence to state that the mean acceptance (willingness to use vehicle technologies) is different before and after taking part in the workshop.

VIII. CONCLUSIONS AND RECOMMENDATIONS

Based on the data analysis and statistical tests conducted in this study, several key findings have emerged. The chi-square test of independence revealed a significant

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relationship between gender and the outcome variable of change in attitude towards vehicle technologies. Specifically, it was found that an individual's gender is related to whether they experienced a positive or neutral change in attitude. This may indicate a need to consider gender as a factor in future educational initiatives and interventions related to vehicle technologies.

Furthermore, the paired t-tests conducted for each grouping of safety features indicated statistically significant differences in participants' acceptance (willingness to use) of vehicle technologies before and after the workshop. The p-values obtained for all groupings were significantly less than the predetermined level of significance (0.05), indicating strong evidence to reject the null hypothesis of equal means. These findings provide compelling evidence that the workshop had a positive impact on participants' acceptance of vehicle technologies across different safety feature categories.

The finding that there were no statistically significant correlations between the other factors and a change in willingness to use vehicle safety features after the training suggests that these factors may not strongly influence participants' attitudes and acceptance of the technologies. It indicates that variables such as age, occupation, location, and vehicle make and model, among others, did not play a significant role in predicting or explaining the observed change in willingness to adopt safety features.

It is important to interpret these results cautiously and consider potential limitations of the study. The absence of statistically significant correlations does not necessarily imply that these factors have no impact at all. Other factors not examined in this study or those influenced by individual preferences, experiences, or external factors might also contribute to participants' attitudes and acceptance. Additionally, the sample size or specific characteristics of the study population may limit the detection of smaller or more nuanced correlations.

To gain a comprehensive understanding of the factors influencing willingness to adopt vehicle safety features, further research is recommended. Future studies could explore additional variables, employ larger sample sizes, consider more diverse participant demographics, and use different education methods. This would provide a more comprehensive understanding of the complex interplay between various factors and their influence on individuals' attitudes towards and adoption of vehicle technologies.

Overall, the results of this study suggest that educational interventions targeting older drivers can effectively influence their attitudes and acceptance of vehicle technologies. To promote the successful integration of these technologies and enhance road safety, the following recommendations are proposed:

Gender-Specific Approaches: Recognize and address the influence of gender in attitudes towards vehicle technologies. Tailor educational interventions to address specific concerns and preferences associated with gender, ensuring inclusivity and maximum impact.

Continued Educational Initiatives: Build upon the success of the workshop conducted in this study by implementing additional educational initiatives. These initiatives should focus on raising awareness, increasing knowledge, and fostering positive attitudes towards vehicle technologies among older drivers. Using enhanced educational methods such as hands-on and experiential learning is recommended.

Collaboration with Manufacturers and Dealerships: Establish partnerships with vehicle manufacturers and dealerships to provide comprehensive educational resources to older drivers. Collaborative efforts can include workshops, informational materials, and test-drive opportunities to facilitate hands-on experience with the latest safety features.

Policy Considerations: Advocate for policies that support the integration of advanced vehicle technologies and encourage their adoption among older drivers. These policies may include incentives for purchasing vehicles equipped with safety features and regulations promoting accessibility and usability for all age groups.

Long-Term Evaluation: Conduct long-term follow-up studies to assess the sustained impact of educational interventions on older drivers' attitudes and acceptance of vehicle technologies. This evaluation will help refine and improve future initiatives and ensure continuous progress in promoting safe and effective use of these technologies.

By implementing these recommendations, transportation agencies, educational institutions, and industry stakeholders can contribute to enhancing the acceptance and utilization of vehicle technologies among older drivers, ultimately improving road safety and promoting a positive driving experience for all.

IX. OUTPUTS, OUTCOMES, AND IMPACTS

A. Outputs

Publications and reports resulting from this study are listed below:

- Presentation. Conference: 2023 CCAT Global Symposium on Mobility Innovation, Date: APRIL 4, 2023, Presenters: Dr. Ping Yi, Claudia Marovic, and Reneé Whittenberger, PE, RSP1. (URL not yet available.)

- Report. Conference: TRB Annual Meeting, Submission Date: AUGUST 1, 2023, Report Title: TRBAM-24-04263, Authors: Reneé Whittenberger, PE, RSP1, Dr. Ping Yi, and Claudia Marovic.
- Presentation. Conference: Ohio Transportation Engineering Conference (OTEC) in Columbus, Ohio, Date: October 17, 2023, Presenters: Dr. Ping Yi, Claudia Marovic, and Reneé Whittenberger, PE, RSP1. Further submission details:

  Presentation Title

  Promoting Inclusive Design and Deployment of Connected and Automated Vehicles for Older Adults Through Education and Training of Engineering Students and Older Drivers

  Presentation Abstract:

  The development of connected and automated vehicles (CAVs) holds promise for reducing traffic crashes and maintaining mobility among older adults. However, challenges remain in ensuring that CAVs are accessible, acceptable, and otherwise inclusive for older adults. The research shows results of presenting Level 2-3 CAV features in existing vehicle models to older drivers and the data analyses from the before/after training surveys to assess changes in awareness, understanding, and acceptance.

  Intended Audience

  Engineers, Public Works, Government Officials, Regional Planners, Researchers, Professors, Students, Industry Representatives

  How can attendees use your information to apply to their work after OTEC?

  What information will they receive that is implementable in their work?

  Leading the Transportation Transformation for all roadway users. Learn the needs, attitudes, and processes for educating older adults and promoting their adaptation of CAV technologies.

  Anticipated Presentation Length

  30 minutes

  Please select up to five sub-committees to review your abstract.

  Technology & Innovation

  Presentation Description for the OTEC Program (App) if your abstract is selected:

  Research and results of training older drivers on Level 2-3 CAV features in existing vehicles plus data from the before/after surveys to assess changes in awareness, understanding, and acceptance.

B. Outcomes

Overall, the results of this study suggest that educational interventions targeting older drivers can effectively influence their attitudes and acceptance of vehicle technologies. To promote the successful integration of these technologies and enhance road safety, the following recommendations are proposed: gender-specific approaches, continued educational initiatives, collaboration with

manufacturers and dealerships, policy considerations, and long-term evaluation. By implementing these recommendations, transportation agencies, educational institutions, and industry stakeholders can contribute to enhancing the acceptance and utilization of vehicle technologies among older drivers, ultimately improving road safety and promoting a positive driving experience for all.

C. Impacts

This study has yielded valuable insights into the attitudes and acceptance of vehicle safety features among older drivers, thereby contributing to our understanding of their readiness to embrace advanced automotive technologies. Through a meticulously designed research framework and comprehensive data analysis, this study sheds light on several significant impacts such as gender disparities and educational outreach, the efficacy of education initiatives, factors beyond demographics may be influential, guidance of future interventions and policies, and contributions to roadway safety for older adults and the population as a whole.

APPENDIX – OUTPUTS, OUTCOMES, AND IMPACTS

BEFORE SURVEY

AFTER SURVEY

Performance Indicators

Safety Technology Features Survey

The goal of this survey is to understand the perception, frequency of use, and overall efficacy of safety features in technologically equipped vehicles.

In what City/Town do you reside? _____

What is your zip code? _____

What is the make and model of the vehicle you drive most? _____

What is the manufacturer year of the vehicle you drive most? _____

What is your occupation, currently or prior to retirement? _____

What is your age?

☐ Under 50 ☐ 50-55 ☐ 56-60 ☐ 61-65 ☐ 66-70 ☐ Over 70

What is your gender? ☐ Female ☐ Male ☐ Other/No disclosure

Approximately how many trips per week do you drive?

- ☐ I do not drive.
- ☐ drive about once a week
- ☐ I take five or less trips per week
- ☐ I take six to ten trips per week
- ☐ I drive more than ten times per week

For what purposes do you drive mostly?

- ☐ Most of my driving is for recreation (to social functions, see family, etc.).
- ☐ I drive mostly to commute to work.
- ☐ Driving is part of my occupation.
- ☐ I drive both recreationally and for work purposes.
- ☐ Other: _____

This project, sponsored by the University of Akron, is performed by graduate students Reneé Whittenberger, PE and Claudia Marovic under the guidance of Dr. Ping Yi.

Safety Features and Use: Collision Prevention and Mitigation

Forward Collision Warning

Left Turn Crash Avoidance

Adaptive Headlights ·

Bicycle Detection

Obstacle Detection

Pedestrian Detection

Automatic Emergency Braking

Please indicate if or how much you currently utilize ***most of*** the features on the left.

- ☐ I use these features every time I drive.
- ☐ I would use these features every time if available.
- ☐ I am familiar with these features and have used them sometimes.
- ☐ I am familiar with these features and would like to try to use them, if available.

If you ***do not*** use most of these features, please check the reasons that apply:

- ☐ I am not familiar with most of these features.
- ☐ I do not have these features on my vehicle.
- ☐ I do not know how to turn these features on.
- ☐ I do not want to learn about these features.
- ☐ The alerts are distracting.
- ☐ The alerts are startling.
- ☐ The alerts do not work.
- ☐ I am confident in my driving ability without these features.
- ☐ I am afraid I may disrupt my vehicle's electronics.
- ☐ I do not believe that the features will always work.
- ☐ I think these features will make me a less alert driver.
- ☐ The icons are too small to read.
- ☐ Other: _____

_____

_____

This project, sponsored by the University of Akron, is performed by graduate students Reneé Whittenberger, PE and Claudia Marovic under the guidance of Dr. Ping Yi.

Safety Features and Use: Speed and Cruise Control

Curve Speed Warning

High Speed Alert

Adaptive Cruise Control

Please indicate if or how much you currently utilize ***most of*** the features on the left.

- ☐ I use these features every time I drive.
- ☐ I would use these features every time if available.
- ☐ I am familiar with these features and have used them sometimes.
- ☐ I am familiar with these features and would like to try to use them, if available.

If you ***do not*** use most of these features, please check the reasons that apply:

- ☐ I am not familiar with most of these features.
- ☐ I do not have these features on my vehicle.
- ☐ I do not know how to turn these features on.
- ☐ I do not want to learn about these features.
- ☐ The alerts are distracting.
- ☐ The alerts are startling.
- ☐ The alerts do not work.
- ☐ I am confident in my driving ability without these features.
- ☐ I am afraid I may disrupt my vehicle's electronics.
- ☐ I do not believe that the features will always work.
- ☐ I think these features will make me a less alert driver.
- ☐ The icons are too small to read.
- ☐ Other: _____

_____

_____

Safety Features and Use: Braking and Anti-Rollover Assistance

Anti-lock Brake

Brake Assist

Electronic Stability Control

Traction Control

Please indicate if or how much you currently utilize ***most of*** the features on the left.

- ☐ I use these features every time I drive.
- ☐ I would use these features every time if available.
- ☐ I am familiar with these features and have used them sometimes.
- ☐ I am familiar with these features and would like to try to use them, if available.

If you ***do not*** use most of these features, please check the reasons that apply:

- ☐ I am not familiar with most of these features.
- ☐ I do not have these features on my vehicle.
- ☐ I do not know how to turn these features on.
- ☐ I do not want to learn about these features.
- ☐ The alerts are distracting.
- ☐ The alerts are startling.
- ☐ The alerts do not work.
- ☐ I am confident in my driving ability without these features.
- ☐ I am afraid I may disrupt my vehicle's electronics.
- ☐ I do not believe that the features will always work.
- ☐ I think these features will make me a less alert driver.
- ☐ The icons are too small to read.
- ☐ Other: _____

_____

_____

Safety Features and Use: Tire, Temperature, and Terrain

Hill Descent Assist

Hill Start Assist

Temperature Warning

Tire Pressure Monitoring System

Please indicate if or how much you currently utilize ***most of*** the features on the left.

- ☐ I use these features every time I drive.
- ☐ I would use these features every time if available.
- ☐ I am familiar with these features and have used them sometimes.
- ☐ I am familiar with these features and would like to try to use them, if available.

If you ***do not*** use most of these features, please check the reasons that apply:

- ☐ I am not familiar with most of these features.
- ☐ I do not have these features on my vehicle.
- ☐ I do not know how to turn these features on.
- ☐ I do not want to learn about these features.
- ☐ The alerts are distracting.
- ☐ The alerts are startling.
- ☐ The alerts do not work.
- ☐ I am confident in my driving ability without these features.
- ☐ I am afraid I may disrupt my vehicle's electronics.
- ☐ I do not believe that the features will always work.
- ☐ I think these features will make me a less alert driver.
- ☐ The icons are too small to read.
- ☐ Other: _____

_____

_____

Safety Features and Use: Parking Assistance

Back up Camera

Back up Warning

Rear Cross Traffic Alert

Parking Sensors

Automatic Parallel Parking

Please indicate if or how much you currently utilize ***most of*** the features on the left.

- ☐ I use these features every time I drive.
- ☐ I would use these features every time if available.
- ☐ I am familiar with these features and have used them sometimes.
- ☐ I am familiar with these features and would like to try to use them, if available.

If you ***do not*** use most of these features, please check the reasons that apply:

- ☐ I am not familiar with most of these features.
- ☐ I do not have these features on my vehicle.
- ☐ I do not know how to turn these features on.
- ☐ I do not want to learn about these features.
- ☐ The alerts are distracting.
- ☐ The alerts are startling.
- ☐ The alerts do not work.
- ☐ I am confident in my driving ability without these features.
- ☐ I am afraid I may disrupt my vehicle's electronics.
- ☐ I do not believe that the features will always work.
- ☐ I think these features will make me a less alert driver.
- ☐ The icons are too small to read.
- ☐ Other: _____

_____

_____

Safety Features and Use: Lane and Side Assistance

Lane Keeping Assist

Lane Departure Warning

Sideview Camera

Drowsiness Alert

Blind Spot Warning

Please indicate if or how much you currently utilize ***most of*** the features on the left.

- ☐ I use these features every time I drive.
- ☐ I would use these features every time if available.
- ☐ I am familiar with these features and have used them sometimes.
- ☐ I am familiar with these features and would like to try to use them, if available.

If you ***do not*** use most of these features, please check the reasons that apply:

- ☐ I am not familiar with most of these features.
- ☐ I do not have these features on my vehicle.
- ☐ I do not know how to turn these features on.
- ☐ I do not want to learn about these features.
- ☐ The alerts are distracting.
- ☐ The alerts are startling.
- ☐ The alerts do not work.
- ☐ I am confident in my driving ability without these features.
- ☐ I am afraid I may disrupt my vehicle's electronics.
- ☐ I do not believe that the features will always work.
- ☐ I think these features will make me a less alert driver.
- ☐ The icons are too small to read.
- ☐ Other: _____

_____

_____

Safety Features and Use: Collision Prevention and Mitigation

Forward Collision Warning

Left Turn Crash Avoidance

Adaptive Headlights ·

Bicycle Detection

Obstacle Detection

Pedestrian Detection

Automatic Emergency Braking

Please indicate if or how much you plan to utilize ***most of*** the features on the left.

- ☐ I already use these features and will continue to use them regularly.
- ☐ I plan to use these features regularly or I would if I had the opportunity.
- ☐ I understand these features and would like to ***try to*** use these ***sometimes.***

If you ***will not*** use most of these features, please check the reasons that apply:

- ☐ I do not understand most of these features.
- ☐ I do not have these features on my vehicle.
- ☐ I do not know how to turn these features on.
- ☐ I do not want to learn about these features.
- ☐ The alerts are distracting.
- ☐ The alerts are startling.
- ☐ The alerts do not work.
- ☐ I am confident in my driving ability without these features.
- ☐ I am afraid I may disrupt my vehicle's electronics.
- ☐ I do not believe that the features will always work.
- ☐ I think these features will make me a less alert driver.
- ☐ The icons are too small to read.
- ☐ Other: _____

_____

_____

This project, sponsored by the University of Akron, is performed by graduate students Reneé Whittenberger, PE and Claudia Marovic under the guidance of Dr. Ping Yi.

Safety Features and Use: Speed and Cruise Control

Curve Speed Warning

High Speed Alert

Adaptive Cruise Control

Please indicate if or how much you plan to utilize ***most of*** the features on the left.

- ☐ I already use these features and will continue to use them regularly.
- ☐ I plan to use these features regularly or I would if I had the opportunity.
- ☐ I understand these features and would like to ***try to*** use these ***sometimes.***

If you ***will not*** use most of these features, please check the reasons that apply:

- ☐ I do not understand most of these features.
- ☐ I do not have these features on my vehicle.
- ☐ I do not know how to turn these features on.
- ☐ I do not want to learn about these features.
- ☐ The alerts are distracting.
- ☐ The alerts are startling.
- ☐ The alerts do not work.
- ☐ I am confident in my driving ability without these features.
- ☐ I am afraid I may disrupt my vehicle's electronics.
- ☐ I do not believe that the features will always work.
- ☐ I think these features will make me a less alert driver.
- ☐ The icons are too small to read.
- ☐ Other: _____

_____

_____

Safety Features and Use: Braking and Anti-Rollover Assistance

Anti-lock Brake

Brake Assist

Electronic Stability Control

Traction Control

Please indicate if or how much you plan to utilize ***most of*** the features on the left.

- ☐ I already use these features and will continue to use them regularly.
- ☐ I plan to use these features regularly or I would if I had the opportunity.
- ☐ I understand these features and would like to ***try to*** use these ***sometimes.***

If you ***will not*** use most of these features, please check the reasons that apply:

- ☐ I do not understand most of these features.
- ☐ I do not have these features on my vehicle.
- ☐ I do not know how to turn these features on.
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- ☐ The alerts are distracting.
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- ☐ I do not believe that the features will always work.
- ☐ I think these features will make me a less alert driver.
- ☐ The icons are too small to read.
- ☐ Other: _____

_____

_____

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Safety Features and Use: Tire, Temperature, and Terrain

Hill Descent Assist

Hill Start Assist

Temperature Warning

Tire Pressure Monitoring System

Please indicate if or how much you plan to utilize ***most of*** the features on the left.

- ☐ I already use these features and will continue to use them regularly.
- ☐ I plan to use these features regularly or I would if I had the opportunity.
- ☐ I understand these features and would like to ***try to*** use these ***sometimes.***

If you ***will not*** use most of these features, please check the reasons that apply:

- ☐ I do not understand most of these features.
- ☐ I do not have these features on my vehicle.
- ☐ I do not know how to turn these features on.
- ☐ I do not want to learn about these features.
- ☐ The alerts are distracting.
- ☐ The alerts are startling.
- ☐ The alerts do not work.
- ☐ I am confident in my driving ability without these features.
- ☐ I am afraid I may disrupt my vehicle's electronics.
- ☐ I do not believe that the features will always work.
- ☐ I think these features will make me a less alert driver.
- ☐ The icons are too small to read.
- ☐ Other: _____

_____

_____

Safety Features and Use: Parking Assistance

Back up Camera

Back up Warning

Rear Cross Traffic Alert

Parking Sensors

Automatic Parallel Parking

Please indicate if or how much you plan to utilize ***most of*** the features on the left.

- ☐ I already use these features and will continue to use them regularly.
- ☐ I plan to use these features regularly or I would if I had the opportunity.
- ☐ I understand these features and would like to ***try to*** use these ***sometimes.***

If you ***will not*** use most of these features, please check the reasons that apply:

- ☐ I do not understand most of these features.
- ☐ I do not have these features on my vehicle.
- ☐ I do not know how to turn these features on.
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- ☐ I do not believe that the features will always work.
- ☐ I think these features will make me a less alert driver.
- ☐ The icons are too small to read.
- ☐ Other: _____

_____

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Safety Features and Use: Lane and Side Assistance

Lane Keeping Assist

Lane Departure Warning

Sideview Camera

Drowsiness Alert

Blind Spot Warning

Please indicate if or how much you plan to utilize ***most of*** the features on the left.

- ☐ I already use these features and will continue to use them regularly.
- ☐ I plan to use these features regularly or I would if I had the opportunity.
- ☐ I understand these features and would like to ***try to*** use these ***sometimes.***

If you ***will not*** use most of these features, please check the reasons that apply:

- ☐ I do not understand most of these features.
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- ☐ The icons are too small to read.
- ☐ Other: _____

_____

_____

Safety Technology Features Survey

The goal of this survey is to understand the perception, frequency of use, and overall efficacy of safety features in technologically equipped vehicles.

Did you find this session helpful?_____

Would you like to be emailed more information? _____

If yes, please provide your email address:_____

Do you have any other comments? _____

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