A Survey on the Desirability, Usability, and Trust of Advanced Driver Assistance System (ADAS)

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A Survey on the Desirability, Usability, and Trust of Advanced Driver Assistance System (ADAS)

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Summary

ADAS technology is becoming more common in vehicles. The goal of this project is to understand the general population's perception of ADAS features performing at different levels of control using surveys. All surveys were performed in person in the Atlanta metro area. The survey found that respondents find features they perceive to perform less function, more desirable and trustworthy. The biggest limitation respondents find about ADAS features are relinquishing control and a fear of failure. The biggest benefits respondents identified of ADAS features are safety and convenience.

1. Introduction

1.1 Project Goals

This thesis presents a study undertaken to understand how the general population feels about Advanced Driver Assistant Systems (ADAS) performing at different levels of control. To achieve this, the project team conducted a survey on ADAS features.

1.2 Literature Review

Advanced Driver Assistance Systems (ADAS) are increasingly integrated into modern vehicles to enhance safety, comfort, and driving efficiency. These systems include features such as lane keeping assistance, adaptive cruise control, blind-spot detection, and automated emergency braking. The perception of ADAS among drivers is a critical factor influencing adoption, usage, and trust. Research indicates that while drivers generally recognize the safety benefits of ADAS, concerns remain regarding reliability and loss of control.

Several studies highlight the role of trust and usability in shaping driver perception. For example, Payre et al. (2014) found that trust in automation significantly predicts driver acceptance, but overreliance without adequate understanding may lead to misuse. Drivers who perceive ADAS as overly complex or unintuitive are less likely to use the systems consistently. Parasuraman and Riley (1997) caution that relying on the system without monitoring can lead to safety risks if system limitations are not understood.

Moreover, demographic factors such as age, driving experience, and technology familiarity influence perception. Older drivers may perceive ADAS as intrusive or difficult to use, while younger drivers tend to show greater openness but may also exhibit riskier behavior due to overtrust (Rahman et al., 2017). Studies also show variability in perceptions based on system performance. When ADAS performs inconsistently or poorly in certain conditions (e.g., adverse weather or urban traffic), users develop skepticism or disengage altogether (Körber et al., 2018).

Finally, exposure and education play a vital role. Drivers with hands-on experience tend to report higher satisfaction and understanding of system capabilities and limits (Bimbraw, 2015). Educational interventions and clear communication from manufacturers can bridge gaps in knowledge and reduce unrealistic expectations. Overall, ADAS holds the potential to reduce accidents and enhance driving experience.

2. Survey Design

The project team met in Houston, Texas on May 13, 2024, to design the survey. Members present at the meeting were:

1. Dr. Jennifer Erdely – Prairie View A&M
2. Dr. Mark Tschaepe – Prairie View A&M
3. Dr. Michael Hunter – Georgia Institute of Technology
4. Christian Douglas – Georgia Institute of Technology
5. Khalid Adebayo – Georgia Institute of Technology

After some research on Ford's ADAS suit of features and discussions by the research team, it was decided that the survey would focus on two ADAS features which are Lane Centering Control (LCC) and Lane Change Assistance (LCA).

These features were chosen in large part because they are the most prominent advanced features in typical ADAS packages.

The research team deduced that Lane Centering Control (LCC), which automatically centers a vehicle in its lane, is a significant ADAS feature as it reduces the need for drivers to constantly steer their vehicle. LCC requires the drivers to relinquish some level of control of the vehicle to the technology to provide lane tracking. It was believed that this technology would help reflect users' trust in ADAS and willingness to cede vehicle control.

Lane Change Assistance (LCA) was chosen for the survey because it required drivers to give up a higher level of control. LCA was deemed by the research team to require a higher level of trust in the technology, with the vehicle making more active decisions.

Additionally, both features were also chosen because they performed just one function and would be easiest to explain and be understood by participants in a 15-30 second timeframe. This is why features which may maintain multiple driving functions simultaneously were not chosen for the survey. More robust ADAS features were to be considered in later venues where more in-depth explanations and discussions could occurs, such as focus groups.

The research team limited the study to two features to limit the survey duration. We aimed to design the survey so it could be completed within ten minutes. Asking questions about two features also allowed for comparison in perceptions of both features.

In the survey design, the research team made sure to emphasize that these features were hands free. This aspect of ADAS significantly increases, at least in terms of perception, the level of control ceded by the driver to the technology. The team sought to understand this higher level of ADAS features.

The target population for the survey were people who meet the following requirements:

1. At least 18 years of age.
2. Had some experience driving a vehicle.
3. Could understand English.

The survey was to be conducted in person using Qualtrics in the Atlanta Metro Area. The survey was reviewed and approved by Georgia Institute of Technology Institute Review Board (IRB). A printout of the survey can be found in appendix A.

The survey was divided into four parts. The first part asked for consent from participants to take the survey. The second part asked questions about Lane Centering Control (LCC).

The third part asked questions about Lane Change Assistance (LCA). The last part asked questions on participants' demographics.

The same set of questions were asked about both ADAS features (LCC and LCA). This is to allow for comparison between perceptions of both features. Demographic questions were asked to understand how participant characteristics might affect their perception of ADAS features.

2.1 Survey First Part – Consent

According to Georgia Tech Internal Review Board (IRB), "No investigator may involve a human being as a subject or use their tissue or data in a research activity without obtaining the informed consent of the subject" (Georgia Tech Office of Research Integrity and Assurance). The requirement for informed consent ensures that participants are informed of their rights and the use of the data collected. The consent form for this survey is shown in appendix 1.

2.2 Survey Second and Third Part – ADAS Technologies:

The second and third part of the survey described LCC (section 2) and LCA (section 3)technology, then asked questions to determine if the respondent had experience with the technology and how they perceived the technology in terms of desirability, usability and trust. Both sections utilize the same set of questions with each targeted to the specific technology.

2.2.1 Technology Description

The technology description is a definition of the ADAS technology with a brief gif showing the technology.

LCC was described as "This hands-free feature keeps you centered in your lane. Driver must remain alert when feature is in use."

An image from the GIF used for LCC is shown below.

Figure 1: Lane Centering Control GIF

Credit: Dietrich's Car Channel: (How to use Ford blue cruise hands free driving and lane change assist, 00:6:46-00:6:56)

LCA was described as "This feature will make lane changes at the drivers request, when it is safe. Drivers must remain alert when this feature is in use.".

An image from the GIF used for LCA is shown below.

Figure 2: Lane Change Assistance GIF

Credit: Dietrich's Car Channel: (How to use Ford blue cruise hands free driving and lane change assist, 00:4:26-00:4:36)

2.2.2 Experience with the Technology

The first question asked participants if they have driven a vehicle with the specific ADAS feature. This question was asked to understand if respondents later responses were based on direct experience (i.e that had used the technology) or perception only (i.e respondents had not used the technology. The question was framed as:

“Have you driven a vehicle with hands free lane centering control capabilities?” for the LCC question and “Have you driven a vehicle with hands free lane change assistance capabilities?” for the LCA question.

Participants could either respond with yes, no, or unsure.

2.2.3 Desirability

Question two and three focus on the desirability of each feature. The questions aim to understand the participants' preference for the technology. The desirability questions captures the likelihood of participants wanting that feature in their vehicle or if they would consider such a feature when they are purchasing their next vehicle.

The second question asks participants the feature desirability. The question is framed as:

"How desirable do you find hands free lane centering control capabilities?" in the LCC section and "How desirable do you find hands free lane change assistance capabilities?" in the LCA section.

Participants can respond on a 5-point Likert scale from extremely undesirable to extremely desirable.

The third question is an open-ended question that asks participants why they responded the way they did in the previous question. The question is framed as:

"What about hands free lane centering control do you find desirable or undesirable?" in the LCC section and "What about hands free lane change assistance do you find desirable or undesirable?" in the LCA section.

2.2.4 Usability

Questions four and five in the LCC and LCA sections focus on the usability of each feature. The usability question captures what participants think of the functionality of the feature and whether they think it helps or impedes driving tasks and how it does so.

The fourth question asks participants how usable the feature is. The question is framed as:

“How usable do you find hands free lane centering control?” in the LCC section and “How usable do you find hands free lane change assistance?” in the LCA section.

Participants can respond on a 5-point Likert scale from extremely unusable to extremely usable.

The fifth question in this section is an open-ended question that asks participants why they responded the way they did in the previous question. The question is framed as:

“What about hands free lane centering control do you find usable or unusable?” in the LCC section and “What about hands free lane change assistance do you find usable or unusable?” in the LCA section.

2.2.5 Trust

Question six and seven focus on the perception of trust of the feature. This question aims to capture the likelihood of drivers using the feature. The expectation is that the more a driver trusts a feature, the more likely they are to use the feature.

The sixth question asks participants how much they trust each feature. The question is frames as:

“How much do you trust hands free lane centering control?” in the LCC section and “How much do you trust hands free lane change assistance?” in the LCA section.

The seventh question in this section is an open-ended question that asks participants why they responded the way they did in the previous question. The question is framed as:

“What about hands free lane centering control do you trust or distrust?” in the LCC section and “What about hands free lane change assistance do you trust or distrust?” in the LCA section.

2.2.6 Feature change

The final question related to the features asks the participant to reflect on the feature and state how they would change the feature to better suit their needs. The question is framed as:

and “How would you change lane centering control to make it suit you?” in the LCC section and “How would you change hands-free lane change assistance to make it suit you?” in the LCA section,

2.3 Survey Fourth Part – Demographics

The fourth and last part of the survey asks participants about their demographic characteristics. Four demographic questions were asked. These questions are race, gender, age, and income.

The race and gender question were open ended and participants could write down their own age and gender. These questions were framed as:

“What is your self-identified ethnicity/race?” and

“What is your self-identified gender?”

The age question was framed as:

"What is your age?"

Participants were given eight options for the age question. These options were:

- 18-24
- 25-34
- 35-44
- 45-54
- 55-64
- 65-74
- 75 or older
- Prefer not to answer

The income question was framed as:

"What is your income?"

Participants were given 13 options for the income question. These options were:

- Less than $10,000
- Between $10,000 and $20,000
- Between $20,000 and $30,000
- Between $30,000 and $40,000
- Between $40,000 and $50,000
- Between $50,000 and $60,000
- Between $60,000 and $75,000
- Between $75,000 and $100,000
- Between $100,000 and $150,000

- Between $150,000 and $200,000
- More than $200,000
- Don’t know
- Prefer not to answer

Participants were also asked about their zip code. The question is framed as:

“What is your zip code?”

The demographic question helps understand how stakeholder characteristics can affect perceptions of ADAS.

3. Internal Review Board (IRB) Approval

IRB approval is required for every research project conducted at the Georgia Institute of Technology. The survey required an exempt IRB approval.

The IRB submittal requires a consent form, recruitment posters, focus group interest form and the project description. All required forms, posters and descriptions were submitted. The project got approval from Georgia Tech IRB. IRB submittal documents can be found in appendix B

4. Data Collection

The survey was created on Qualtrics and administered using the Qualtrics offline survey app called "Qualtrics Surveys" in apple's app store. The survey was then uploaded into the research team cloud-based Qualtrics account.

All surveys were administered in person using four I-pad pro tablets. Respondents were given tablets to register their response. Survey representatives were present with all respondents as they completed the survey and responded to any question posed by participants during the process.

Survey data was collected from August 28th to November 18th. All survey data were collected in the Atlanta Metro Area. Locations where data were collected include:

1. Georgia Tech Atlanta Campus – Tech Green
2. Atlanta Beltline – In front of "A whole dog market" at 931 Monroe Dr NE Ste 113B, Atlanta, GA 30308
3. Quick trip – 1999 Mountain Industrial Blvd, Tucker, GA 30084
4. Dekalb Tennis Center – ALTA Games
5. Tesla Charging Station – behind Grease Monkey at 4410 Hugh Howell Rd, Tucker, GA 30084
6. Glenlake Tennis Center - 1121 Church St, Decatur, GA 30030

5. Survey Analysis

There were 181 recorded responses for the survey. Of these, 58 of the responses are from students at Georgia Tech and the other 123 are from nonstudents.

5.1 Thematic Analysis Methodology

Prior to statistical analysis of the survey results the open ended responses were categorized using a thematic analysis. The following key words were used for each part of the thematic analysis. For the desirability and usability open ended responses each participant response was categorized into one of these six categories. The process to develop the categories was manual and iterative, based on analyst judgement for the category selection and assignment. Listed with each category below is the type of comments provided by the participant which result in assignment of the response to the given category. As seen, most categories can have a positive or negative connotation. Rather than seek the positive or negative sentiment of the participant, the goal was to determine the aspects of the feature on which the participant focused, e.g., convenience, which could be convenient or inconvenient. Positive or negative reactions were captured by the Likert questions.

<u>Desirability / Usability Key Words</u>

- Attentiveness
    - Distraction: The technology itself is distracting / annoying / jerky
    - Attention: the driver is distracted or tired, or the feature can reinforce distracting behavior in users, the feature calls your attention, the feature should call your attention

- Control
    - Control: allows for more or takes away control from drivers
    - Overcorrect: the technology overcorrects mistakes/ too sensitive.
    - Aggressive: Not aggressive enough (for LCA)
- Convenience
    - Better to have: the technology is cool, helps, etc. Overall favorable attitude to the technology.
    - Comfortability: Makes driving easier or convenient in some way. The technology assists in some way. Makes driving less comfortable/ causes worry.
    - Guidance: provides guidance to the vehicle (for LCC)
    - Ease of use: the feature is easy to access, requires no learning curve, or is automatic. The feature requires some learning and getting used to.
- Other
    - Irrelevant: the comment is irrelevant
    - Unaware: comments “Nothing” or something similar
    - Unknown: does not understand the technology or have never used the technology
- Reservation
    - Skeptical: skepticism over the effectiveness of the technology/ feature. Thinks people should be able to drive without the feature. Does not see too much of a benefit from using the system, area use limitations, thinks it needs more testing.

  - Guarded: has reservations about the technology for a particular reason.
- Safety
  - Safety: Improves safety in some way
  - Danger: technology can help avert danger or can lead to dangerous situations or can encourage dangerous behavior.

Trust Key Words

Based on a review of the open-ended responses, it was deemed the categories utilized for the desirability and usability analysis, while overlapping with the trust response, were not sufficient. The following six categories were selected for the trust categorization.

- Consistent
  - Accuracy: glitches, is or is not very accurate
  - Consistency: makes unexpected movements, does not work in certain conditions (dark, large vehicles, roadway conditions), is consistent and works every time
- Safety
  - Safety: is or is not safe.
  - Failure: it has the possibility of failure or malfunction
- Reliability
  - Reputation: trust or do not trust certain manufacturer, trust or do not trust that the technology has gone through testing, trust or do not trust technology type (e.g sensor/ camera), personal experience from technology

- Reliance: participants can or cannot rely on the feature. Reliable or not reliable in the moments it is needed, makes driving easier or helps, makes drivers less cautious because they rely on the technology.

- Reservation
  - Skeptical: skeptical of technology or, automation in general
  - Guarded: skeptical of technology due to not having experience with it, or needing to learn more, or needing more time with the technology, skeptical of the ability to operate in certain conditions.
- Control
  - Control: allows for more or takes away control from drivers.
  - Aggressive: Not aggressive enough (for LCA).
- Other
  - Irrelevant: the comment is irrelevant
  - Unaware: comments "Nothing" or something similar
  - Unknown: does not understand the technology or have never used the technology

Change Key words

The open-ended responses to how the participant would you change the ADAS feature were categorized as follows. The same categorization was used for both LCA and LKS.

- Accessibility

- Accessibility: make the feature more accessible by ease of use or make it more available in more vehicles
  - Openness: be more open about how the technology works, open sources to learn about the technology.
- Dependability
  - Reliability: improve the reliability or safety of the system
  - Testing: more testing of the technology with data, more testing by the participant, technology needs more time to develop.
  - Accuracy: make it more accurate at what it does.
  - Skeptical: would not use it, it's not very useful
- Optional
  - Optional: participant does not want the feature at all, make the feature optional, and allow more options within the feature (less sensitivity).
- Features
  - Notification: remove or change notification to drivers, notification to other vehicles on the road, and notification from drivers
  - Detection: detection of driver, detection of other vehicles, detect roadway features.
  - Operational Design Domain (ODD): improve feature ODD (make it self-driving, add AI) or reduce where the feature operates (only on highway, only at certain speed limits or infrastructure).
- Other
  - Irrelevant: the comment is irrelevant.

    - Unaware: comments “Nothing” or something similar.
    - Unknown: does not understand the technology or have never used the technology.
    - Nothing: no changes.

The open-ended race and gender responses were also categorized as follows.

<u>Unified Race</u>

- Mixed
- Black
- White
- Asian
- Hispanic
- MENA - Middle East North Africa
- Unknown

<u>Unified Gender</u>

- F - Female
- M - Male
- N – non-binary
- U - Unknown

The next section summarizes the response from the survey and describes the results of the analysis.

5.2 Response Description

5.2.1 Survey Second and Third Part – Desirability, Usability and Trust

5.2.1.1 Lane Centering Control – Driven

Figure 3 below shows the responses from the question "Have you driven a vehicle with lane centering control capabilities?"

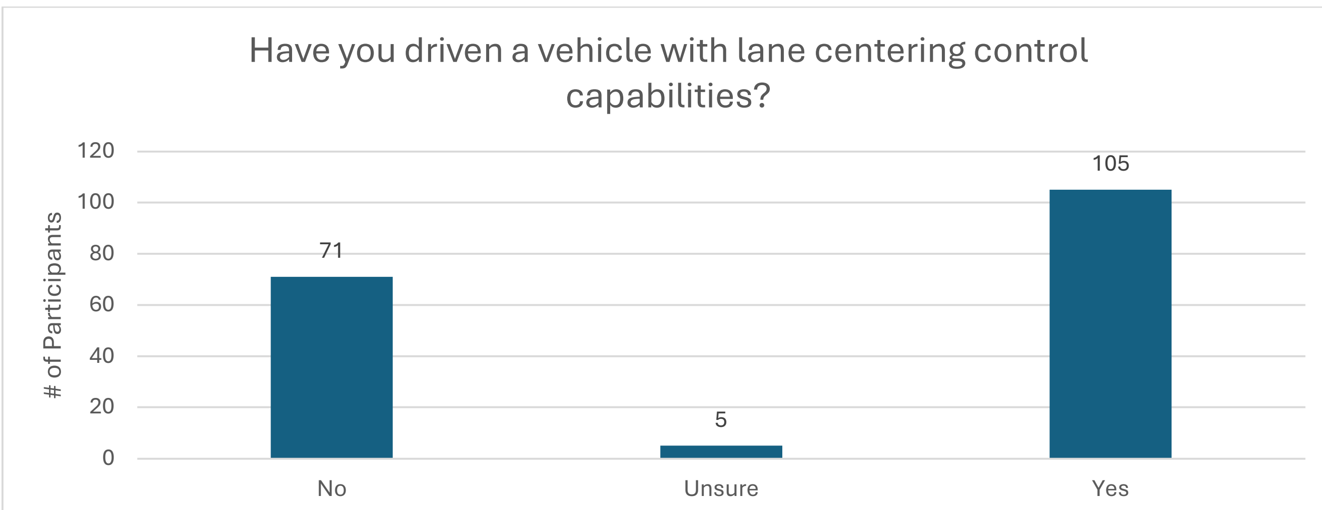

Figure 3: Response to "Have you driven a vehicle with lane centering control capabilities?"

More survey participants have driven a vehicle with LCC than have not. About 58% of participants have driven a vehicle with LCC. This shows that LCC technology is quite common in vehicles that respondents drive.

5.2.1.2 Lane Centering Control Desirability

Figure 4 below shows the response to the question "How desirable do you find lane centering control?"

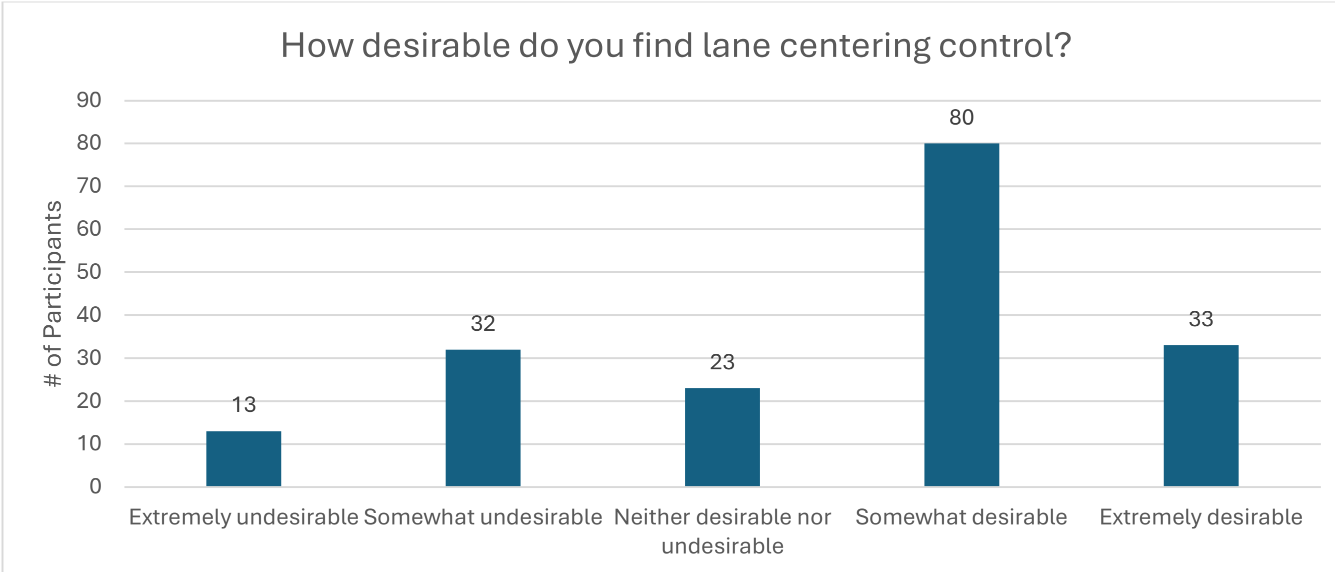

Figure 4: Response to "How desirable do you find lane centering control?"

The majority of survey participants find LCC to be desirable. About 62% of survey participants find LCC to be either somewhat or extremely desirable. The highest frequency response was for "somewhat desirable" at 80 responses. This shows that most participants find LCC desirable but also have some reluctance or doubts about the technology that keeps them from finding LCC extremely desirable.

Applying a Likert scale from 1 to 5 on the response options, it is found that the mean score for LCC desirability is 3.5. The falls right between Neither desirable nor undesirable and somewhat desirable.

Table 1 below shows the result of the thematic analysis on the open-ended question "What about lane centering control do you find desirable or undesirable?". In this table, a participant may be represented more than once if their comments covered multiple categories.

Table 1: Thematic Analysis Summary for "What about lane centering control do you find desirable or undesirable?"

	Themes						
LCC Desirability	Attentiveness	Control	Convenience	Other	Reservation	Safety	Total
Extremely undesirable	1	3	4	1	2	3	14
Somewhat undesirable	7	13	3	0	6	8	37
Neither desirable nor undesirable	2	3	4	7	6	5	27
Somewhat desirable	17	10	43	2	3	24	99
Extremely desirable	7	1	18	1	0	14	41
Total	34	30	72	11	17	54	218

5.2.1.2.1 Extremely Undesirable

Extremely undesirable accounts for 6% of the comments. The most common themes people who find LCC to be extremely undesirable are control, convenience, and safety.

Surprisingly, six of the comments from respondents who responded extremely undesirable were positive. These six comments had the themes of convenience and safety. The respondents highlight that the technology makes driving "seem safer" and easier. The comments also outline scenarios in which the technology could help such as "staying in the lane", "when getting close to the median", "highway driving in low traffic conditions".

One respondent gave an irrelevant comment.

The other six comments were negative and the most common theme for these comments are control, safety and reservation. Respondents did not like the loss of control that they felt the technology implied. Some respondents found the technology to be annoying and distracting. Other respondents were skeptical about the technology. These respondents highlighted their distrust in "AI" and "technology" driving a vehicle.

The comments from respondents who find LCC to be extremely undesirable reflect distrust towards LCC. They do not find technology to be reliable and prefer to maintain control over their vehicle. Their concerns include the potential for LCC to make drivers lazy and less attentive. Some respondents acknowledge the benefits of LCC such as enhanced safety, but the predominant sentiment is one of skepticism and a preference for self-control of the vehicle.

5.2.1.2.2 Somewhat Undesirable

Somewhat undesirable accounts for 17% of the comments. The most common themes of participants that find LCC to be somewhat undesirable are control, safety, attentiveness, and reservation.

As with the extremely undesirable case, some of the comments from respondents who selected somewhat undesirable were positive. These comments were about how it "keeps them focused" or "is useful for long drives". Under the safety theme, respondents highlight that it "keeps/forces them in their lane" or how "it is an added safety feature".

For the control theme, respondents highlight that the technology “overcorrects”, “is sensitive”, or “is jerky”. Respondents also noted that they like to always keep control of their vehicle.

A number of comments are labeled with both the control and safety themes. These comments highlight that the overcorrection and jerkiness of the feature could cause a very unsafe situation, especially when they must react abruptly.

For the attentiveness theme, respondents highlight that the jerkiness, overcorrection and alerts of the feature causes them to be distracted.

For the reservation theme, respondents highlight that they do not trust the technology or how the technology has a limited operational design domain (ODD). The trust comments highlight that respondents are “not interested in a vehicle that controls itself” or that “a human should always control their vehicle”. The limited ODD comments highlight that the technology “does not work where there are no lane markings” or “the technology lacks street intelligence”.

5.2.1.2.3 Neither Desirable nor Undesirable

Neither desirable nor undesirable accounts for 12% of the comments. The most common themes people find LCC to be neither desirable nor undesirable are other, reservation, and safety.

Four of the participants with the theme other commented that they have no experience with LCC or are unsure what it is. Three comments in the other category commented “nothing” or “no response”.

For the reservation theme, three respondents highlight that they trust their own driving skills better than using the technology, or that the technology does not help very much. One respondent highlight that they are not interested in the technology and other highlights how the technology does not work in certain scenarios.

Four of the comments with the safety theme are negative. These comments highlight that LCC can be scary or dangerous sometimes. One comment highlights that LCC is good but can create complacency, especially in newer drivers.

5.2.1.2.4 Somewhat Desirable

Somewhat desirable accounts for 45% of the comments. The most common reasons respondents find LCC somewhat desirable are convenience and safety.

A number of comments within the theme convenience highlight that LCC makes highway driving or long road trips “easier” and more “relaxed”. Other comments within the theme convenience highlight that the “additional help” LCC provides is good.

Comments within the safety theme highlight that the technology “helps you stay in your lane”, “keeps you safe”, reduces the risks of accidents, and “human error”.

Comments within the safety and attentiveness theme highlight that the technology “alerts you” in dangerous situations such as when the driver is tired or using their phone.

Comments within the safety and convenience theme highlight that the technology helps and reduces fatigue due to less constant attention required from the driver.

Some comments within the attentiveness theme highlight that the alerts are good but can be annoying or distracting sometimes.

5.2.1.2.5 Extremely Desirable

Extremely desirable accounts for 18% of the total comments. The most common themes respondents provide as to why they find LCC to be extremely desirable are convenience and safety.

Comments within the safety theme highlight that LCC is safer because it “keeps you in your lane”, “prevents accidents”, “safer for everyone”, “safer for newer drivers”, and “drivers are distracted”.

Comments within the convenience theme highlight that LCC makes driving more “comfortable”, “less stressful”, and “less tiring” especially on long trips or highway driving. Respondents also highlight that it is convenient when “swerving out of your lane”.

5.2.1.2.6 LCC Desirability Summary

Respondents who rated LCC extremely or somewhat undesirable (23% combined) often cited concerns about loss of control, safety risks, distractions, and distrust in the technology, though a few acknowledged potential benefits like improved lane keeping. Neutral respondents (12%) were mostly unfamiliar with LCC or felt it offered limited value, with some raising concerns about its effectiveness in certain driving conditions. The majority of respondents found LCC somewhat or extremely desirable (63% combined), highlighting its convenience, ability to reduce fatigue, and contribution to safer driving—especially on highways or long trips. Overall, while a portion of users remain skeptical, many see LCC as a helpful tool that enhances comfort and safety behind the wheel.

5.2.1.3 Lane Centering Control Usability

Figure 5 below shows the response to the question “How usable do you find lane centering control?”

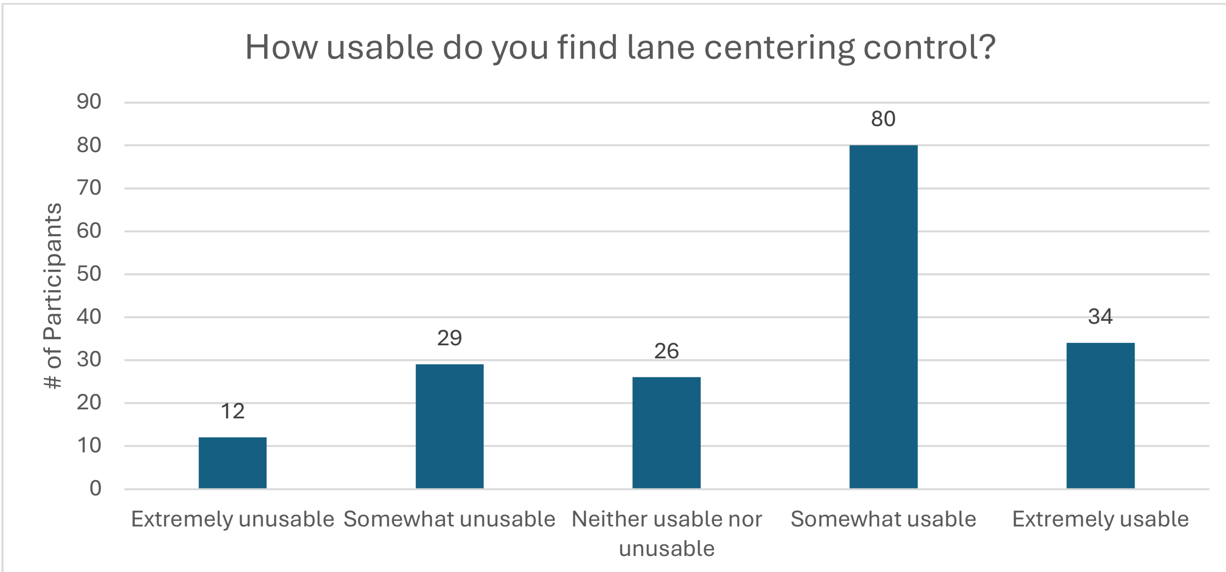

Figure 5: Response to “How usable do you find lane centering control?”

About 63% of respondents find lane centering control to be somewhat or extremely usable. The most common response is somewhat usable with a frequency of 80. This shows that most participants find LCC usable but also have some reluctance or doubts about the technology that keeps them from finding LCC as extremely usable.

Applying a likert scale from 1 to 5 to LCC usability, a mean score of 3.5 is calculated. The falls right between Neither desirable nor undesirable and somewhat desirable. This is the same as the desirability score.

Table 2 below shows the result of the thematic analysis on the open-ended question “What about lane centering control do you find usable or unusable?”

Table 2: Thematic Analysis summary for "What about lane centering control do you find usable or unusable?"

	Themes						
LCC Usability	Attentiveness	Control	Convenience	Other	Reservation	Safety	Total
Extremely unusable	2	2	5	0	4	1	14
Somewhat unusable	3	3	10	5	7	4	32
Neither usable nor unusable	3	1	5	13	4	0	26
Somewhat usable	13	8	50	5	8	10	94
Extremely usable	4	1	27	2	0	2	36
Total	25	15	97	25	23	17	202

5.2.1.3.1 Extremely Unusable

Extremely unusable accounts for 7% if the comments. The most common themes for why respondents find LCC extremely unusable are convenience and reservation.

Interestingly, all the comments with the convenience theme are positive. Respondents highlight that LCC is easy to use and helps the driver stay in their lane.

Comments within the reservation theme highlight that the technology is "not helpful" or "is stupid".

5.2.1.3.2 Somewhat Unusable

Somewhat unusable accounts for 16% of the comments. The most common themes for participants who find LCC somewhat unusable are also convenience and reservation.

As with respondents who selected extremely unusable, comments within the convenience theme are mostly positive with just two comments highlighting that LCC makes them "nervous" or that it does not function well on poorly marked roads.

Comments within the reservation theme highlight that the technology does not work in certain scenarios, or that the respondents is not aware of how effective the technology is generally or in certain scenarios.

5.2.1.3.3 Neither Usable nor Unusable

Neither usable nor unusable accounts for 13% of the comments. The most common themes for participants who find LCC neither usable nor unusable are other, convenience, and reservation.

In the other theme, most of the respondents are not familiar with the technology.

Comments within the convenience theme mostly highlight the ease of use of the technology.

Comments within the reservation theme highlight trust issues with the technology. One respondent comments "Why the need to tell them they aren't in the center of the lane?".

5.2.1.3.4 Somewhat Usable

Somewhat usable accounts for 47% of the comments. The most common themes for why respondents find LCC somewhat usable are convenience, attentiveness, and safety.

Comments within the convenience theme highlight that the technology "guides them", that the technology is good for highway driving, that it is just a nice feature to have for added safety, and how easy it is to use.

Comments within the attentiveness theme highlight that the technology alerts are beneficial, that LCC helps keep the driver alert and that LKS assists when a driver is not paying attention. Four comments under this theme highlight some negative aspects of the technology. These comments highlight that LCC can be annoying and stiff or that LCC can be irritating when changing lanes.

Comments within the safety theme highlight that the technology helps "prevent accidents" or an added safety measure.

5.2.1.3.5 Extremely Usable

Extremely usable accounts for 18% of the comments. The most common theme for why people find LCC extremely usable is convenience. These comments highlight that LCC is easy to use and makes driving more comfortable by "keeping the car in the lane during a curve", making driving less tiring or that LCC does not force them to drive differently.

5.2.1.3.6 LCC Usability Summary

LCC was rated as extremely unusable by 7% of respondents, with comments split between positive remarks on convenience and negative ones expressing reservations about its usefulness. The positive comments might have arisen due to respondents' interpretation of usability. These respondents might have interpreted usability as reliability and rated it low because they believe it will not work in some situations. Somewhat unusable feedback (16%) followed a similar pattern, where most comments praised ease of use, but some raised concerns about reliability and uncertainty in different driving conditions. Among those who found LCC neither usable nor unusable (13%), many lacked familiarity with the technology, though some still commented on its ease of use or trust issues. The largest group (47%) found LCC somewhat usable, often citing convenience, safety, and attentiveness, though a few noted irritations like stiffness or alerts during lane changes. Finally, 18% of respondents rated LCC as extremely usable, mostly emphasizing how it made driving easier, safer, and more comfortable, especially on curves and long trips.

5.2.1.4 Lane Centering Control Trust

Figure 6 below shows the response to the question "How much do you trust lane centering control?"

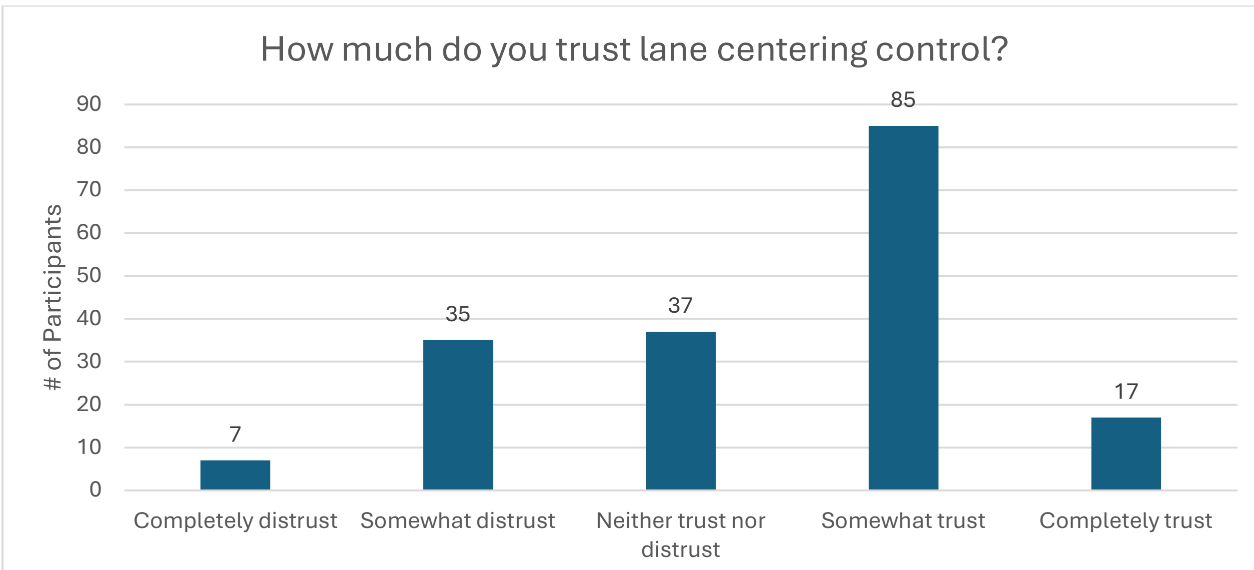

Figure 6: Response to "How much do you trust lane centering control?"

About 56% of respondents somewhat or completely trust lane centering control. The most common response is somewhat trust with a frequency of 85. This shows that many participants trust LCC but also have some reluctance or doubts about the technology that keeps them from completely trusting it.

If we apply a Likert scale from 1 to 5 on our response option, we can find the mean score for LCC trust. The mean score for LCC desirability is 3.4, which is slightly lower than the average desirability and usability score (3.5). This is close to the middle of somewhat trust and extremely trust.

Table 3 below shows the result of the thematic analysis on the open-ended question "What about lane centering control do you trust or distrust?"

Table 3: Thematic Analysis summary for "What about lane centering control do you trust or distrust?"

	Theme							
LCC Trust	Consistency	Control	Other	Reliability	Reputation	Reservation	Safety	Total
Completely distrust	1	0	1	1	0	4	1	8
Somewhat distrust	8	0	2	8	1	15	5	39
Neither trust nor distrust	7	0	13	5	0	12	4	41
Somewhat trust	27	3	5	24	1	31	10	101
Completely trust	8	0	2	7	0	0	0	17
Total	51	3	23	45	2	62	20	206

5.2.1.4.1 Completely Distrust

Completely distrust accounts for 4% of the comments. The most common theme for participants who completely distrust LCC is reservation. Comments under the reservation theme highlight distrust with technology and AI. One comment just says "Everything".

5.2.1.4.2 Somewhat Distrust

Somewhat distrust accounts for 19% of the comments. The most common themes for participants who somewhat distrust LCC are reservation, reliability and consistency.

Comments within the reservation theme highlight that respondents do not really trust the technology yet and would rather wait for the technology to get better, implying a time may arrive when they will trust the technology.

Comments within the reliability theme highlight that the respondents do not trust the technology to be perfect every time.

5.2.1.4.3 Neither Trust nor Distrust

Neither trust nor distrust accounts for 20% of the comments. The most common theme for participants who neither trust nor distrust LCC is reservation.

Comments within the reservation theme highlight that respondents are not familiar with the technology and that the responsibility for driving is mostly on the driver.

5.2.1.4.4 Somewhat Trust

Somewhat trust accounts for 49% of the comments. The most common theme for participants who somewhat trust LCC is reservation.

Comments within the reservation theme highlight that respondents have trust issues with technology, that no technology works all the time. Respondents also highlight that technology can malfunction and have “hiccups”.

5.2.1.4.5 Completely Trust

Completely trust accounts for 8% of the comments. The most common themes for participants who completely trust LCC is reliability.

Comments within the reliability theme highlight that the technology seems to work in their experience and that respondents do not have any problems with it.

5.2.1.4.6 LCC Trust Summary

Comments on trust in LCC varied widely, with the largest share (49%) falling under "somewhat trust," where participants expressed cautious optimism but noted concerns about reliability and occasional malfunctions. About 20% of comments showed neutrality, with respondents often unfamiliar with the technology and emphasizing that the driver still bears responsibility. "Somewhat distrust" was reported by 19% of participants, primarily due to reservations about the technology's current limitations and inconsistent performance. Only 8% of respondents completely trusted LCC, generally citing personal experiences of reliability and no major issues, while 4% completely distrusted it, often expressing deep skepticism toward AI and automated systems. Across most categories, the theme of "reservation" was dominant, reflecting a general sense of caution and hesitation toward fully trusting LCC.

5.2.1.5 Lane Centering Control Change

Table 4 below shows the results for the thematic analysis for "How would you change lane centering control to make it better suit you?"

Table 4: Thematic Analysis for "How would you change lane centering control to make it better suit you?"

Themes	**Frequency**
Accessibility	15
Dependability	39
Features	54
Optional	21
Other	55
Total	184

The most common themes for changes to LCC are features, dependability and other.

Responses within the feature theme suggests adding a new component to the technology that they believe would improve the feature. Some of these feature changes are more notifications, different types of notifications, more detection capabilities, improving the operational design domain and better processing capabilities.

Comments within the accessibility theme highlight a desire for more flexible methods to activate or deactivate the system, such as voice commands. Some respondents also expressed interest in seeing LCC made available in a wider range of vehicles. Additionally, several comments reflected a curiosity about how the technology functions and a desire to better understand its capabilities

Responses within the dependability theme are largely negative, with some participants stating they would never use the technology. Others emphasized the need for more extensive testing and real-world trials to build trust. Several respondents also expressed a desire for the system to operate more smoothly and consistently across all driving conditions.

Responses with the other theme are from participants that indicated that they are unaware or unsure of what changes to make or they comment “nothing”.

5.2.1.6 Lane Change Assistance – Driven

Figure 7 below shows the response to the question “Have you driven a vehicle with hands-free lane change assistance capabilities?”

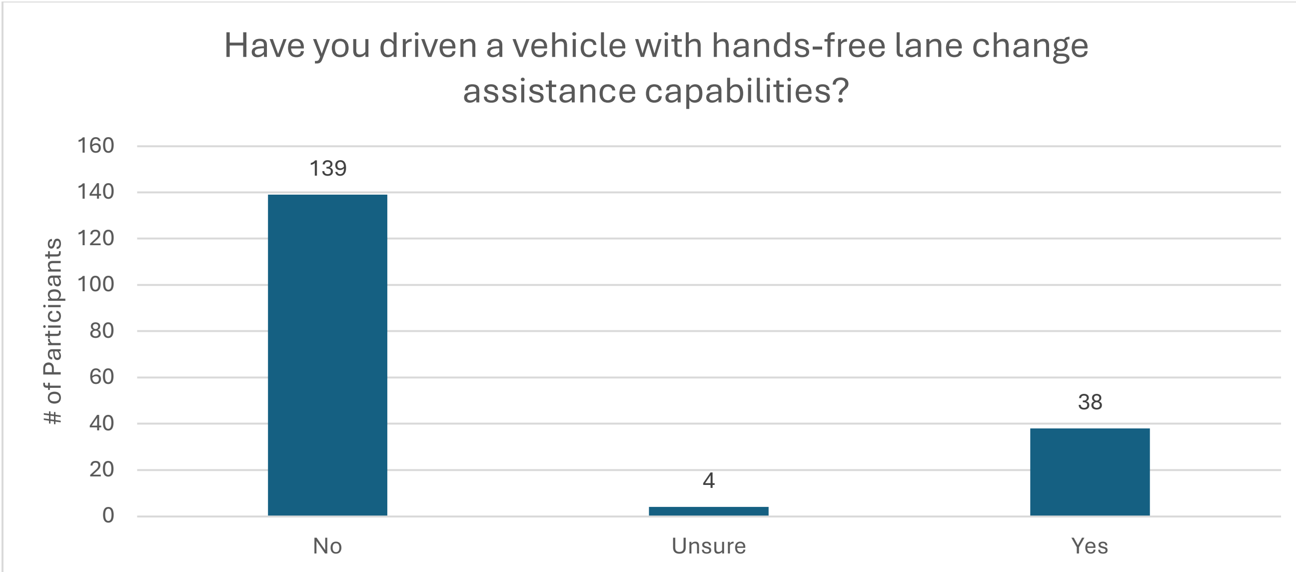

Figure 7: Response to "Have you driven a vehicle with hands-free lane change assistance capabilities?"

Unlike LCC a vast majority of respondents have not driven a vehicle equipped with LCA.

5.2.1.7 Lane Change Assistance Desirability

Figure 8 below shows the response to the question "How desirable do you find hands-free lane change assistance capabilities?"

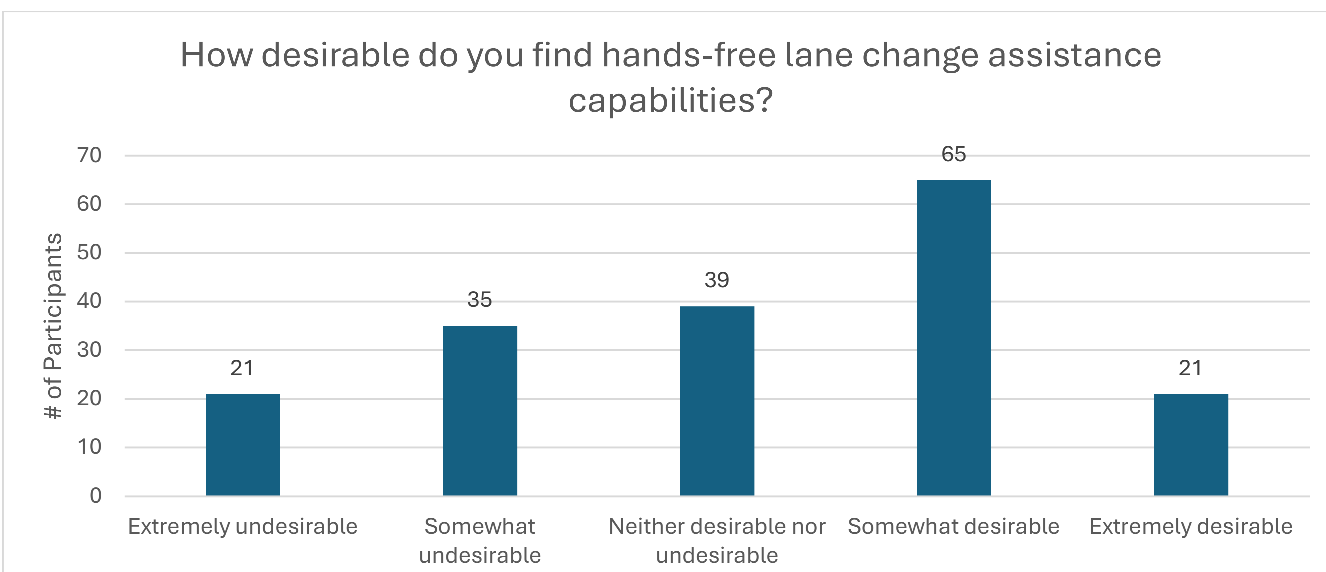

Figure 8: Response to "How desirable do you find hands-free lane change assistance capabilities?"

About 48% of respondents find lane change assistance somewhat or extremely desirable. The most common response is somewhat desirable with a frequency of 65 or 36% of respondents.

If we apply a Likert scale from 1 to 5 to the responses, the mean score for LCA desirability is 3.16. This is less than the mean score for LCC desirability(3.5) and indicates respondents have a more neutral stance on LCA's desirability.

Table 5 below shows the thematic analysis response to "What about hands free lane change assistance do you find desirable or undesirable?"

Table 5: Thematic Analysis Summary for "What about hands free lane change assistance do you find desirable or undesirable?"

Row Labels	Attentiveness	Control	Convenience	Other	Reservation	Safety	Total
Extremely undesirable	0	10	3	0	6	3	22
Somewhat undesirable	0	4	4	4	18	9	39
Neither desirable nor undesirable	1	4	6	17	8	6	42
Somewhat desirable	4	3	38	4	10	11	70
Extremely desirable	0	0	16	1	0	5	22
Total	5	21	67	26	42	34	195

5.2.1.7.1 Extremely Undesirable

Extremely undesirable accounts for 11% of the comments. The most common theme for participants who find LCA extremely undesirable is control. Most of these respondents prefer to have complete control over more complicated driving functions, such as lane changing.

The second most common theme for respondents who find LCA extremely undesirable is reservation. Comments within this theme indicate distrust in technology or certain parts of technology, such as AI. Respondents expressed a sense of wanting independence from technology during some driving tasks.

5.2.1.7.2 Somewhat Undesirable

Somewhat undesirable accounts for 20% of the comments. The most common theme for respondents who find LCA somewhat undesirable is reservation. These respondents have the same concerns as those who find LCA extremely undesirable with similar expressions of distrust of technology. Some respondents indicate that there are more “moving parts” and requirements for a more complex task such as lane changing. These respondents do not trust an automated system to take all these requirements into consideration.

The second most common theme for respondents who find LCA somewhat undesirable is safety. Respondents indicate that relying on LCA to change lanes may create dangerous situations either through system malfunction or by encouraging driver bad habits.

5.2.1.7.3 Neither Desirable nor Undesirable

Neither desirable nor undesirable accounts for 22% of the comments. The most common theme for respondents who find LCA neither desirable nor undesirable is other. These respondents indicate that they have not used LCA before or are not familiar with the technology.

The second most common theme for respondents who find LCA neither desirable nor undesirable is reservation. These respondents indicate that they are unsure about the effectiveness of the technology and do not trust it sufficiently to use it.

5.2.1.7.4 Somewhat Desirable

Somewhat desirable accounts for 36% of the comments. The most common theme for respondents who find LCA somewhat desirable is convenience. These respondents indicate that having this technology takes some of the “guess work” out of changing lanes and would be helpful especially in certain traffic conditions.

The second most common theme for respondents who find LCA somewhat desirable is safety. Respondents indicate that LCA would make driving safer.

5.2.1.7.5 Extremely Desirable

Extremely desirable accounts for 11% of the comments. The most common theme from respondents who find LCA extremely desirable is convenience. These respondents raise the same points as those who find LCA somewhat desirable but with less skepticism. Respondents indicate that LCA would help them change lanes with less difficulty and would help ease blind spot issues.

The second most common theme for respondents who find LCA extremely desirable is safety. These respondents indicate that LCA can help prevent crashes.

5.2.1.7.5 LCA Desirability Summary

Those who find LCA extremely or somewhat undesirable (31% combined) often cite concerns about control and a lack of trust in technology, particularly with the complexity of lane-changing tasks and safety risks from system errors or overreliance. About 22% of respondents are neutral, mostly because they are unfamiliar with LCA or uncertain about its reliability. On the more positive side, 36% find LCA somewhat desirable and appreciate the convenience and added safety, especially in complex traffic situations. The 11% who find LCA extremely desirable express strong support, noting that it reduces lane-changing difficulty and can help prevent crashes.

5.2.1.8 Lane Change Assistance Usability

Figure 9 below shows the response to the question "How usable do you find hands-free lane change assistance?"

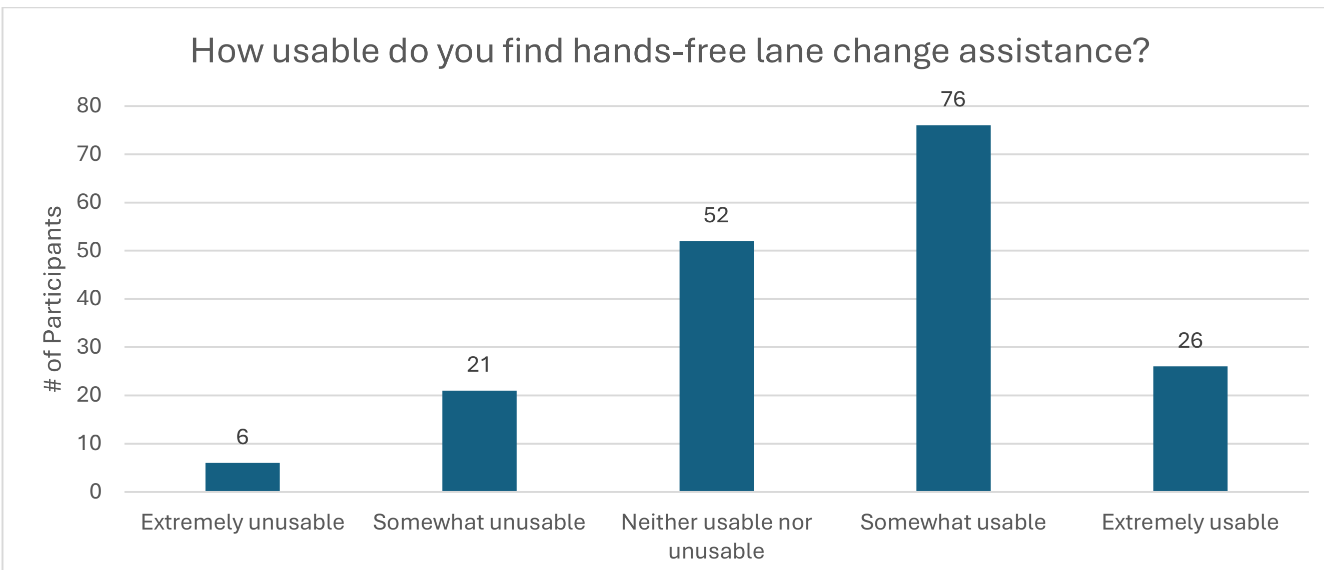

Figure 9: Response to "How usable do you find hands-free lane change assistance?"

Approximately 56% of respondents find lane change assistance somewhat or extremely usable. The most common response is somewhat usable with a frequency of 76 or 42% of respondents.

Applying a Likert scale from 1 to 5 to the response options, the mean score for LCA usability is 3.52. This indicates that on average respondents find LCA between neither usable or unusable and somewhat usable.

Table 6 below shows the thematic analysis response to “What about hands free lane change assistance do you find usable or unusable?”

Table 6: Thematic Analysis Summary for “What about hands free lane change assistance do you find usable or unusable?”

Row Labels	Attentiveness	Comfortability	Control	Convenience	Other	Reservation	Safety	Total
Extremely unusable	0	0	2	1	0	2	1	6
Somewhat unusable	4	0	7	5	1	5	1	23
Neither usable nor unusable	0	0	4	2	35	9	3	53
Somewhat usable	5	1	4	40	9	6	13	78
Extremely usable	1	0	0	20	1	0	2	24
Total	10	1	17	68	46	22	20	184

5.2.1.8.1 Extremely Unusable

Extremely unusable accounts for 3 % of the comments. The most common themes for respondents who find LCA extremely unusable are control and safety. These comments indicate that these respondents do not want a machine driving their vehicle and feature similar comments as in the desirability section where respondents want control over their vehicle and distrust technology.

5.2.1.8.2 Somewhat Unusable

Somewhat unusable accounts for 13% of the comments. The most common theme for respondents who find LCA somewhat unusable is control. These comments indicate that respondents prefer control of their vehicle or that the system does not drive how respondents would and makes them feel unsafe.

The next most common theme for respondents who find LCA somewhat unusable are convenience and reservation. Comments within the convenience theme indicate that when the feature is in control, it gives them anxiety. Comments within the reservation theme indicate that these respondents have distrust of technology, or do not feel that the feature would help in certain traffic condition (e.g Atlanta traffic).

5.2.1.8.3 Neither Usable nor Unusable

Neither usable nor unusable accounts for 29% of the comments. The most common theme for respondents who find LCA neither usable nor unusable is other. These respondents have not had experience with LCA.

The second most common theme for respondents who find LCA neither usable nor unusable is reservation. These comments indicate that the respondents realize the benefit of the system but do not think it has gone through sufficient testing, or they just do not find it thrust worthy or useful.

5.2.1.8.4 Somewhat Usable

Somewhat usable accounts for 42% of the comments. The most common theme for respondents who find LCA somewhat usable is convenience. Comments within the convenience theme indicate that these respondents perceive LCA as making driving more comfortable with fewer tasks for the driver. Respondents also identify situations where LCA would be most useful for people with disabilities and newer drivers.

The second most common theme for respondents who find LCA somewhat usable is safety. These comments indicate that respondents believe that LCA could make driving a safer task.

5.2.1.8.5 Extremely Usable

Extremely unable accounts for 13% of the comments. The most common theme for respondents who find LCA extremely usable is convenience. These comments indicate that LCA helps them drive with less worry and the technology is easy to use.

5.2.1.8.6 LCA Usability Summary

Only 3% of respondents found LCA extremely unusable, primarily due to concerns over losing control and safety, reflecting a broader distrust in technology. Those who rated it somewhat unusable (13%) also emphasized a preference for control and expressed anxiety or skepticism, especially in complex traffic scenarios. A significant portion (29%) were neutral, often due to a lack of experience with LCA, though some were cautious about its reliability. Most respondents found LCA somewhat (42%) or extremely usable (13%), appreciating its convenience, safety benefits, and usefulness for specific groups like new drivers and people with disabilities.

5.2.1.9 Lane Change Assistance Trust

Figure 10 below shows the response to the question “How much do you trust hands-free lane change assistance?”

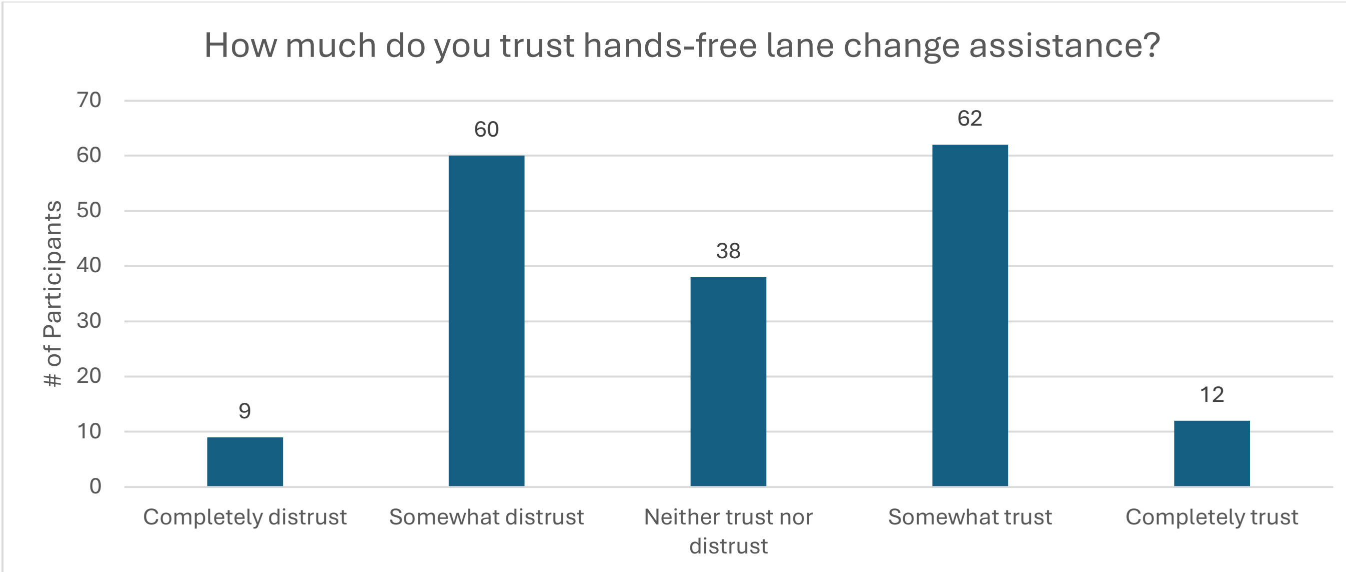

Figure 10: Response to "How much do you trust hands-free lane change assistance?"

Approximately 41% of respondents somewhat or completely trust lane change assistance. The most common response is somewhat trust with a frequency of 62 or 34% of all respondents.

Applying a Likert scale from 1 to 5 to the response option, the mean score for LCA trustworthiness is 3.04. This is the lowest value of all survey responses.

Table 7 below shows the thematic analysis response to "What about hands free lane change assistance do you trust or distrust?"

Table 7: Thematic Analysis Summary for "What about hands free lane change assistance do you trust or distrust?"

Row Labels	Consistent	Control	Other	Reliability	Reservation	Safety	Skeptical	Total
Completely distrust	0	1	0	1	4	4	0	10
Somewhat distrust	3	10	4	14	31	14	0	76
Neither trust nor distrust	0	4	25	2	8	2	0	41
Somewhat trust	7	5	11	22	12	13	1	71
Completely trust	4	1	1	5	2	1	0	14
Total	14	21	41	44	57	34	1	212

5.2.1.9.1 Completely Distrust

Completely distrust accounts for 5% of the comments. The most common theme for respondents who completely distrust LCA is reservation and safety.

Respondents within the reservation theme do not trust in LCA's capability and effectiveness.

Respondents within the safety theme indicate that LCA feels "unsafe" and "dangerous".

5.2.1.9.2 Somewhat Distrust

Somewhat distrust accounts for 36 percent of comments. The most common theme for respondents who somewhat distrust LCA is reservation.

Comments within the reservation theme indicate how changing lanes is a tricky task and respondents would not trust an autonomous system to handle such tasks. Respondents also indicate that the technology is new and needs time to improve.

The second most common theme for respondents who somewhat distrust LCA is safety and reliability. Comments within the safety theme indicate that LCA is scary, risky and dangerous. Comments within the reliability theme indicate that LCA needs more testing and cannot be trusted yet.

5.2.1.9.3 Neither Trust nor Distrust

Neither trust nor distrust accounts for 19% of the comments. The most common theme for respondents who neither trust nor distrust LCA is other. Comments within this theme indicate that respondents are not familiar with LCA or have never driven a vehicle with LCA.

5.2.1.9.4 Somewhat Trust

Somewhat trust accounts for 33% of the comments. The most common theme for respondents who somewhat trust LCA is reliability. Comments with this theme are split between trusting the technology reliability and having some reservations about the technology reliability especially in the realm of safety.

The second most common theme for respondents who somewhat trust LCA is safety. These comments highlight the possibility of failure of LCA.

5.2.1.9.5 Completely Trust

Completely trust accounts for 7% of the comments. The most common theme for respondents who completely trust LCA are reliability and consistency.

Comments within the reliability theme indicate that LCA can serve as an extra set of eyes on the road and can reinforce good driving behaviors as with using the indicator.

Comments within the consistency theme indicate that LCA works and respondents have not had any issues with it.

5.2.1.9.5 LCA Trust Summary

A small portion (5%) completely distrust LCA, mainly due to concerns about safety and a lack of trust in its capabilities. The largest group (36%) somewhat distrusts LCA, citing the complexity of lane changes, perceived safety risks, and the technology's lack of maturity. Meanwhile, 19% of respondents neither trust nor distrust LCA, often because they are unfamiliar with the system or have no firsthand experience. On the positive side, 33% somewhat trust LCA—many acknowledging its potential reliability while still expressing some safety concerns—while 7% completely trust the system, citing consistent performance and its ability to enhance safe driving behaviors.

5.2.1.10 Lane Change Assistance Change

Table 8 below shows the results for the thematic analysis for "How would you change lane change assistance to make it better suit you?"

Table 8: Response to "How would you change lane change assistance to make it better suit you?"

Themes	Frequency
Accessibility	21
Dependability	28
Features	29
Optional	23
Other	79
Other	1

Reservation	6
Total	187

The most common theme for changes respondents want to make to LCA is others. These comments are from respondents who do not have any improvement or have no experience using LCA.

The second most common theme for changes respondents want to make to LCA is features. These respondents have feature improvements and additional feature ideas that would allow them to increase their trust in LCA. The feature changes include more advanced software, more alerts (audible and visual), increase the operational domain (at higher speeds) and better detection.

5.2.1.11 Thematic Analysis Limitations

From the comments, it seems some respondents confuse the functionality of Lane Centering Control (LCC) with Lane Keeping Assistance (Alert, Aid, Alert + Aid) (LKA). This is because some comments highlight features such as jerkiness, overcorrection when veering out of the lane or alerts when veering out of the lane. These features are more representative of LKA. LCC constantly keeps the vehicle in its lane, not just provide alerts when veering out of your lane or just assisting when the vehicle veers out of the lane.

This creates heterogeneity in the comments where some respondents are commenting on LCC and others on LKA. This is most likely due to LKA being far more common than LCC, and respondents are more likely to have experience with LKA (PARTS, 2024). This also distorts responses to the question “have you driven a vehicle with lane centering control”.

5.2.2 Survey Fourth Part - Demographics

5.2.2.1 Age

Figure 11 below shows the age distribution of survey respondents.

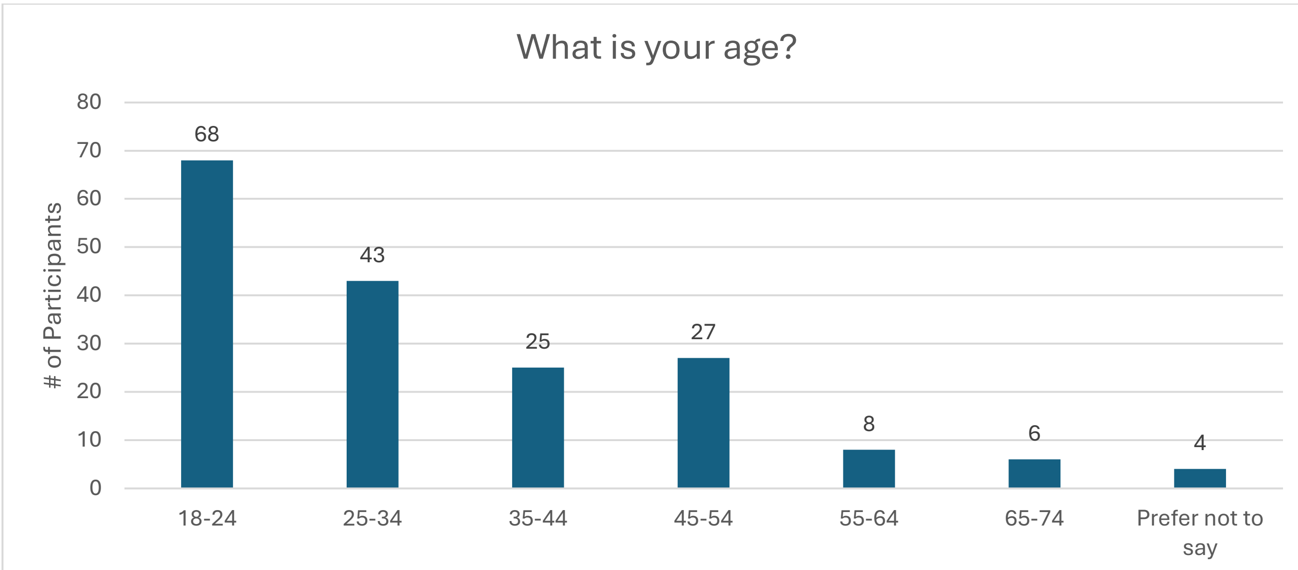

Figure 11: Age Distribution of Respondents

Most of the respondents to the survey are between the ages of 18-34. This is due to the 62 student responses. Of these, 55 of the 62 student respondents are between the ages of 18 and 24.

5.2.2.2 Race

Figure 12 below shows the race distribution of survey respondents. The race question was open ended, so responses were grouped into categories.

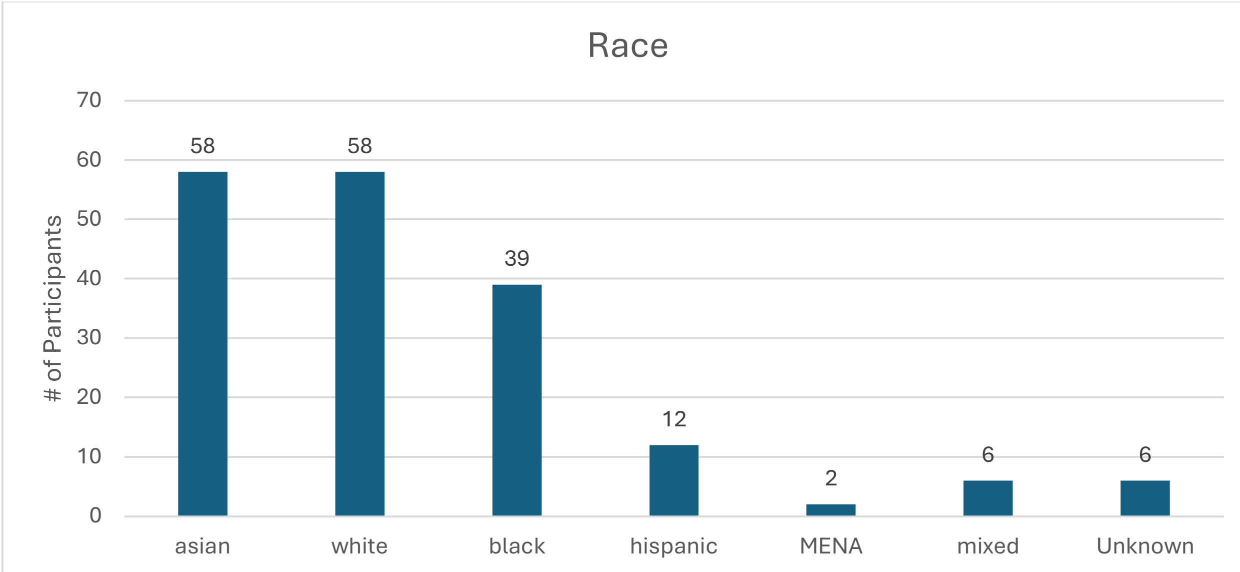

Figure 12: Race Distribution of Respondents

The three largest race categories for respondents are asian, white and black. Very few respondents are MENA or mixed.

5.2.2.3 Income

Figure 13 below show the income distribution of survey respondents.

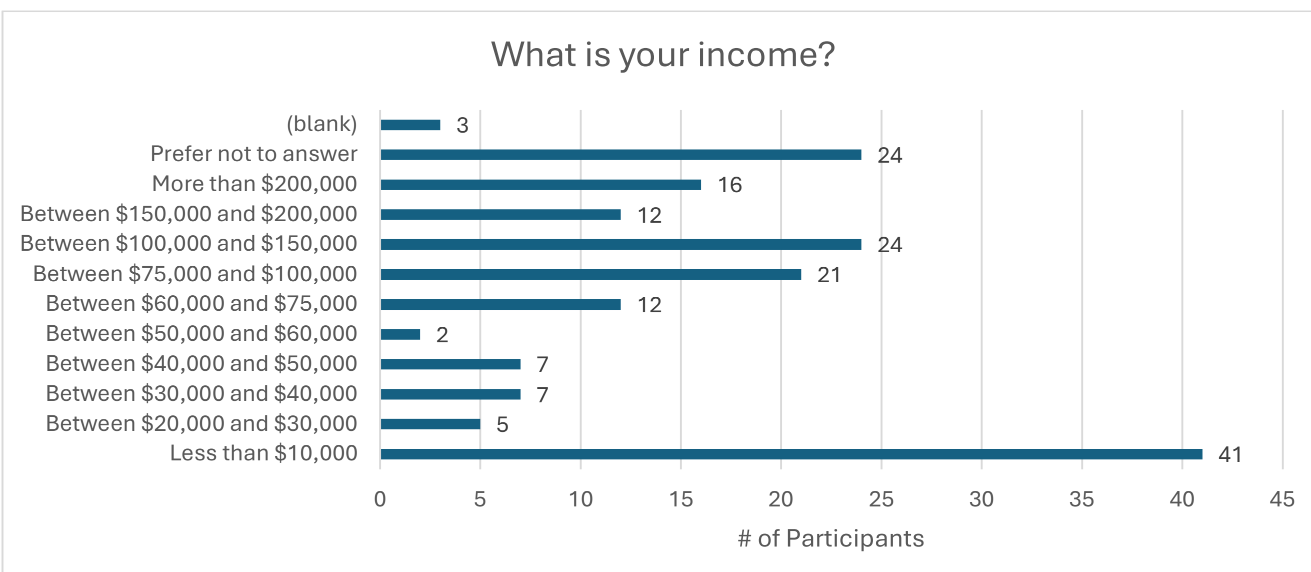

Figure 13: Income Distribution of Respondents

Most respondents make less than $10,000. This is largely due to the 62 student respondents. Most of the student respondents make less than $10,000.

5.2.2.4 Gender

Figure 14 below shows the gender distribution of survey respondents.

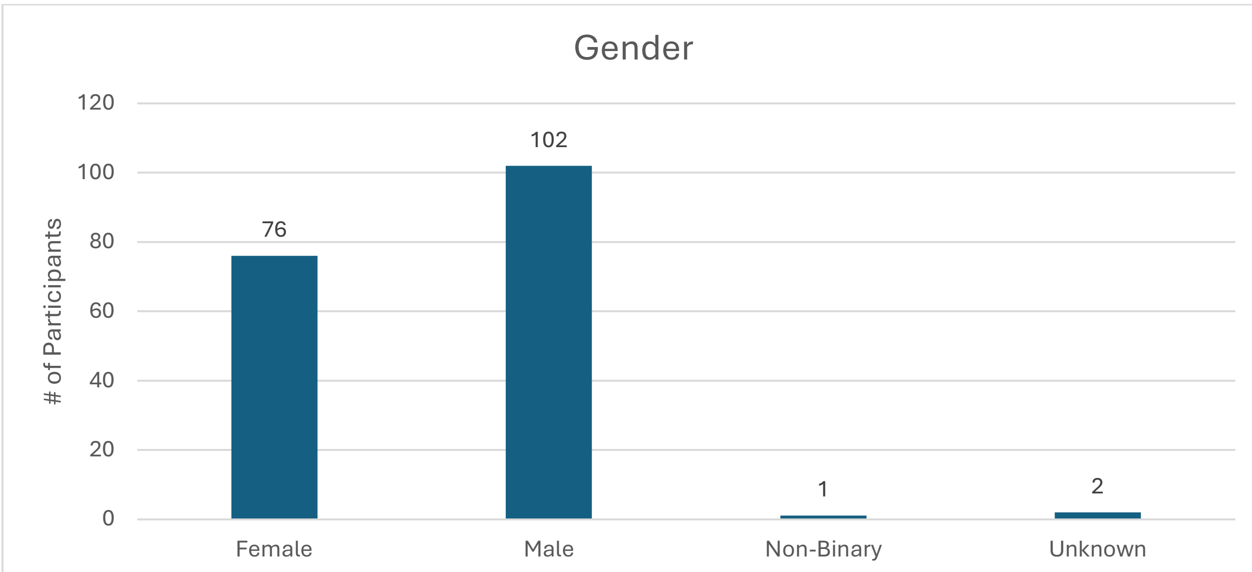

Figure 14: Gender Distribution of Respondents

Male respondents represent 56% of all respondents.

5.3 Cross-tabular Analysis

5.3.1 Demographic Variables

To understand the respondents to our survey, a cross tabular analysis is performed to understand the relationship between several demographic characteristics.

5.3.1.1 Age and Race

Table 9 below shows the age distribution of survey participants by race.

Table 9: Age and Race Distribution of Respondents

	Race							
Age	Asian	black	Hispanic	MENA	mixed	Unknown	white	Grand Total
18-24	40	8	3	2	1	2	12	68
25-34	9	12	4		3		15	43
35-44	3	7	1		1	2	11	25
45-54	4	6	4		1		12	27
55-64	1	4					3	8
65-74		1					5	6
Prefer not to say	1	1						2
(blank)						2		2
Grand Total	58	39	12	2	6	6	58	181

To understand if there is a statistically significant relationship between participants' age and race, a chi square test is performed. Before performing the chi square test, age segments are combined and only three race segments are considered. The updated categories are shown in table 10 below. Table 10 below is used to perform the chi square test.

Table 10: Age and Race Distribution of Respondents

What is your self-identified ethnicity/race?	**18-34**	**35-54**	**55-74**
Asian	49	7	1
Black	20	13	5
White	27	23	8

In performing the chi square test, a p value of 0.000228 was obtained. This signifies that the variables of age and race are not independent. To understand the level of this relationship, the Cramer's V value is determined. We got a Cramer's v value of 0.266. This indicates a moderate association between age and race.

Figure 15 below shows a mosaic plot showing the relationship between age category and race.

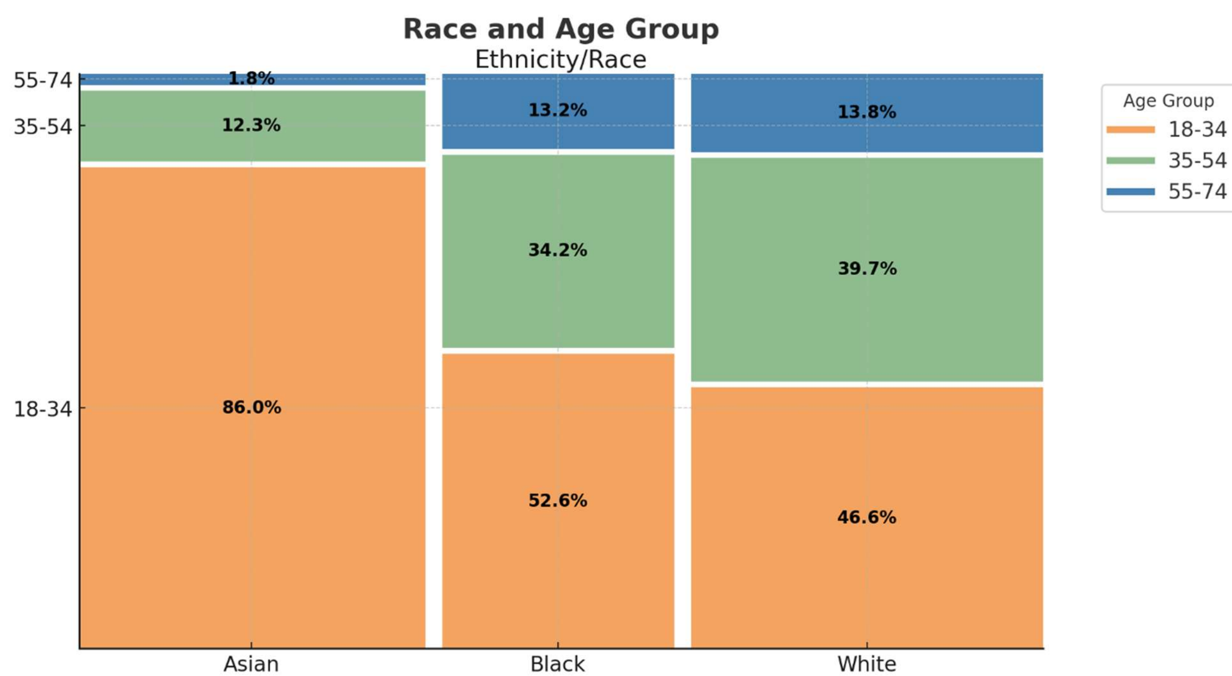

Figure 15: Race and Age Mosaic Plot

From the graph we can see that the age distribution for black and white respondents is similar but is drastically different for Asian respondents. Asian respondents for the survey tend to be younger, with 86% of them being in the 18-34 age range. This is because most students surveyed were Asian who are between ages 18-24. If only non-students were considered these differences would likely not be as pronounced, which will be checked next

Table 11 below shows the age and race distribution of students. We can see from the table that a vast majority of students surveyed were between 18-34. This likely explains the association we are seeing between race and age.

Table 11: Students Age and Race Distribution

	Age		
Race	18-34	(blank)	Total
Asian	36	1	37
black	9	1	10
Hispanic	2		2
MENA	2		2
mixed	1		1
Unknown	1	1	2
white	8		8
Grand Total	59	3	62

Table 12 below shows the chi square table for the age and race distribution of non-student population by age and race.

Table 12: Age and Race Distribution of Students

Age	Asian	black	white
18-34	13	11	19
35-54	7	13	23
55-74	1	5	8

Using this new table, the new chi square p value is 0.35. This indicates that age and race are likely independent. The Cramer's V value is 0.149 indicating a weak association between age and race for the non-student group.

Figure 16 below shows the mosaic plot for age and race for the non-student group. We can see from the plot that the age distribution for white and black respondents remains similar. The age distribution for Asian respondents differs somewhat.

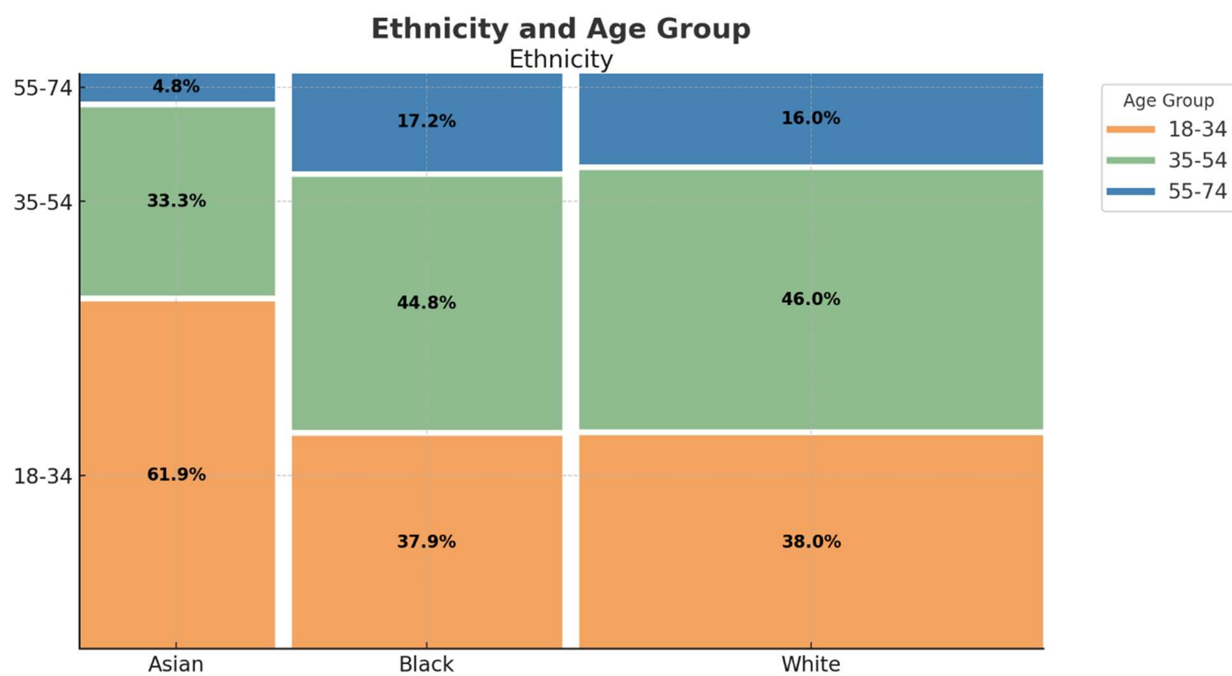

Figure 16: Age and Race Distribution of Non-Students

This indicates that the student status of a respondent is a confounding variable for race.

5.3.1.2 Age and Income

Table 13 below shows the age distribution of survey participants by income.

Table 13: Age and Income Distribution of Respondents

	Age								
Income	18-24	25-34	35-44	45-54	55-64	65-74	Prefer not to say	(blank)	Grand Total
Between $10,000 and $20,000	6			1					7
Between $100,000 and $150,000	2	9	6	3	2	2			24
Between $150,000 and $200,000	2	7	2		1				12
Between $20,000 and $30,000	2		2	1					5
Between $30,000 and $40,000	4	3							7
Between $40,000 and $50,000		3	2	1	1				7
Between $50,000 and $60,000		1				1			2
Between $60,000 and $75,000	1	7	1	2	1				12
Between $75,000 and $100,000	5	9	1	5	1				21
Less than $10,000	38	1	1				1		41
More than $200,000		3	3	6	2	2			16
Prefer not to answer	7		7	8		1	1		24
(blank)	1							2	3
Grand Total	68	43	25	27	8	6	2	2	181

Using the same method, as in the age and race analysis categories are combined to develop an updated contingency table for the chi square test. Table 14 below shows the contingency table used for the chi square test.

Table 14: Age and Income Distribution of Respondents

What is your age?	0-50,000	100,000 and above	50,000-100,000
18-34	57	23	23
35-54	8	20	9
55-74	1	9	3

The p value of the chi square test is 0.000060. This signifies that age and income are not independent. To understand the level of this relationship, the Cramer's V value is calculated. A Cramer's v value of 0.284 is obtained. This indicates a moderate association between age and income.

Figure 17 below shows the mosaic plot showing the relationship between age and income.

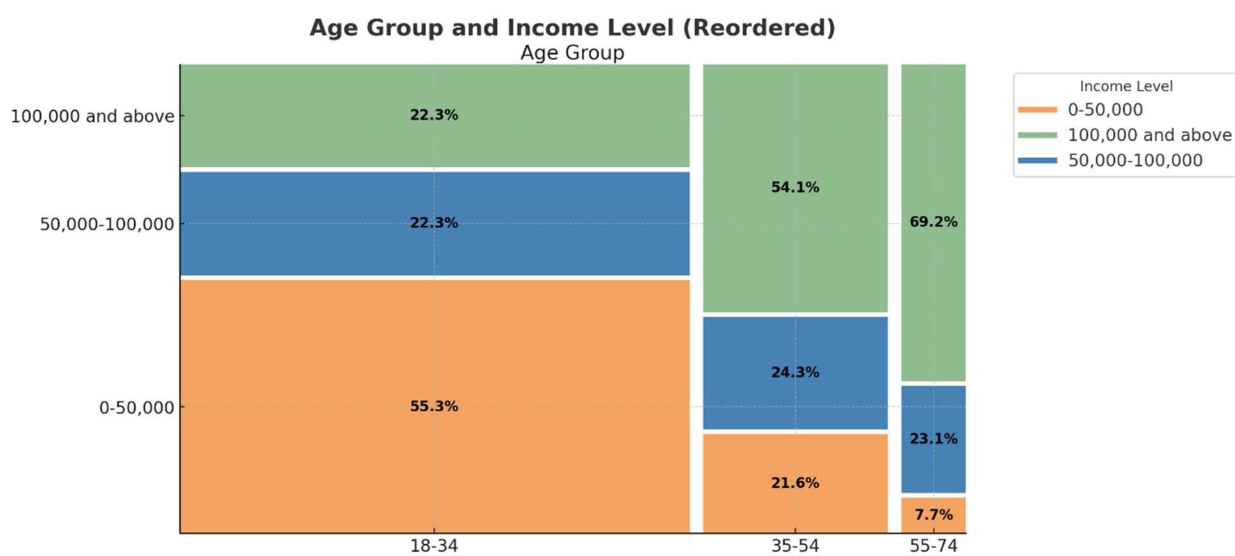

Figure 17: Age and Income Distribution of Respondents

From the graph, we can see that as the age group increases income skews higher. Over 50% of respondents aged 18-34 make below $50,000. As the age category increases, the share of respondents in the category making below $50,000 decreases (55.3% to 21.6% to 7.7%). Likewise as the age category increase, the share of respondents in the category making above $100,000 increases (22.3% to 54.1% to 69.2%). This shows that as respondents age increases, their income increases.

5.3.1.3 Age and Gender

Table 15 below shows the age distribution of survey participants by gender.

Table 15: Gender and Age Distribution of Respondents

	Gender				
Age	Female	Male	Non-binary	Unknown	Grand Total
18-24	23	44	1		68
25-34	19	24			43
35-44	13	12			25
45-54	13	14			27
55-64	4	4			8
65-74	3	3			6
Prefer not to say	1	1			2
(blank)				2	2
Grand Total	76	102	1	2	181

Again categories are combined and remove to obtain a new contingency table for the chi square test. Table 16 below shows the contingency table used for the chi square test.

Table 16: Age and Gender Distribution of Respondents

What is your age?	F	M
18-34	42	68
35-54	26	26
55-74	7	7

The p value of the chi square test is 0.308. This signifies that age and gender are independent. To understand the level of independence, the Cramer's V value is calculated for a value of 0.116. This indicates a very weak association between age and gender.

Figure 18 below shows a mosaic plot showing the relationship between age and gender.

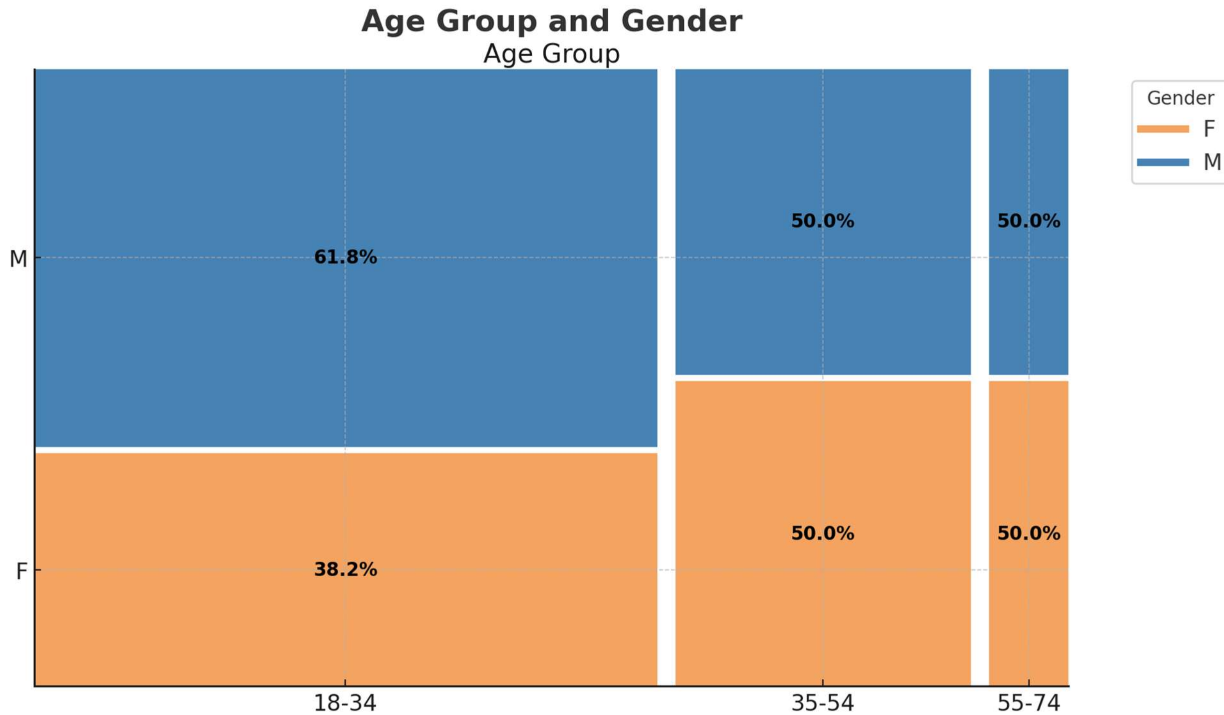

Figure 18: Age and Gender Mosaic Plot

The gender distribution for the age group 35-54 and 55-74 are equal. The age distribution for the age group 18-34 is more imbalanced as a higher percentage of respondents in this group identify as male.

5.3.1.4 Race and Income

Table 17 below shows the income distribution of survey participants by race.

Table 17: Race and Income Distribution of Respondents

	Race							
Income	Asian	Black	Hispanic	MENA	Mixed	Unknown	white	Grand Total
Between $10,000 and $20,000	2	2	3					7
Between $100,000 and $150,000	2	7	1	1	3		10	24
Between $150,000 and $200,000	4		1		1		6	12
Between $20,000 and $30,000		3				1	1	5
Between $30,000 and $40,000	5	2						7
Between $40,000 and $50,000		6	1					7
Between $50,000 and $60,000		2						2
Between $60,000 and $75,000	1	4	3				4	12
Between $75,000 and $100,000	7	6	1				7	21
Less than $10,000	28	3	1	1			8	41
More than $200,000	2	2					12	16
Prefer not to answer	6	2	1		2	3	10	24
(blank)	1					2		3
Grand Total	58	39	12	2	6	6	58	181

Again categories are combined and removed to obtain a new contingency table for the chi square test. Table 18 below shows the contingency table used for the chi square test.

Table 18: Race and Income Distribution of Respondents

What is your self-identified ethnicity/race?	0-50,000	50,000-100,000	100,000 and above
Asian	35	8	8
black	16	12	9
white	9	11	28

The p value of the chi square test is 0.00000258. This signifies that race and income are dependent. To better understand the level of relationship, the Cramer's V value is calculated with a value of 0.339. This indicates a moderate association between race and income.

Figure 19 below shows a mosaic plot showing the relationship between race and income.

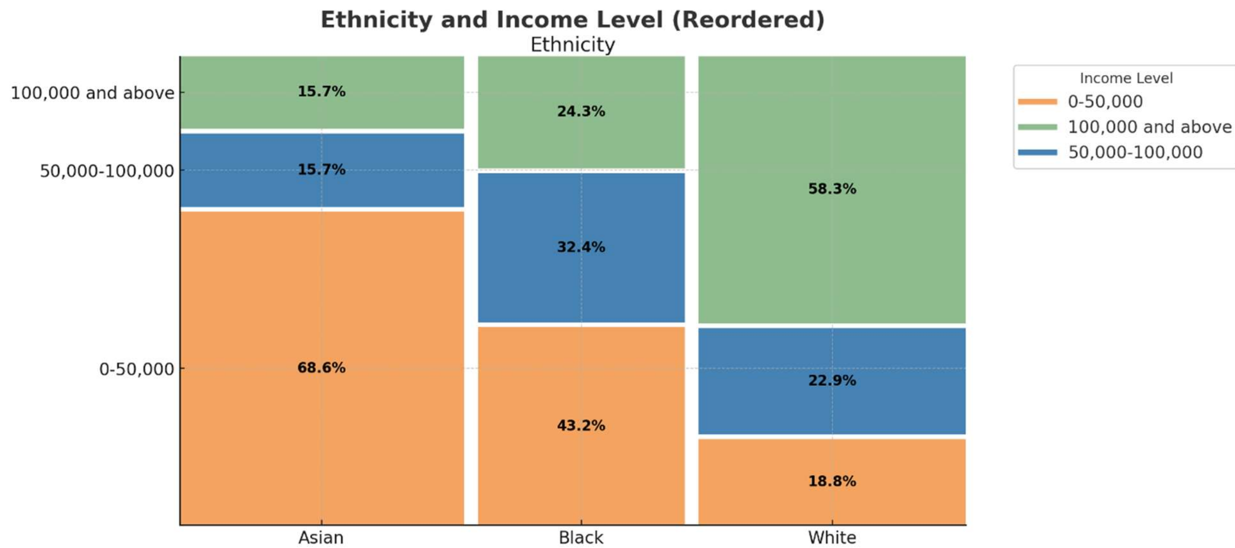

Figure 19: Race and Income Mosaic Plot

From the plot, we can see that most of the Asians surveyed made below $50,000. This is because most of the student population surveyed were Asians who have an income less than $10,000.

Table 19 below shows the race and income distribution of students surveyed. It is seen that 64% of all Asians surveyed were students (37 out of 58) and that 70% of Asian students had income less than $10,000. This explains the dataset skew.

Table 19: Race and Income Distribution of Respondents

	Race							
Income	Asian	black	Hispanic	MENA	mixed	Unknown	white	Grand Total
Less than $10,000	26	2	1	1			5	35
Between $10,000 and $20,000	2	1	1					4
Between $20,000 and $30,000		1						1
Between $30,000 and $40,000	3	1						4
Between $50,000 and $60,000		1						1
Between $75,000 and $100,000	2	2						4
Between $100,000 and $150,000		1		1	1		1	4
Between $150,000 and $200,000	1							1
Prefer not to answer	2	1				1	2	6
(blank)	1					1		2
Grand Total	37	10	2	2	1	2	8	62

As established in the age and race analysis, respondent's student status is a confounding variable for race which can lead to false results on association. If only non-students' respondents are considered, we can better understand the income distribution of respondents.

Table 20 below shows the chi square table that will be used for the non-student population.

Table 20: Race and Income Distribution of Respondents

	Income		
Race	0-50,000	50,000-100,000	100,000 and above
Asian	4	6	7
Black	11	9	8
White	4	11	27

Using this table, the chi square value and the Cramer's V value are calculated. The chi square p value is 0.0181, indicating that race and income are not independent. A Cramer's v value of 0.252 indicates a moderate association between race and income.

Figure 20 below shows the mosaic plot representing the race and income of respondents from the non-student population.

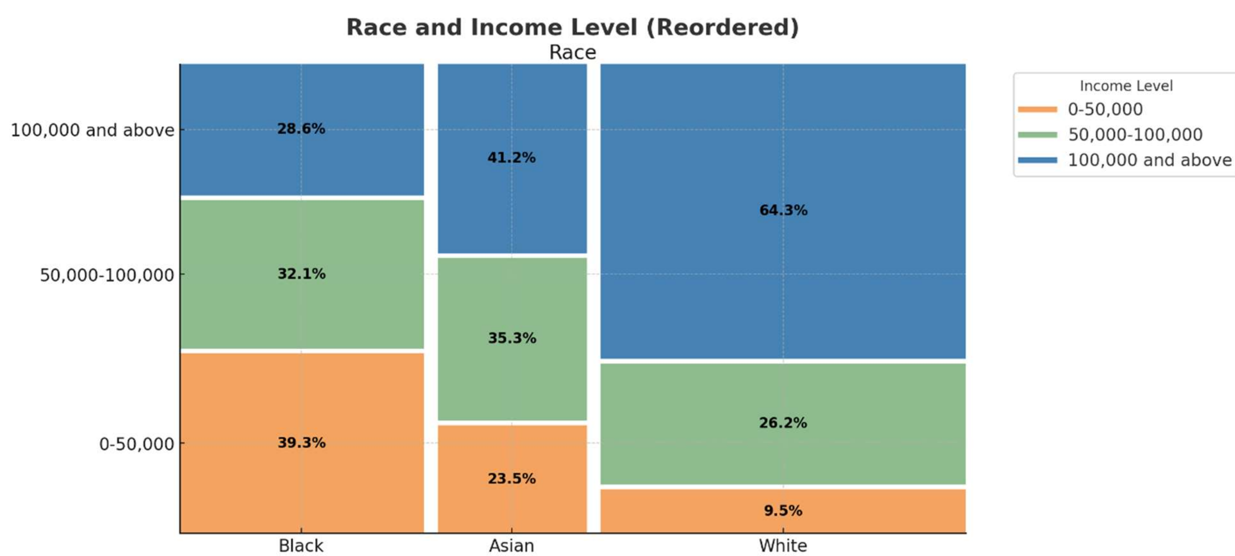

Figure 20: Race and Income Mosaic Plot

From the graph, it is seen that the relationship between race and income changes when considering all data. Black respondents had the lowest income with most of the respondents being in the lower income category. White respondents have the highest income with a majority making 100,000 and above. This confirms respondent's student status as a confounding variable for race.

5.3.1.5 Race and Gender

Table 21 below shows the race and gender distribution for respondents.

Table 21: Race and Gender Distribution of Respondents

	Gender				
Race	F	M	N	U	Grand Total
asian	21	37			58
black	17	21	1		39
hispanic	5	7			12
MENA	1	1			2
mixed	4	2			6
Unknown	2	2		2	6
white	26	32			58
Grand Total	76	102	1	2	181

Table 22 below shows the aggregated chi square table used to calculate the chi square p value and Cramer V value.

Table 22: Race and Gender Distribution of Respondents

What is your self-identified gender?	Asian	black	white
F	21	17	26
M	37	21	32

Using the table above, the chi square p value is 0.578 indicating that race and gender are independent. To understand the level of this independence, the Cramer V value is calculated and a value of 0.084 is obtained, indicating a weak association between race and gender.

Figure 21 below shows the mosaic plot showing the relationship between race and gender.

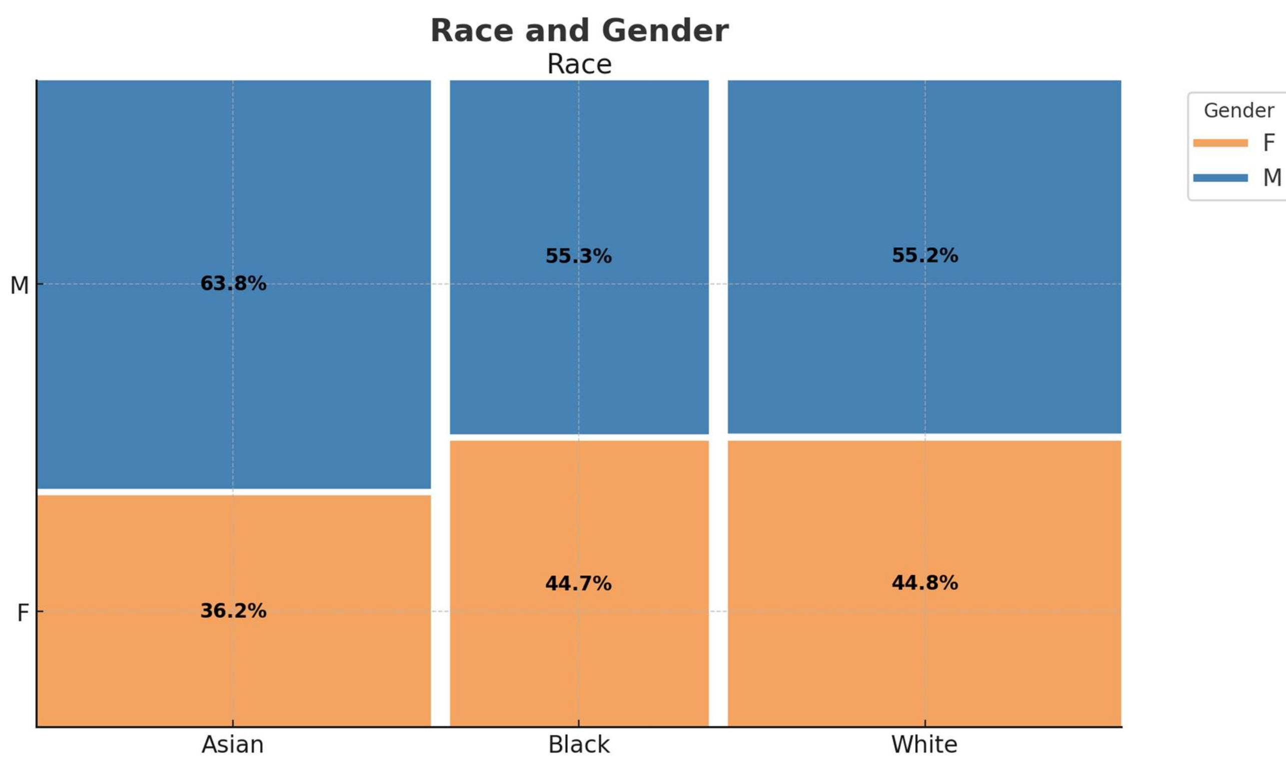

Figure 21: Race and Gender Mosaic Plot

From the plot it is seen that the gender distribution for black and white respondents are similar. The gender distribution among Asian residents are more unequal and different than that of white and black respondents.

5.3.1.6 Income and Gender

Table 23 below shows the income and gender distribution of residents.

Table 23: Gender and Income Distribution of Respondents

Income	F	M	N	U	Grand Total
Between $10,000 and $20,000	1	5	1		7
Between $100,000 and $150,000	13	11			24
Between $150,000 and $200,000	4	8			12
Between $20,000 and $30,000	4	1			5
Between $30,000 and $40,000	2	5			7
Between $40,000 and $50,000	4	3			7
Between $50,000 and $60,000	1	1			2
Between $60,000 and $75,000	5	7			12
Between $75,000 and $100,000	11	10			21
Less than $10,000	11	30			41
More than $200,000	7	9			16
Prefer not to answer	13	11			24
(blank)		1		2	3
Grand Total	76	102	1	2	181

Table 24 below shows the chi square table for the income and gender distribution.

Table 24: Gender and Income Distribution of Respondents

What is your self-identified gender?	0-50,000	100,000 and above	50,000-100,000
F	22	24	17
M	44	28	18

Using the table above, the chi square p value is 0.22 indicating that race and gender are independent. To understand the level of this independence, the Cramer V value is calculated a value of 0.14 is obtained, indicating a weak association between race and gender.

5.3.2 Demographic and Experience

The goal of this analysis is to understand what type of relationship between any of the demographic variables and experience with LCC or LCA.

5.3.2.1 Age

There is no relationship between age and experience with LCC and LCA based on the chi square test. A decreasing trend between experience and age is seen, that is as participants age category increases, the probability they have had an experience with LCC. Figure 22 below shows a mosaic plot showing the relationship between age and experience with Lane centering control.

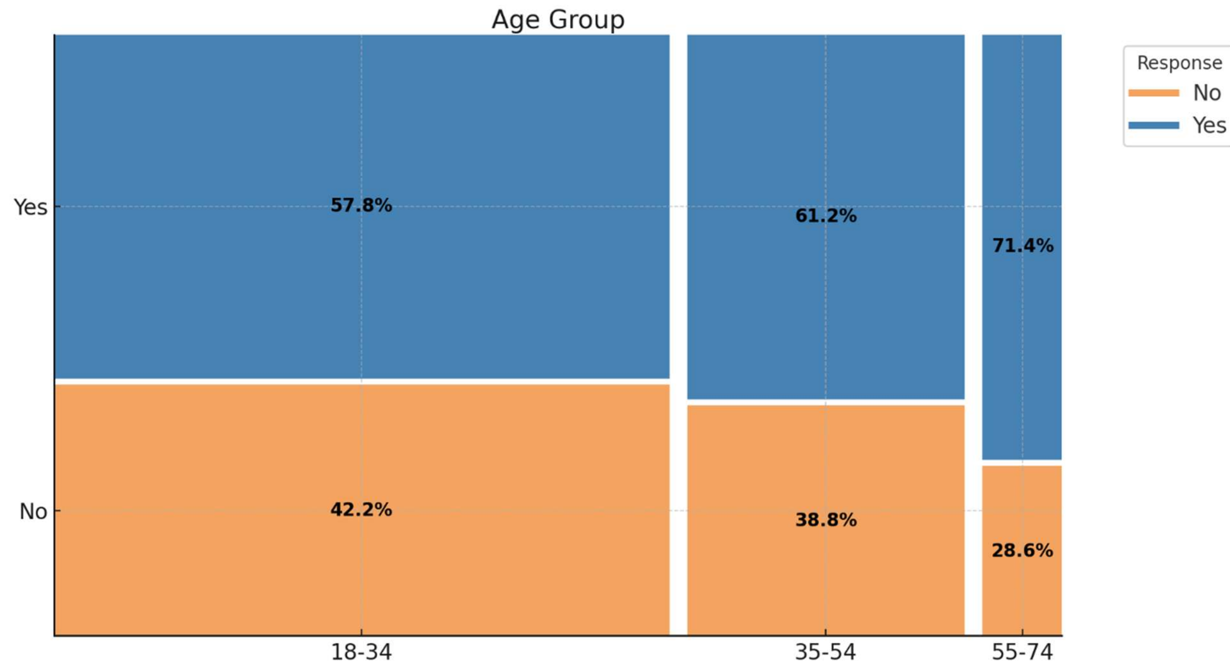

Figure 22: Age and Experience with LCC Mosaic Plot

5.3.2.2 Race

There is no relationship between race and experience with LCC and LCA based on the chi square test.

5.3.2.3 Income

There is a relationship between income and experience with LCC but no correlation between income and experience with LCA.

For income and experience with LCC, the chi square P value is 0.006. This indicates a relationship between income and experience with LCC. Figure 23 below shows the mosaic plot for experience with LCC and income level.

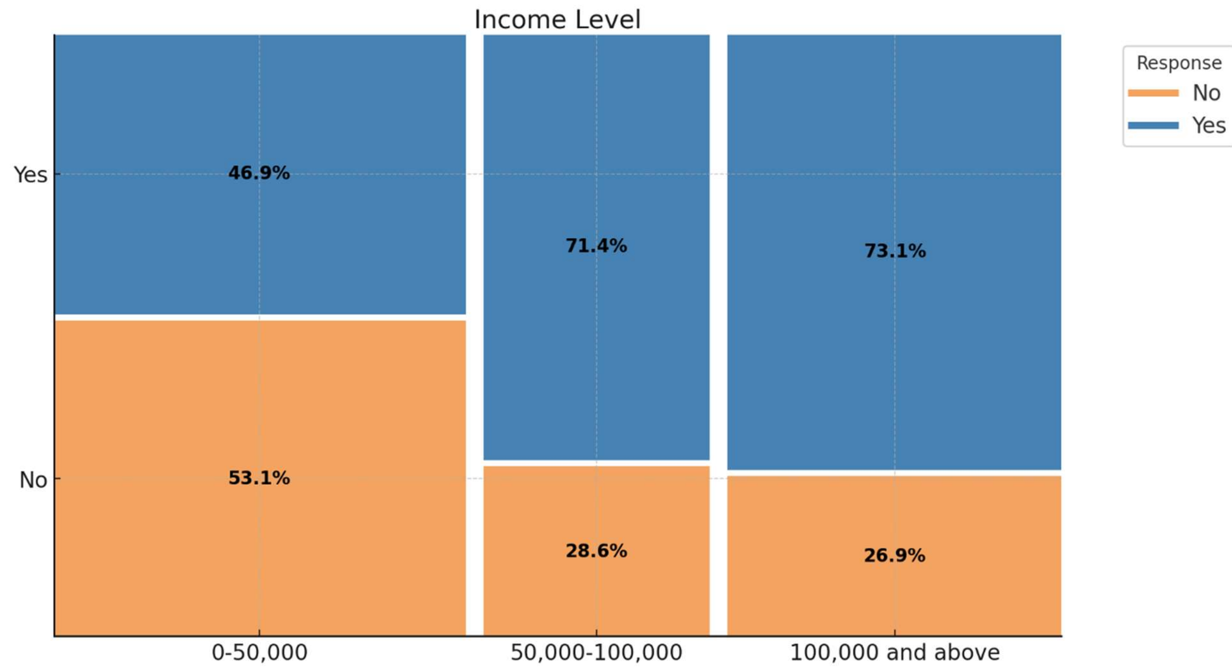

Figure 23: Income and Experience with LCC.

Respondents who made less than $50,000 have a much higher likelihood of not having experience with LCC than other participants. Participants who made more than 50,000 have about the same likelihood of having experience with LCC.

5.3.2.4 Gender

There is no relationship between gender and experience with LCC or LCA

5.3.3 Desirability, Usability, and Trust (Across LCC and LCA)

With both LCC and LCA, there is a correlation between desirability, usability and trust. This is because most people who find a feature desirable are most likely to find it usable and trustworthy. The table below shows the results of the chi squared test for the desirability, usability and trust across LCC and LCA.

Table 25: Chi Square Test Table Showing the Relationship between Usability, Trust and Desirability Across LCC and LCA

	Desirable LCC	Usable LCC	Trust LCC	Desirable LCA	Usable LCA	Trust LCA
Desirable _LCC		0.00	0.00	0.01	0.01	0.02
Usable _LCC	0.00		0.00	0.01	0.00	0.04
Trust LCC	0.00	0.00		0.00	0.02	0.00
Desirable LCA	0.01	0.01	0.00		0.00	0.00
Usable LCA	0.01	0.00	0.02	0.00		0.00
Trust LCA	0.02	0.04	0.00	0.00	0.00	

Respondents with a favorable view of one feature are more likely to have a favorable view of the other feature.

5.3.4 Demographic and Dependent Variables (Desirability, Usability and Trust)

A new dataset was created, consisting of 99 non-student responses with valid answers to every question and 15 student responses, ensuring the race distribution of the student group matches that of the non-student group. This results in a dataset with a total of 114 responses.

The dataset uses grouped dependent and grouped independent variables. The independent variables were grouped in the same way as that of the chi square test. For the dependent variables, a participant could find a technology either desirable or not desirable, usable or not usable, and trustworthy or not trustworthy. Desirable is a grouping of somewhat and extremely desirable and not desirable is a grouping of somewhat undesirable, extremely undesirable and neither desirable nor undesirable.

Using binary logistic regression, three models were created for each of the 6 dependent variables.

The first model includes age, race and gender as the dependent variables. The second model includes age, income and gender as dependent variables. The third model includes age, race, income and gender as dependent variables. This was done because race and income show a significant correlation.

A model with all the independent variables was created because we want to understand the effects of every variable on the outcome.

The independent variables were encoded for the model creation. The variables were coded as shown below:

1. Age: age is an ordinal variable. It is coded using its order.
    a. 18-34 as 0
    b. 35-54 as 1
    c. 55-74 as 2
2. Race: Race is a nominal variable. It is coded using one-hot encoding. A new variable is created for all possible responses to the race question except one race category. This last response is the reference response and does not get its own variable. The reference race response in this model is “other”.
3. Income: as with age, income is an ordinal variable. It is coded using the order
    a. 0-50,000 as 0

b. 50,000-100,000 as 1

c. 100,000 and above as 2

4. Gender: Gender is a nominal variable and is coded using one hot encoding. Female is the reference variable.

The dependent variable is coded as a binary variable [0, 1]. 0 represents a negative outcome (i.e not desirable, or not usable) and 1 represents a positive outcome.

Table 26 below shows an example of the results for the binary logistic regression model:

Table 26: Binary Logistic Regression Model for LCA Desirability.

Dependent Variable: Desirability LCA						
Term	**Coef.**	**Std.Err.**	**z**	**P>|z|**	**[0.025**	**0.975]**
const	-1.9770	0.7177	-2.7545	0.0059	-3.3837	-0.5703
age	0.5563	0.3155	1.7630	0.0779	-0.0621	1.1747
Race Asian	1.3271	0.7619	1.7418	0.0815	-0.1662	2.8204
Race black	0.6967	0.7162	0.9728	0.3307	-0.7070	2.1004
Race white	0.8591	0.6735	1.2756	0.2021	-0.4609	2.1792
income	0.4013	0.2562	1.5660	0.1173	-0.1009	0.9035
Gender_Male	0.5541	0.4026	1.3762	0.1687	-0.2350	1.3431

The first column of the table shows the variable. The second column shows the co-efficient. A positive coefficient shows an increase in the likelihood of a positive result. The constant represents the log odds when the value of all the variables is zero. That means -1.9770 represents the log odds when a participant is 18-34, with race other, has an income of 0-50,000 and is female.

The standard error represents the measure of error for the coefficient estimate. The error values for all our variables are very high indicating an unreliable model output.

The z value represents the test statistic against the null hypothesis that the coefficient is zero. A larger absolute z value indicates stronger evidence against the null hypothesis.

The p-value assesses the effect of the dependent variable on the independent variable. A P-value of less than 0.05 indicates that the variable has a statistically significant effect on the dependent variable. In the table, only the constant has a p-value less than 0.05. The only other variables close to this threshold are "Race Asian" and "age". All other variables do not have a statistically significant effect on the dependent variable.

[0.025] and [0.975] represent the 95% confidence interval for the coefficient. If there is a 0 within this interval, it indicates that the variable does not have a statistically significant effect.

Using the table above, if the desire is to find the probability that an individual who is 18-34, black, male and makes between 0-50,000 dollars a year would find LCA desirable, the calculation would be as follows:

1. Define the variable values:
    a. Age: 0
    b. Race Asian: 0
    c. Race Black: 1
    d. Race White: 0
    e. Income: 0
    f. Gender Male: 1

2. Calculate the log odds

$$Log\ odds = \beta_0 + [\beta_1 \times Age] + [\beta_2 \times Race\ Asian] + [\beta_3 \times Race\ Black] + [\beta_4 \times Race\ White] + [\beta_5 \times Income] + [\beta_6 \times Gender\ Male]$$

Using the formular for log odd:

$$Log\ odds = -1.9770 + [0.5563 \times 0] + [1.3271 \times 0] + [0.6967 \times 1] + [0.8591 \times 0] + [0.4013 \times 0] + [0.5541 \times 1] = -0.7262$$

We get a log odd of - 0.7262

3. The next step is to calculate the probability:

$$P(Y = 1) = \frac{1}{1 + e^{-\log o}}$$

$$P(Y = 1) = \frac{1}{1 + e^{-(-0.7262)}} = 0.326$$

This means that there is a 32.6% probability that the individual would find LCA desirable. This would also mean there is a 67.4% probability that the individual would find LCA not desirable.

Table 27 below shows the dependent variables and their corresponding binary logistic model for all three models discussed for desirability, usability and trust.

Table 27: Binary Logistic Regression Model for all Dependent Variables.

	Desirability LCA						Desirability LCC					
Term	**Coef.**	**Std.Err.**	**z**	**P>|z|**	**[0.025**	**0.975]**	**Coef.**	**Std.Err.**	**z**	**P>|z|**	**[0.025**	**0.975]**
const	-1.9770	0.7177	-2.7545	0.0059	-3.3837	-0.5703	-0.75219	0.657656	-1.14374	0.252731	-2.04117	0.536794
age	0.5563	0.3155	1.7630	0.0779	-0.0621	1.1747	0.199873	0.321064	0.622532	0.533592	-0.4294	0.829147
Race_asian	1.3271	0.7619	1.7418	0.0815	-0.1662	2.8204	0.948305	0.719654	1.317724	0.187596	-0.46219	2.358801
Race_black	0.6967	0.7162	0.9728	0.3307	-0.7070	2.1004	1.938326	0.717344	2.702086	0.006891	0.532357	3.344296
Race_white	0.8591	0.6735	1.2756	0.2021	-0.4609	2.1792	0.856087	0.635989	1.346072	0.178279	-0.39043	2.102602
income	0.4013	0.2562	1.5660	0.1173	-0.1009	0.9035	0.211143	0.261059	0.808795	0.418633	-0.30052	0.722809
Gender_M	0.5541	0.4026	1.3762	0.1687	-0.2350	1.3431	-0.47239	0.407025	-1.16058	0.245811	-1.27014	0.325368
	Trust LCA						Trust LCC					
	Coef.	**Std.Err.**	**z**	**P>|z|**	**[0.025**	**0.975]**	**Coef.**	**Std.Err.**	**z**	**P>|z|**	**[0.025**	**0.975]**
const	-0.00763	0.618711	-0.01232	0.990167	-1.22028	1.205025	-1.30095	0.704565	-1.84646	0.064826	-2.68187	0.079974
age	-0.00942	0.297878	-0.03163	0.974765	-0.59325	0.574407	-0.0098	0.319135	-0.03071	0.9755	-0.63529	0.615692
Race_asian	-0.11939	0.687252	-0.17372	0.862082	-1.46638	1.227596	1.996879	0.786019	2.540498	0.011069	0.456311	3.537447
Race_black	-0.29792	0.64569	-0.4614	0.644513	-1.56345	0.967609	1.771614	0.733888	2.414011	0.015778	0.33322	3.210007
Race_white	-0.80139	0.612331	-1.30876	0.190616	-2.00154	0.398753	1.566177	0.682883	2.293479	0.02182	0.227752	2.904603
income	0.204805	0.249082	0.822238	0.410941	-0.28339	0.692998	0.468337	0.263846	1.775039	0.075891	-0.04879	0.985466
Gender_M	-0.13646	0.385928	-0.3536	0.723641	-0.89287	0.619942	-0.50456	0.414815	-1.21636	0.223848	-1.31759	0.308459
	Usability LCA						Usability LCC					
	Coef.	**Std.Err.**	**z**	**P>|z|**	**[0.025**	**0.975]**	**Coef.**	**Std.Err.**	**z**	**P>|z|**	**[0.025**	**0.975]**
const	0.023661	0.618416	0.038261	0.96948	-1.18841	1.235734	-0.0368	0.624186	-0.05895	0.952989	-1.26018	1.186584
age	0.38708	0.300925	1.286301	0.198338	-0.20272	0.976882	0.148595	0.302958	0.490482	0.623793	-0.44519	0.742382
Race_asian	-0.13385	0.68836	-0.19444	0.845828	-1.48301	1.215313	1.031892	0.722091	1.429032	0.152995	-0.38338	2.447165
Race_black	-0.36519	0.648111	-0.56347	0.573117	-1.63546	0.905085	0.176233	0.651804	0.270378	0.78687	-1.10128	1.453745
Race_white	0.12891	0.606847	0.212427	0.831774	-1.06049	1.318308	0.407769	0.611639	0.666682	0.504975	-0.79102	1.606559
income	-0.11763	0.244813	-0.48047	0.63089	-0.59745	0.362198	0.146981	0.248528	0.591409	0.554247	-0.34012	0.634086
Gender_M	0.203382	0.383028	0.530985	0.595429	-0.54734	0.954103	-0.57481	0.392952	-1.46279	0.143526	-1.34498	0.195367

We see very high P values for almost all variables. This means that our models cannot have very limited predictive capacity in their current form. The dataset we have is either too small, there is not an underlying relationship, or the categorizations need to be reconsidered to make any sort of reliable prediction model based on more than one demographic variable. Additional iterations should be undertaken with these models and variables before settling on their final form and any conclusion.

Another approach to explore the relationship between the demographic and dependent variable is with one demographic variable.

Table 28 below shows a particular demographic variable (columns) and the distribution of responses for desirability, usability and trust across LCC.

Table 28: Distribution for LCC Dependent Variables by Demographics

Lane Centering Control																
		Race				Gender			Age				Income			
		asian	black	white	Grand Total	F	M	Grand Total	18-34	35-54	55-74	Grand Total	0-50,000	100,000 and abo	50,000-100,00	Grand Total
Desirability	Desirable	67%	77%	55%	65%	64%	62%	63%	62%	62%	64%	62%	66%	65%	54%	63%
	Neither desirable nor undesirable	17%	8%	14%	14%	9%	15%	12%	15%	12%	0%	13%	16%	12%	14%	14%
	Undesirable	16%	15%	31%	21%	26%	24%	25%	23%	27%	36%	25%	18%	23%	31%	23%
	Grand Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Usability	Usable	81%	51%	57%	65%	67%	60%	63%	65%	58%	57%	62%	66%	63%	57%	63%
	Neither usable nor unusable	9%	13%	19%	14%	13%	16%	15%	14%	13%	21%	15%	15%	15%	17%	16%
	Unusable	10%	36%	24%	22%	20%	25%	22%	21%	29%	21%	23%	19%	21%	26%	21%
	Grand Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Trust	Distrust	22%	21%	24%	23%	22%	25%	24%	23%	27%	14%	24%	22%	15%	23%	20%
	Neither trust nor distrust	19%	18%	17%	18%	17%	23%	20%	20%	25%	7%	20%	28%	15%	11%	20%
	Trust	59%	62%	59%	59%	61%	53%	56%	57%	48%	79%	56%	49%	69%	66%	60%
	Grand Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Thus for example, from the table it may be seen that the group that is most likely to have a favorable view of LCC are Asian, female, younger (18-34) and older (55-74), and individuals with an income between (0 to 50,000).

Table 29 below shows a particular demographic variable (columns) and the distribution of responses for desirability, usability and trust across LCA.

Table 29: Distribution for LCA Dependent Variables by Demographics

Lane Change Assistance															
	Race				Gender			Age				Income			
	asian	black	white	Grand Total	F	M	Grand Total	18-34	35-54	55-74	Grand Total	0-50,000	100,000 and above	50,000-100,000	Grand Total
desirable	55%	44%	47%	49%	43%	50%	47%	42%	56%	57%	47%	43%	60%	43%	49%
Neither desirable nor undesirable	22%	21%	17%	20%	32%	14%	21%	23%	17%	14%	21%	24%	13%	23%	20%
undesirable	22%	36%	36%	31%	25%	36%	31%	34%	27%	29%	32%	33%	27%	34%	31%
Grand Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
usable	66%	49%	53%	57%	55%	58%	57%	55%	58%	57%	56%	60%	56%	54%	57%
Neither usable nor unusable	19%	38%	33%	29%	32%	25%	28%	29%	25%	43%	29%	24%	33%	34%	29%
unusable	16%	13%	14%	14%	13%	17%	15%	16%	17%	0%	15%	16%	12%	11%	14%
Grand Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
trust	45%	41%	31%	39%	37%	43%	40%	41%	37%	50%	40%	40%	44%	40%	42%
Neither trust nor distrust	22%	18%	24%	22%	30%	15%	21%	18%	25%	29%	21%	16%	21%	23%	19%
distrust	33%	41%	45%	39%	33%	42%	38%	41%	38%	21%	39%	43%	35%	37%	39%
Grand Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Again for example, from the table it is seen that the group that is most likely to have a favorable view of LCC are Asian, male, older (55-74), and individuals with an income of 100,000 and above.

6. Conclusion

Overall, the survey respondents have more positive views of LCC over LCA. The biggest factor for this discrepancy is the desire to have more control over their vehicles for what respondents perceive as a complex task (changing lanes) and distrust of technology to handle more complex tasks. Respondents seem more comfortable allowing ADAS features to control simpler tasks.

Older and younger respondents of the survey have a more positive view of ADAS features than middle-aged respondents. Male respondents have a more positive view of LCA and female respondents have a more positive view of LCC. Respondents who identified as Asians have a more positive of ADAS features than respondents who identified as white or black.

A higher percentage of higher income respondents have had experience with LCA over lower income respondents. This could be because vehicle manufacturers are more likely to include more advanced features (such as LCA) in higher trim models first before releasing it in lower level models. Lower income individuals are also more likely to have older vehicles or keep their vehicle for longer which makes may also limit their access to more advanced features (Schipper, 2018).

Appendix A: Full Survey

Georgia Institute of Technology

Survey Title: Diversity, Equity and Inclusion (DEI) considerations when developing Advanced Driver Assistance Systems (ADAS)

You are being asked to volunteer to participate in this 10 minute survey to get your opinion on hands free lane change assist and lane keeping system

Purpose:

The purpose of this survey is to understand what the needs are for a diverse population for Advanced Driver Assistance Systems (ADAS) and ensure that current technology limits and future technology advances comprehend these needs in order to ensure a DEI mindset when developing ADAS.

Exclusion/Inclusion Criteria:

Participants in this survey must be a self-identified driver, 18 years of age or older.

Procedures:

The survey has three parts. The first and second part asks you about your opinions on two different driver assistance technologies. The third part asks about your demographic information.

Risks and Discomfort:

There is minimal risk in participating in this survey. We do not anticipate risks beyond those experienced in daily conversations or risks encountered in everyday life.

Benefits:

You are not likely to benefit in any way from participating in this survey but you will likely be contributing to an improvement in the generalized knowledge of designing more equitable ADAS systems.

Compensation:

You will be compensated with a $10 gift card for participating in this survey.

Storing and Sharing information:

Survey results may be shared or published, although your name or any personally identifiable information (if provided) is not associated with your response in any way, in any part of the research. Survey participant's name or any personally identifiable information (if provided) will not be used in any oral or written presentations of the study. Your decision to participate or not participate in this survey will not affect any future, past or present relationship with any institution involved in this study which includes Georgia Institute of Technology, and Prairie View A&M University.

Confidentiality:

The following procedure will be followed to keep your personal information confidential in this study: we will comply with any applicable laws and regulation regarding confidentiality. Your name and other facts that might point to you will not appear when the results of this study are presented or published. Your personally identifiable information will not be associated with your responses. Your personally identifiable information will not be used for any other research except the one you are currently participating in. The Georgia Institute of Technology and Prairie View A&M University IRB and the office of Human Research Protection may look over the study records during required review.

Costs to you:

The cost to you for participating in this study would be the time taken to participate in this survey.

If you have any questions about the study, you may contact the research team director, Dr. Michael Hunter of the Georgia Institute of Technology, at telephone (404) 385-1243. If you have any questions about your rights as a research subject, you may contact Ms. Melanie Clark, Georgia Institute of Technology, at (404) 894-6942.

Questions about your rights as a research participant

- Your participation in this survey is voluntary
- You do not have to take this survey if you don't want to
- You have the right to stop taking this survey at any time without giving any reason and without any penalty
- You do not waive any of your legal rights by agreeing to take this survey
- Your completion of this survey provides your consent to participation

Thank you very much for your time and responses!

a. **Yes**

b. **No**

Part 1: Lane Centering Control

Credit: Dietrich's Car Channel: (How to use Ford blue cruise hands free driving and lane change assist, 00:6:46-00:6:56)

This hands free feature keeps you centered in your lane. Driver must remain alert when feature is in use.

(Scroll down to move to the next question)

In the next several questions you will be asked to rate and comment on Lane Centering Control based on desirability, usability, and trust.

Part 1: Question 1

Have you driven a vehicle with lane centering control capabilities?

a. Yes

b. No

c. Unsure

Part 1: Question 2

How desirable do you find lane centering control?

a. Extremely undesirable
b. Somewhat undesirable
c. Neither desirable or undesirable
d. Somewhat desirable
e. Extremely desirable

Part 1: Question 3

What about Lane Centering Control do you find desirable or undesirable?

Part 1: Question 4

How usable do you find hands-free lane centering control?

a. Extremely unusable
b. Somewhat unusable
c. Neither usable nor unusable
d. Somewhat usable
e. Extremely usable

Part 1: Question 5

What about Lane Centering control do you find usable or unusable?

Part 1: Question 6

How much do you trust Lane Centering Control?

a. Completely distrust

b. Somewhat distrust

c. Neither trust nor distrust

d. Somewhat trust

e. Completely trust

Part 1: Question 7

What about Lane centering control do you trust or distrust?

Part 1: Question 8

How would you change Lane Centering control to make it suit you?

Part 2: Hands-Free Lane Change Assistance

Credit: Dietrich's Car Channel: (How to use Ford blue cruise hands free driving and lane change assist, 00:4:26-00:4:36)

This feature will make lane changes at the driver’s request, when it is safe. Drivers must remain alert when this feature is in use.

(Scroll down to move to the next question)

In the next several questions you will be asked to rate and comment on hands free Lane Change Assistance based on desirability, usability, and trust.

Part 2: Question 1

Have you driven a vehicle with hands-free lane change assistance capabilities?

a. Yes
b. No
c. Unsure

Part 2: Question 2

How desirable do you find hands-free lane change assistance capabilities?

a. Extremely undesirable
b. Somewhat undesirable
c. Neither desirable or undesirable
d. Somewhat desirable
e. Extremely desirable

Part 2: Question 3

What about hands-free lane change assistance do you find desirable or undesirable?

Part 2: Question 4

How usable do you find hands-free lane change assistance?

a. Extremely unusable
b. Somewhat unusable
c. Neither usable nor unusable
d. Somewhat usable
e. Extremely usable

Part 2: Question 5

What about hands-free lane change assistance do you find usable or unusable?

Part 2: Question 6

How much do you trust hands-free lane change assistance?

a. Completely distrust
b. Somewhat distrust
c. Neither trust nor distrust
d. Somewhat trust
e. Completely trust

Part 2: Question 7

What about hands-free lane change assistance do you trust or distrust?

Part 2: Question 8

How would you change hands-free lane change assistance to make it suit you?

Part 3: Demographics

Part 3: Question 1

What is your self-identified ethnicity/race?

Part 3: Question 2

What is your self-identified gender?

Part 3: Question 3

What is your age?

- ○ 18-24
- ○ 25-34
- ○ 35-44
- ○ 45-54
- ○ 55-64
- ○ 65-74
- ○ 75 or older
- ○ Prefer not to answer

Part 3: Question 4

To ensure our study is representative of all income groups in the area, please indicate your household's annual gross income range (before taxes are taken out).

- ○ Less than $10,000
- ○ Between $10,000 and $20,000
- ○ Between $20,000 and $30,000

○ Between $30,000 and $40,000

○ Between $40,000 and $50,000

○ Between $50,000 and $60,000

○ Between $60,000 and $75,000

○ Between $75,000 and $100,000

○ Between $100,000 and $150,000

○ Between $150,000 and $200,000

○ More than $200,000

○ Don’t know

○ Prefer not to answer

Part 3: Question 5

What is your zip code?

Part 3: Question 6

Would you be willing to learn about and potentially participate in a follow up focus group on driver assistance features?

a. Yes

b. No

Appendix B: IRB Submittal Documents

Section 1: Poster

$10 Amazon Giftcard for a 5 to 10 Minute Survey on Driving Features in Cars

Section 2: Interest form

Focus Group Interest Form

Full Name: ______________________________

Race: ______________________________

Gender: ______________________________

What is your Age?

○ 18-24 ○ 25-34 ○ 35-44
○ 45-54 ○ 55-64 ○ 65-74
○ 75 or older ○ Prefer not to say

Phone Number: ______________________________

Email - Address: ______________________________

Zip Code: ______________________________

Thank you for taking the time to complete our focus group interest survey.

Section3: Gift Card Form

Diversity, Equity and Inclusion (DEI) considerations when developing Advanced Driver Assistance System (ADAS) – Survey Gift card form

Date

Name	Signature

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