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Assessing Public Perception and Proposing an Organized Questionnaire for the Deployment and Adoption of Autonomous Vehicles

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ASSESSING PUBLIC PERCEPTION AND PROPOSING AN ORGANIZED QUESTIONNAIRE FOR THE DEPLOYMENT AND ADOPTION OF AUTONOMOUS VEHICLES

by

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ABSTRACT

Since the general public will play a central role in the evolution of AVs, research has been performed to assess their perception and acceptance of AVs. Nevertheless, the most potential users of AVs, i.e., young, students, and more educated people, have not received any particular focus in those studies. This research gap has motivated us to assess their perceptions. Extensive data analyses of the survey at the University of Central Florida with a sample of 315 reveal that on average 57% of the respondents were familiar with AVs, and about 44% of the respondents felt positive perceptions toward AVs. Around 51% of the respondents had some concerns regarding the perceived negative aspects of AVs, however, a significant percentage of people (around 34%) maintained a neutral position regarding the negative aspects of AVs. In addition, structural equation modeling was performed considering five latent variables and 32 observed variables to investigate the inter-relationship among those variables. Model results suggest that as more people have positive primary perceptions about different aspects of AVs, their attitudes toward AVs would be more positive, and the concerns regarding AVs would be reduced. Demographic characteristics do not significantly influence the willingness to possess AVs, and people want to own AVs despite their different demographic backgrounds. These study findings could help policymakers to apprehend different prospects of people's perceptions regarding AVs and have implications for the stakeholders of autonomous vehicles. In addition to that, the study proposed an organized questionnaire based on which the responses of the stakeholders should be collected and analyzed. Findings from literature using heterogeneous questionnaires produced perplexing results for making relevant policies for the adoption and deployment of AVs. The current study addressed this research gap. Particularly this study attempted to identify the organizational pattern of the questionnaire of the previous studies, and eventually proposed a uniform questionnaire

based on which future studies might be conducted to obtain varying outcomes from different contexts for the same input. The proposed questionnaire is divided into two portions: a) general content, and b) special content. The general content is applicable to all studies that seek to assess the perceptions of people regarding AVs. This content consists of 4 main categories i.e., perceptions, concerns, expected benefits, and ownership. In addition to general content, special content is also proposed to be added with the general content for some specific cases where the studies will focus on Shared AVs (SAVs) or investigate the perceptions of vulnerable road users or assess the perceptions of the respondents after riding AVs. The current study has the potential to help future studies produce effective policy measures for the quick adoption and deployment of AVs.

Keywords: Autonomous vehicles; public perception; questionnaire; survey; data collection; shared autonomous vehicles; educational institution; structural equation modeling.

I dedicate this thesis to two persons I love most in this world

My Grandfather Late Md Abdur Rahman Mollah

and

My First and Only Son Muhammad Ruwaifi Rahman

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CHAPTER 1: INTRODUCTION

1.1 Background of the Study

The US National Highway Traffic Safety Administration (NHTSA) defined Autonomous Vehicles (AVs) as vehicles having the ability to operate mission-critical controls without human intervention (Adnan et al., 2018). Fully AVs can sense the surrounding environments and navigate through different traffic conditions with little or no human input (Penmetsa et al., 2019). AVs are expected to increase road safety significantly by eliminating the mistakes of human drivers (Hulse et al., 2018; Penmetsa et al., 2019), and will provide more accessible transportation options, particularly where mass transit is unavailable (Chan, 2017; Chikaraishi et al., 2020; Greenblatt & Shaheen, 2015). In addition, many believe that AVs will reduce traffic congestion, improve fuel efficiency, and thus will contribute to reducing air pollution and mitigate vulnerable climate change issues (Penmetsa et al., 2019; Shladover et al., 2012; Tientrakool et al., 2011). Hence, large-scale implementation of AVs will offer enormous social and economic benefits (Fagnant & Kockelman, 2018; J. Lee et al., 2021) and thus it has become a symbol of futuristic and intelligent transport innovation (Faisal et al., 2020; Z. Islam & Abdel-Aty, 2021).

Apprehending its future prospects, AVs received heightened attention from researchers and industry leaders since before the twenty-first century to develop the first fully autonomous vehicle that would be robust, reliable, and safe enough for real-world and high-speed driving environments (Faisal et al., 2020; Van Brummelen et al., 2018). Particularly AV's technology is emerging at an unprecedented rate since the introduction of US Defense Advanced Research Projects Agency (DARPA) challenges in 2004 (Chavan, 2020). Automotive companies (e.g., General Motors, Ford, Daimler, Renault-Nissan) and tech companies (e.g.,Uber, Waymo) have accelerated the development, testing, and deployment to bring AVs on roadways within the shortest possible time

(Penmetsa et al., 2019). This has created much speculation among the general population, and eventually, they will play a central role in purchasing AVs (Penmetsa et al., 2019). Hence, assessing the perception of the people from the target group is imperative.

1.2 **Motivation of the Study**

Fundamental problem in the earlier studies is that these studies did not focus particularly on the most potential users of AVs i.e., young, students, and more educated people (Goldbach et al., 2022; Haboucha et al., 2017; Hudson et al., 2019; Y.-C. Lee et al., 2020). There is a wide difference in perceiving control and behavioral attitudes between this group with other groups of people (Hudson et al., 2019; Porter & Donthu, 2006; Specht et al., 2013). Hence, there is a strong need to assess the perception of that group of people. On the other hand, the research conducted so far attempted discretely to assess the perception of different user groups of AVs using different analytical methodologies, and proposed different policies based on their findings. However, one problem with such studies is its underlying heterogeneity in questionnaire design to collect data from the respondents. When interpreting results based on such heterogeneous questionnaires (Rattray & Jones, 2007), there is a high probability of suggesting ambiguous policies regarding the deployment and adoption of AVs. In addition, how the questions are organized and presented might affect the responses from the respondents, and hence might alter the overall result since questionnaire design are considered to be sophisticated cognitive process and it is an interplay between questions and answers as a complex communication process between researchers and respondents, their assumptions, expectations and perceptions (Lietz, 2010). Thus, there is a strong need of organized content/questionnaire to get feedback from the potential users of AVs considering different aspects to make uniform policies for quick adoption and deployment of AVs.

To the best of the authors' knowledge, almost no study was conducted focusing particularly on the perception of the young, students, and more educated people, and at the same time proposed an organized uniform questionnaire to obtain the different respondent's responses from the same input. This motivated the authors to conduct this study. Particularly the present study was aimed to assess the perception regarding AVs of the people from an international education institution, where the percentage of young, students and more educated people would be maximum, and heterogeneity of opinions from different nations and cultures would have been obtained. In addition, filled the research gap by systematic review of the previous literatures, those investigated the perceptions of the users regarding AVs on different aspects and proposed an organized content to assist the future research for the quick adoption and deployment of AVs.

1.3 **Objectives**

The main objective of this study is to assess the public perception regarding autonomous vehicles to accelerate the adoption and deployment of this futuristic mode of transportation.

The specific objectives of this study are:

1. To assess the perception regarding AVs from the most potential users of AVs.

2. To propose an organized questionnaire to assist the future research for the quick adoption and deployment of AVs.

1.4 **Thesis Contribution**

This thesis has made several contributions to the quick adoption and deployment of the AVs. Particularly the study will assess the data collected from the most potential users of AVs, analyze them from scientific angle to get more insight of their perceptions and propose a structural modeling to explore the correlations among the contributing factors for the early adoption and

deployment of AVs. In addition, the study will propose an organized questionnaire, which will help all the stakeholders of AVs to assess the perceptions around the world through same questionnaire and get different feedback for the acceleration of the adoption and deployment of AVs. The findings and proposition of this study have the potential to contribute to the process of building smart cities through the quick adoption and deployment of AVs.

1.5 **Thesis Structure**

Apart from the introductory chapter, the remainder of the thesis is structured into five more chapters. Chapter 2 outlines the literature review related to the perception analyses and modeling of autonomous vehicles studies. Chapter 3 elaborately describes the questionnaire design, data collection and data analyses methodology. Chapter 4 describes the results from the questionnaire survey analyses and modeling. Chapter 5 proposes the organized questionnaire to assist quick adoption and deployment of autonomous vehicles. Finally, Chapter 6 summarizes the main findings of the thesis and discusses the future research directions.

CHAPTER 2: LITERATURE REVIEW

This chapter outlines the theoretical reviews of the research related to the perception based autonomous studies. To better align with the study objectives, this chapter will discuss the earlier studies in two subsections. The first sub-section will discuss the literatures those are relevant to the first objective to analyze the perceptions of the people. The second sub-section will discuss the literatures used to design the proposed organized questionnaire.

2.1 **Literature Related to Survey Study**

Perception is defined as the way people think about something, understand it, or have an impression of it (Kassens-Noor, Wilson, et al., 2020). Since the future evolution of AVs will largely depend on how the target group perceives it (H. Liu et al., 2019), a significant number of studies have been conducted to assess the general people's perception regarding AVs. Some studies focused on assessing public perception regarding AVs, where prospects of AVs were prioritized as a public transit (Hulse et al., 2018). Others conducted their studies focusing on the perception of non-motorists and vulnerable road users regarding AVs (Das et al., 2020; Penmetsa et al., 2019). Many studies also studied the perception of people regarding the advantages, disadvantages, limits, and ideal applications of technologies used in the AVs (Van Brummelen et al., 2018). Some came forward to assess the relationship between social influence, technophobia, perceived safety of autonomous vehicle technology, the number of automobile-related accidents, and the intention to use autonomous vehicles (Koul & Eydgahi, 2019). Many performed stated preference surveys and advanced modeling techniques to determine different preference attributes and key demographic indicators (Cai et al., 2019). Few studies targeted a specific group, i.e., public transit riders, to analyze their perceptions (Kassens-Noor, Kotval-Karamchandani, et al., 2020).

Whereas some studies focused on analyzing the type of information concerning AVs that are of consumers' interest (Hryniewicz & Grzegorczyk, 2020). Few attempts were also made to develop a psychological model to explain AVs acceptance measures (H. Liu et al., 2019). An interesting study on AVs was conducted to investigate the differences in public perception based on word choice, i.e., autonomous vehicles and self-driving vehicles. This study suggested that the language used to describe the next generation of vehicles may shape public reaction and acceptance (Kassens-Noor, Wilson, et al., 2020). A perception-based study was also conducted by taking the opinions of the riders after traveling in AVs (Hilgarter & Granig, 2020). Another study analyzed the perception of general individuals and experts (M.-K. Kim et al., 2019). Some studies were also conducted highlighting the ethical perceptions regarding AVs (Adnan et al., 2018).

However, the fundamental problem is that these studies did not focus particularly on the most potential users of AVs. Many previous studies mentioned that early AVs adopters will likely be the young, students, and more educated people (Goldbach et al., 2022; Haboucha et al., 2017; Hudson et al., 2019; Y.-C. Lee et al., 2020). The rationale for identifying this group was that the older group of people are more likely to be inclined to their particular beliefs and they are less ready to try new technologies compared to the young groups. Students and educated groups of people are already familiar with the AVs and they are more likely to try and accept new technologies. In addition, this group of people spends more time driving and in some countries, young drivers need to pay higher insurance rates because of higher crash probability (Haboucha et al., 2017; Hudson et al., 2019). In addition, overall there is a wide difference in perceiving control and behavioral attitudes between this group with other groups of people i.e., young and more educated group use more internet than older and less educated group (Hudson et al., 2019; Porter & Donthu, 2006; Specht et al., 2013). Hence, there is a strong need to assess the perception

of that group of people. To the best of the authors' knowledge, almost no study was conducted focusing particularly on the perception of the young, students, and more educated people. This motivated the authors to conduct this study. Particularly the present study was aimed to assess the perception regarding AVs of the people from an international education institution, where the percentage of young, students and more educated people would be maximum, and heterogeneity of opinions from different nations and cultures would have been obtained.

2.2 **Literature Review Related to Questionnaire Design**

To achieve the goal of this study, around 200 articles were downloaded from electronic databases i.e., ISI Web of Science, Scopus and Google Scholar. During downloading the papers, it was ensured that these are from good quality and high impact factor journals. The Boolean search terms that were used to find the journal articles were "autonomous vehicles perception", "autonomous vehicles", "driverless vehicle concern", "autonomous vehicles survey"

Then the paper's relevance of different journals articles with the current study was determined by their title, abstract, keywords, figures, tables, and discussion and conclusion. In addition, some few more aspects were considered during the selection of the articles i.e., heterogeneity of these studies was ensured i.e., the considered studies present different countries around the world; most recent relevant studies were selected i.e., 2014 to 2021; different target population were considered i.e., general people, drivers, researchers, stakeholders and so on. After the scrutiny process, finally 50 articles were selected for this study. Summary of the data collection year, sample size, study location, target population and key findings of the selected studies are presented in the **Table 1**.

Table 1: Summary of the literatures

Paper Reference	Data Collection Year	Sample Size	Study Location	Distribution Method	Target Population	Key Findings
Kim et al. (2019)	2018	98	Korea	Online	Drivers and Experts	Identified safety as the most important attributes and found concern in common. Individuals found personal benefits or concerns important, whereas experts found social benefits more important.
Liu et al. (2019)	2017	740	China	In person	Urban People	Respondents found fully AVs are more beneficial than highly AVs. Trust had direct and indirect effect on acceptance. Perceived benefits had more direct effects than perceived risk in acceptance.
J. Lee et al. (2019)	2018	313	Korea	Online	Research Institution	Investigated the influential factors for of AVs. Motivating a user for forming psychological bond might be effective strategy in promoting AVs.
Yuen, Wong, et al. (2020)	2019	526	Korea	Online and In-Person	Subway Station	Influence of the innovation diffusion attributes on public acceptance is fully mediated by the public's perceived value of AVs . Effect of perceived value on public acceptance is partially mediated by the public's trust in AVs.
Ge et al. (2019)	2019	440	USA	Online	General People	Defined the latent variables (9) and their corresponding set of questions (44) to understand the underlying factors that might affect AVs.
Koul & Eydgahi (2019)	2017	377	USA	Online	General People	Social influence and perceived safety had significant positive relationships with the intention to use AVs. Significant negative relationship was found among technophobia and intention to use AVs. No relationship was found between the number of automobile related accidents and intention to use AVs.

Paper Reference	Data Collection Year	Sample Size	Study Location	Distribution Method	Target Population	Key Findings
Islam et al. (2022)	2019	372	USA	In Person	Young, students and educated group	Assessed the perceptions of most potential and early adopters of AVs As people get more familiar with AVs, their perceptions and attitudes towards AVs would improve and concerns would reduce Demographic background did not influence the willingness to possess AVs
Lijarcio et al. (2019)	2019	1205	Spain	In-Person	Drivers	Intention to adopt AVs could be predicted through demographic and driving related factors, and level of interaction of individuals with technologies. Emphasis on the safety, causality prevention and efficiency-related benefits might strengthen the acceptance of AVs.
Bansal et al. (2016)	2014	358	USA	Online	General People	Study found fewer crashes as the primary benefits and equipment failure as the major concern. Willingness to pay is much higher for level 4 ($7253) than for level 3 ($3300). Higher income, technology savvy males from urban area with more crashes experience are more willing to pay higher.
Rovira et al. (2019)	2018	126	USA	Online and In-Person	Technology Experienced Person	Trust in AVs depended on multiple interacting variables i.e., age, risk during travel, impairment level, and reliability of the AVs. Although there is a long distrust from the respondents in AVs, their rating varied with situational characteristics i.e., reliability, driver impairment, risk level.

Paper Reference	Data Collection Year	Sample Size	Study Location	Distribution Method	Target Population	Key Findings
Dirsehan & Can (2020)	2020	391	Turkey	Online	General People	Participants' intention to use the AVs depends on how useful it is rather than how easy it is to use Sustainability concerns, has a stronger effect than perceived ease of use and perceived usefulness Individuals have cybersecurity concern to trust and adopt AVs
Yuen, Huyen, et al. (2020)	2019-2020	268	Vietnam	Online	Shared AVs	Synthesized the unified theory of acceptance and use of technology 2 and the theory of planned behaviour, and expanded the range of factors that influence the use of SAVs
Penmetsa et al. (2019)	2018	1119	USA	Online	Vulnerable road users	Respondents with direct experience of interacting with AVs have higher expectations of safety benefits. As people more interact with AVs, their perception towards AVs get more positive.
Das et al. (2020)	2018	321 Member 793 General Public	USA	Online	Vulnerable road users	Perception measures vary among participants based on the nature of the stakeholder. Participants having direct interaction experience with AVs. have higher expectations and interest in AVs than the participants with no experience.
Gurumurthy & Kockelman (2020)	2017	2588	USA	Online	General People	Willingness to pay to share rides would rise over time. SAVs would be popular for long-distance business travel. Privacy might not be an important concern.
Stoma et al. (2021)	2020	579	Poland	In-Person	Automotive Market Users	AVs might not appear on polish roads in very near future due to costs, legal regulations and conviction Hybrid vehicles and electric vehicles might dominate on polish roads soon

Paper Reference	Data Collection Year	Sample Size	Study Location	Distribution Method	Target Population	Key Findings
Kyriakidis et al. (2020)	2019	1639	8 European Countries	Online	General People	Safety would be major factor in accepting AVs Age, gender, education level and number of household members influence the decision of how AVs to be used
Zajc et al. (2020)	2018	153	Slovenia	in person	General People	Respondents were not experienced with AVs and they lack basic technology knowledge. Respondent's opinions are neutral regarding the readiness of the adoption of AVs.
Ackaah et al. (2021)	2020	417	Ghana	online + in person	General People	Majority are familiar with AVs, and they have positive opinions about AVs, however safety is their main concern People believe AVs will be available in next ten years
Hilgarter & Granig (2020)	2018	19	Austria	In person	Qualified Participants	AVs can shift transportation modes from private cars to public transportation Experience and speed might be key factors regrading safety
Hewitt et al. (2019)	2018	187	USA	Online	General People	Users are reluctant to high autonomy levels Partial autonomy are perceived to require higher driver engagement than full autonomy.
Das (2021)	2019	795	USA	Online	Vulnerable road users	Vulnerable road users felt less negative concerns Safety found to be important factor for assessing perception
Cunningham et al. (2019)	2017	6133	Australia, New Zealand	Online	General People	Perceived benefits, and secondary activities might be important factors than sociodemographic variables, concerns or awareness in predicting willingness to pay.

Paper Reference	Data Collection Year	Sample Size	Study Location	Distribution Method	Target Population	Key Findings
Moody et al. (2020)	2016-17	33958	51 countries	Mobile Phone based data	General People	Young male perceived more positive attitudes towards safety and deployment of AVs Urban people with high income and education level also predicted fewer years for AVs to be a safe mode of transportation Individuals from developed countries with more motirization rate and less fatal crashes on roads predicted high times for AVs to be safely deployed. This is opposite for developing countries with higher death rate on roads.
Pyrialakou et al. (2020)	2018	400	USA	Online	General People	Different attitudinal factors, level of automation, and other intrinsic and extrinsic factors are related to safety perceptions rather than exposure to and awareness of AVs Cycling near AVs was found to be least safe, followed by walking and driving.
Woldeamanuel & Nguyen (2018)	2017	919	USA	Not mentioned	Student and Faculty	There is dichotomy in perceptions regarding AVs between the millennial and non-millennial generation.
Wang et al. (2020)	2018	721	USA	Online	General People	Those who adopt technology early and support strict traffic rules felt positive attitudes towards AVs People who avoid risky traffic behaviors are neutral about AVs, and People are reluctant to share ride in AVs Larger portion are not ready to use AVs without driver
Jing et al. (2019)	2018	906	China	Online	General People	Lack of knowledge about AVs and perceived risk are main obstacles in adopting AVs and SAVs

Paper Reference	Data Collection Year	Sample Size	Study Location	Distribution Method	Target Population	Key Findings
Y.-C. Lee & Mirman (2018)	2017	60	USA	Online	Parents	Parent's intention to travel, their technology readiness and child demographic profiles are important in adoption of AVs. The study identified two AV user groups: the curious and the practical group.
Zhu et al.(2020)	2019	355	China	In Person	Young Generation	Self-efficacy can be enhanced by Mass media, while social media has the potential to strengthen subjective norms. Mass media helps to perceive the usefulness and risks of AVs, however, social media can help to reduce risk perceptions.
Mack et al.(2021)	2017	776	USA	Online and Phone call	General People	Political ideology is an important determinant of AVs adoption The Moderates and the Liberals are more positive about AVs than the Conservatives.
Nair & Bhat (2021)	2017	5341	USA	web-based and self-administered	General People	There is a need of considering the socio-technical and human-related factors in addition to technological and other infrastructure-related factors to promote AVs.
Rahman et al. (2021)	2019	795	USA	Email	Vulnerable road users	Lack of perceived safety, comfort and are the main negative contributors in accepting AVs. Respondent's view on safety, familiarity with technology, and automobile ownership helped to shape their perceptions.
X. Xu & Fan (2019)	2017	1164	China	Online	Insurance Holder	42.35% and 45.28% of the respondents expected lower risk and lower insurance premiums for AVs.
Al Barghuthi & Said (2019)	2019	204	UAE	Online	General People	Safety would be the major concern

Paper Reference	Data Collection Year	Sample Size	Study Location	Distribution Method	Target Population	Key Findings
Hussain et al. (2021)	2020	509	Qatar	Online	General People	Respondents had positive perceptions on safety and human errors, and negative perceptions on interaction with human-driven vehicles and security. Non-Arabs had higher concerns than Arabs. Those have higher knowledge about AVs are more concerned about safety and interaction with human driven vehicles.
Asgari & Jin (2019)	2017	1198	USA	Online	General People	It would be hard to convince those who enjoy driving Technology savvy people showed higher intention for AVs People are ready to pay if they find AVs as reliable and trustworthy Those have higher concerns for trust, are more willing to pay
Zhang et al. (2020)	2018	647	China	Web-Based	Drivers	Social influence and initial trust are most crucial in AVs adoption Personality traits are important; sensation seekers are more positive, whereas neurotic people showed lower level of trust
Kassens-Noor et al. (2021)	2019	1861	USA	On-board intercept	Special Needs People	Special needs people rely more on public transportation, and they perceived AVs negatively. Visual impaired people were more likely to accept autonomous public transport than the mobility disabled people.
S. S. Ahmed et al. (2020)	2017	584	USA	Online	University Students and Employees	Socio-demographic characteristics, and driving related factors affect the perceptions of safety and security. Equipment/system failure in poor weather, security threats, and privacy issues were found major concerns for AVs adoption.

Paper Reference	Data Collection Year	Sample Size	Study Location	Distribution Method	Target Population	Key Findings
Zhang et al. (2019)	2018	216	China	face to face	General People	Initial trust is most crucial factor, and it can be enhanced by improving perceived usefulness and reducing perceived safety risk.
Hulse et al. (2018)	2016	925	UK	Online	General People	AVs are perceived as low risk mode of transport, and different users perceived the level of risk differently Males and younger adults are more positive to accept AVs It is premature to draw conclusion on risk-taking and acceptance.
Hegner et al. (2019)	2018	369	Germany	Online	General People	Trust and giving up the control would be major area of concerns. Perceived usefulness and losing the driving pleasure are respectively the important positive and negative aspects of AVs.
Tennant et al. (2019)	2015-17	11827	11 European Countries	Mixed	Drivers	Drivers expected to interact with AVs the same way as the human-driven vehicles. However, more sociable drivers are less enthusiastic about AVs.
Choi & Ji (2015)	2015	552	Korea	Online	Drivers	Perceived usefulness and trust are the major factors to adopt AVs. System transparency, technical competence, and situation management have positive effects on trust. Trust has negative effects on perceived risk. Locus of control has significant effects on behavioral intention, however sensation seeking effects was not found significant.
Yuen et al. (2021)	2020	274	China	In Person	General People	Perceived usefulness and perceived ease of use have positive effect on behavioral intention to use AVs, and they are influenced by perceived characteristics of innovation

Paper Reference	Data Collection Year	Sample Size	Study Location	Distribution Method	Target Population	Key Findings
Guo et al. (2021)	2019	1302	USA	Online	General People	Advantages, road safety improvement potential, compatibility with lifestyles and travel needs, and attitudes towards driving are key factors in adopting AVs
Park et al. (2021)	2020-2021	318	Korea	Online	General People	Social influence, facilitating conditions, and perceived usefulness are the key factors in adopting AVs Demographic variables have moderate effects on adopting AVs
Z. Xu et al. (2018)	2017	300	China	In Person	Students	Trust, perceived ease of use, perceived usefulness increased with the participants' experience with the AVs, however, experience had effect on behavioral intention
Raue et al. (2019)	2016	1748	USA	Online	General People	Positive feelings of enjoyment had higher benefit perception and trust, negative feelings had higher risk and higher benefit perception. Feelings of control were inversely related to risk and benefit perception.
Manfreda et al. (2021)	2018	382	Slovenia	Online	Millennials	Perceived benefits were vital factors for AVs adoption Perceived safety significantly reduced the influence of various concerns regarding AVs.

After the final selection, 50 articles were rigorously reviewed. From **Table 1**, it is evident that the present study has covered the countries who are leading the AVs research, to those countries where AVs related studies are at the beginning stage. Some of the common and notable key findings from these studies are as following: a) As people will have the opportunity to know more about AVs, their perceptions will be more positive towards AVs, and social and mass media can influence them in building such perception; b) safety and security are the common concerns of the people in accepting AVs; c) trust would be an important factor in accepting AVs; d) People are willing to pay extra money for AVs; e) Young male educated and high income people have a greater intention to use AVs compared to their counterparts; f) People expect that AVs will bring many societal benefits, however, they have many concerns regarding many aspects of AVs. Most of these studies used different questionnaires to collect data and different techniques to analyze them, and finally contributed to the AVs research through their findings. However, very few studies put an arduous effort to propose/use an organized uniform questionnaire for collecting data to assess people's perceptions regarding AVs (Ge et al., 2019). Rather it was found that there is heterogeneity in considering and categorizing variables in particular group. Particularly some studies considered one variable in a particular category, whereas other studies considered the same variable in different category/latent group. In addition, there are very few studies which considered adequate number of variables in their studies. These heterogeneity and lack of uniformity in collecting data from the respondents produced ambiguous results for the policymakers and other stakeholders to adopt appropriate policies for accelerating the deployment of AVs. This study made an attempt to fill this gap by proposing an organized uniform questionnaire for collecting data from the potential users of AVs to assess their perceptions, and hence to accelerate the development, adoption and deployment of AVs. Particularly this study proposes an organized

questionnaire for collecting data to assess the perception of prospective users of AVs, and contribute to the research on AV to get it as a smart, sustainable, and viable mode of transportation.

2.3 **Overview**

This chapter has pinpointed the earlier research gap and justified the rationale for conducting this study.

CHAPTER 3: METHODOLOGY

This chapter will be divided into four subsections to better explain how the study has been conducted. The first subsection will describe the survey design for the perception analyses study, second subsection will justify the rationale for selecting the study area, the third subsection will describe the data collection process, and finally it will be concluded by describing the data analyses techniques.

3.1 Survey Design

As a part of the project from the Florida Department of Transportation, a detailed questionnaire was designed based on the previous literature, project objectives, and initial opinions from the respondents. In the main questionnaire, there were two major parts i.e., questions related to AVs and questions related to respondents. There was total of 40 questions in this questionnaire. However, to conduct the current study, 8 of these 40 questions were eliminated as they are not suitable for converting to the Likert Scale (M. T. Ahmed et al., 2021; Anwari et al., 2021) or project confidentiality. Finally, 32 questions were validated and selected to be analyzed for the current study. The selected 32 questions are shown in **Table 2** with references.

Table 2 Selected Questions for Survey with References

Question No	Question	Reference
Q1	I am familiar with autonomous vehicles	(Ackaah et al., 2021; Bansal et al., 2016; Das, 2021; Das et al., 2020; Raue et al., 2019; Stoma et al., 2021)
Q2	I think autonomous vehicles would decrease my risk of being involved in a crash.	(Das et al., 2020; Ge et al., 2019; M.-K. Kim et al., 2019; Lijarcio et al., 2019)
Q3	I think autonomous vehicles would operate better than human drivers.	(Cunningham et al., 2019; Guo et al., 2021; Hegner et al., 2019; Pyrialakou et al., 2020; Rahman et al., 2021; Yuen et al., 2021; Zhang et al., 2020)
Q4	I think autonomous vehicles would let me be more productive because I can spend my time on things other than driving (working, texting, etc.)	(Bansal et al., 2016; Dirsehan & Can, 2020; M.-K. Kim et al., 2019; J. Lee et al., 2019; Yuen, Wong, et al., 2020)
Q5	I think autonomous vehicles would decrease my travel time compared to manual-controlled vehicles (assume the traffic is mixed with autonomous and manual-controlled vehicles)	(Choi & Ji, 2015; Cunningham et al., 2019; Hegner et al., 2019; Manfreda et al., 2021; Zhang et al., 2019)
Q6	I think autonomous vehicles would let me have a less stressful driving experience/ a more enjoyable travel	(Asgari & Jin, 2019; Hewitt et al., 2019; Hussain et al., 2021; Zhang et al., 2019)
Q7	I think it is necessary that an autonomous vehicle requires the user to remain sitting in the driver's seat and pay constant attention to the autonomous vehicle while it is in use.	(Lijarcio et al., 2019; H. Liu et al., 2019; Mack et al., 2021; Wang et al., 2020)
Q8	If the autonomous system needs me to recover to take over the vehicle in some unexpected/complicated situations, I think I can quickly switch to manual driving status and handle the situation.	(Dirsehan & Can, 2020; Ge et al., 2019; Hewitt et al., 2019; M.-K. Kim et al., 2019; Kyriakidis et al., 2020; Yuen, Huyen, et al., 2020)
Q9	I am concerned that autonomous vehicles may not drive as well as human drivers do.	(Bansal et al., 2016; Cunningham et al., 2019; M.-K. Kim et al., 2019; H. Liu et al., 2019; Mack et al., 2021; Manfreda et al., 2021)
Q10	I am concerned about possible equipment failures or system failures of autonomous vehicles.	(Bansal et al., 2016; Cunningham et al., 2019; M.-K. Kim et al., 2019; H. Liu et al., 2019; Mack et al., 2021; Manfreda et al., 2021)

Question No	Question	Reference
Q11	I am concerned about possible privacy issues caused by steady tracking of the exact location and velocity when using autonomous vehicles.	(Bansal et al., 2016; Cunningham et al., 2019; M.-K. Kim et al., 2019; H. Liu et al., 2019; Mack et al., 2021; Manfreda et al., 2021)
Q12	I am concerned about possible security problems caused by hackers when using an autonomous vehicle.	(Bansal et al., 2016; Cunningham et al., 2019; M.-K. Kim et al., 2019; H. Liu et al., 2019; Mack et al., 2021; Manfreda et al., 2021)
Q13	I am concerned that an autonomous vehicle may be dangerous when it is interacting with human operated vehicles on the streets.	(Bansal et al., 2016; Cunningham et al., 2019; M.-K. Kim et al., 2019; H. Liu et al., 2019; Mack et al., 2021; Manfreda et al., 2021)
Q14	I am concerned that an autonomous vehicle may be dangerous when it is interacting with pedestrians and bicyclists	(Bansal et al., 2016; Cunningham et al., 2019; M.-K. Kim et al., 2019; H. Liu et al., 2019; Mack et al., 2021; Manfreda et al., 2021)
Q15	I am concerned about possible poor performance of autonomous vehicles in unexpected traffic situations/unprecedented situations/poor weather conditions.	(Bansal et al., 2016; Cunningham et al., 2019; M.-K. Kim et al., 2019; H. Liu et al., 2019; Mack et al., 2021; Manfreda et al., 2021)
Q16	I am concerned about possible legal liability issues for the driver/owner when a crash is caused by autonomous vehicle itself (the vehicle is drove by its own).	(Bansal et al., 2016; Cunningham et al., 2019; M.-K. Kim et al., 2019; H. Liu et al., 2019; Mack et al., 2021; Manfreda et al., 2021)
Q17	I am concerned about possible high price of the autonomous vehicle.	(Bansal et al., 2016; Cunningham et al., 2019; M.-K. Kim et al., 2019; H. Liu et al., 2019; Mack et al., 2021; Manfreda et al., 2021)
Q18	I am concerned that autonomous vehicles may deprive me from the pleasure of driving manually	(Bansal et al., 2016; Cunningham et al., 2019; M.-K. Kim et al., 2019; H. Liu et al., 2019; Mack et al., 2021; Manfreda et al., 2021)
Q19	I think I would be proud to show the autonomous vehicle to people who are close to me.	(Hewitt et al., 2019; Koul & Eydgahi, 2019; Park et al., 2021; Rovira et al., 2019; Yuen et al., 2021; Zhu et al., 2020)
Q20	I think having an autonomous vehicle would make me have a high profile among my friends/colleagues	(Hewitt et al., 2019; Koul & Eydgahi, 2019; Park et al., 2021; Rovira et al., 2019; Yuen et al., 2021; Zhu et al., 2020)

Question No	Question	Reference
Q21	I think people whose opinions are important to me such as my parents would like the autonomous vehicle too.	(Hewitt et al., 2019; Koul & Eydgahi, 2019; Park et al., 2021; Rovira et al., 2019; Yuen et al., 2021; Zhu et al., 2020)
Q22	Are you eager to try new technologies?	(Hewitt et al., 2019; Koul & Eydgahi, 2019; Park et al., 2021; Rovira et al., 2019; Yuen et al., 2021; Zhu et al., 2020)
Q23	I think using the autonomous vehicle is a good idea	(H. Liu et al., 2019), (Ge et al., 2019), (Yuen, Huyen, et al., 2020), (Hilgarter & Granig, 2020)
Q24	I hesitate to use the autonomous vehicle system for fear of making mistakes I cannot correct.	(Das, 2021), (Pyrialakou et al., 2020), (S. S. Ahmed et al., 2020), (Hegner et al., 2019)
Q25	I would be comfortable allowing my car to transmit encrypted data, such as its current location and velocity, to surrounding cars in order to better coordinate its path with the surrounding vehicles and keep me safe.	(Das, 2021), (Pyrialakou et al., 2020), (S. S. Ahmed et al., 2020), (Hegner et al., 2019)
Q26	I think that an individual should be required to attain a proper license endorsement, through the Department of Motor Vehicles, in order to legally operate an autonomous vehicle.	(Alawadhi et al., 2020; Ilkova & Ilka, 2017; Nowakowski et al., 2015)
Q27	Please specify your gender	(Park et al., 2021), (Hulse et al., 2018), (S. S. Ahmed et al., 2020), (Kassens-Noor et al., 2021)
Q28	What is your age?	(Ackaah et al., 2021), (Rovira et al., 2019), (Pyrialakou et al., 2020), (Hulse et al., 2018), (Park et al., 2021)
Q29	What is the highest level of education you have completed?	(Ackaah et al., 2021), (Rovira et al., 2019), (Pyrialakou et al., 2020), (Hulse et al., 2018), (Park et al., 2021)
Q30	How many years do you have your driver license?	(Park et al., 2021), (Hulse et al., 2018), (S. S. Ahmed et al., 2020), (Kassens-Noor et al., 2021)
Q31	How many traffic citations did you get within the last five years?	(Ackaah et al., 2021), (Rovira et al., 2019), (Pyrialakou et al., 2020), (Hulse et al., 2018), (Park et al., 2021)

Question No	Question	Reference
Q32	How long is your daily one-way travel time on weekdays?	(Park et al., 2021), (Hulse et al., 2018), (S. S. Ahmed et al., 2020), (Kassens-Noor et al., 2021)

3.2 Study Area

To fulfill the research objectives, the main campus of the University of Central Florida (UCF) was chosen as the study area. The UCF is one of the largest universities in the USA, with more than 68,500 students. Institutional Review Board (IRB) approval was obtained before commencing the survey administration (Approval copy is attached in the Appendix).

3.3 Data Collection

To perform this study, a face-to-face in-person survey was conducted in the main campus of the UCF to obtain the target group's views and opinions about AVs. The questionnaire was formulated and framed based on a rigorous literature review, inventory discussion with the target group, and project constraints. There was a total of 32 questions in the questionnaire, and after getting approval from IRB, paid and trained surveyors were employed to distribute the survey and collect the data from the respondents from different important locations of the UCF where there is a mass gathering of students, employees, and visitors. Surveyors described the purpose of the survey, and different aspects of the AVs to all the prospective respondents, and collected written consent from those who were voluntarily interested to participate in the survey. No potential bias was made during the recruitment of the respondents. The survey was conducted in the Fall semester of 2019 (August 2019 to December 2019), and a total of 372 respondents participated in the survey. All the respondents were offered a pen with the official logo of the department and research group. Out of these 372 responses, 315 were counted as valid. A response was considered valid when all the questions were answered. It has been found that respondents were very interested in the AVs,

and almost 93% of them willingly completed the survey. However, some participants left it uncompleted due to the fact that the questionnaire seemed lengthy to them, and some others were busy with their work. After collecting the data, extensive analyses were performed, and possible reasoning and interpretation of the findings were explored.

3.4 Data Analyses

First, the full questionnaire was divided into major five groups based on the pattern of the questions asked during the survey. First eight questions (Q1 TO Q8) were asked mainly to record the respondent's primary perception of AVs. Particularly their responses were recorded on whether they were familiar with AVs, whether they believed AVs would decrease the risk of being involved in a crash, whether AVs would operate better than human drivers, whether AVs would be more productive in the sense that they could spend their time on things other than driving (working, texting, etc.), whether AVs would decrease their travel time compared to manual-controlled vehicles (assuming that the traffic was mixed with autonomous and manual-controlled vehicles), whether AVs would offer less stressful driving experience/ a more enjoyable trip, whether they would have to remain sitting in the driver's seat and pay constant attention to the autonomous vehicle while it is in use, and whether they could quickly switch to manual driving status and handle the situation in any unexpected/complicated situations. The next ten questions were related to the concerns of the respondents regarding AVs. Particularly, they were asked whether they had any concern regarding AVs that it might not drive as well as human drivers do, possible equipment failures or system failures of the AVs, possible privacy issues caused by steady tracking of the exact location and velocity when using the AVs, possible security problems caused by hackers when using the AVs, AVs might be dangerous when it would be interacting with the human-operated vehicles on the streets, AVs might be dangerous when it is interacting with

pedestrians and bicyclists, the possible poor performance of the AVs in unexpected traffic situations/unprecedented situations/poor weather conditions, possible legal liability issues for the driver/owner when a crash caused by AV itself, the possible high price of the AVs, lose the pleasure of driving manually. The next four questions were asked mainly to assess the respondent's perception of owning AVs. Particularly they were asked whether they would be proud to show the AVs to the people who were close to them, whether AVs would make them a high-profile person among their friends/colleagues, whether they think people whose opinions are important to them such as their parents would like the AVs too, and whether they are interested in new technologies. Since psychology cannot be observed directly, these questions indirectly measure the intention of the respondents to own AVs (Jhangiani & Chiang, 2012). The next four questions were asked to assess the overall attitude of the respondents towards AVs. Particularly they were asked whether they think using AVs would be a good idea, whether they would hesitate to use the AVs in fear of making mistakes that could not be corrected, whether they would be comfortable sharing the location and velocity, and whether they would be willing to attain a proper license endorsement. All these responses were recorded as per the Likert Scale ranging from 1 to 5, where 1 denotes strongly disagree, 2 denotes disagree, 3 denotes fair, 4 denotes agree, and 5 denotes strongly agree (M. T. Ahmed et al., 2021). Finally, six questions were asked to the respondents about their gender, age, the highest level of education, years of driving experience, traffic citations received in the last 5 years, and how long the daily travel time during weekdays to assess the demographic and driving characteristics, and this data was grouped in the 5th and final group.

After grouping, analyses were performed to investigate the Primary Perception regarding AVs (PP), Public Concern about AVs (PC), Attitude toward AVs (AT), Ownership of AVs (OW), and Demographic and Driving Information (DDI) using RStudio (version 4.1.3) software. After

analyzing the initial data, an attempt to assess their relationship was put forward through Structural Equation Modeling (SEM). The SEM was performed based on six hypotheses. Later, correlation matrix was formed to assess the correlation among the variables. Model fitness and data reliability test were also performed, and hypotheses results were analyzed using the same software.

3.5 Overview

This chapter has discussed the methodology to conduct this study by describing survey design method, justifying the rationale for selecting the study area, illustrating the data collection process, and elaborating the data analyses techniques.

CHAPTER 4: RESULTS AND DISCUSSION

This chapter will discuss the analyses and results from the survey methodology described in the methodology section to assess the perceptions of the most potential users of AVs.

4.1 **Primary Perception regarding AVs (PP)**

The findings from the descriptive analyses of the Q1 to Q8 regarding the Primary Perception of AVs (PP) are presented in **Table 3** as follows:

4.1.1 Familiarity with AVs

The respondents were asked whether they were familiar with AVs. Around 57 % (i.e., 36.19 % agree and 20.32% strongly agree) of the respondents were affirmative with the question that they were already familiar with AVs. Nearly 13% were not familiar with the concept of AVs. However, a significant group of people (i.e., 30.79%) were not sure whether they know about AVs or not.

4.1.2 Whether AVs Would Decrease Crash Risk

The respondents were asked about their perceptions of whether AVs would decrease the crash risk compared to human-operated vehicles. Around 46% of people were not sure what the safety consequences of the introduction of AVs would be, and hence they preferred the fair position. However, more participants (i.e., 23.81% agree and 16.83% strongly agree) believed that AVs would decrease crashes compared to those who did not think safety would be improved after introducing the AVs (i.e., 8.89% disagree and 4.44% strongly disagree).

Table 3 Primary Perception regarding AVs (PP)

(unit: %)

Question No	Question	1= Strongly Disagree	2= Disagree	3= Fair	4= Agree	5= Strongly Agree
Q1	I am familiar with autonomous vehicles	5.4	7.3	30.79	36.19	20.32
Q2	I think autonomous vehicles would decrease my risk of being involved in a crash.	4.44	8.89	46.03	23.81	16.83
Q3	I think autonomous vehicles would operate better than human drivers.	4.13	10.16	47.94	22.22	15.56
Q4	I think autonomous vehicles would let me be more productive because I can spend my time on things other than driving (working, texting, etc.)	8.25	10.16	36.83	28.25	16.51
Q5	I think autonomous vehicles would decrease my travel time compared to manual-controlled vehicles (assume the traffic is mixed with autonomous and manual-controlled vehicles)	5.71	15.56	43.17	21.59	13.97
Q6	I think autonomous vehicles would let me have a less stressful driving experience/ a more enjoyable travel	4.44	8.89	36.83	30.48	19.37
Q7	I think it is necessary that an autonomous vehicle requires the user to remain sitting in the driver's seat and pay constant attention to the autonomous vehicle while it is in use.	2.86	3.49	35.24	28.25	30.16
Q8	If the autonomous system needs me to recover to take over the vehicle in some unexpected/complicated situations, I think I can quickly switch to manual driving status and handle the situation.	2.86	7.3	33.02	34.6	22.22

4.1.3 Whether AVs Would Have Better Driving Performance than Human Operated Vehicles

Although a large percentage of people (i.e., 22.22% agree and 15.56% strongly agree) believed that AVs would be better in operation than human-operated vehicles, there was still a

major group of people (47.94% fair) who had no idea about this, and hence they did not incline to particular positive or negative direction. Around 14% of participants opposed the idea that AVs would be better at operating vehicles than human drivers.

4.1.4 Productive Use of Time

Most people (around 45%) agreed on the point that they would be able to use their time productively when they would be in AVs. Currently, they had to give their full time concentrating on driving, which induced tiredness and other inefficient use of time. Once the AVs would be in operation, they could relax rather than drive and make productive use of time. On the contrary, about 19% (i.e., 10.16% disagree and 8.25% strongly disagree) were opposed to that idea, and they believed they would still need to be concentrated on driving.

4.1.5 Whether AVs Would Decrease Travel Time

Participants' opinions about whether AVs could reduce their travel time show that a large percentage of respondents (43.17%) were unsure about whether the introduction of AVs would reduce travel time or not compared to human-operated vehicles, and they choose the fair position. However, more people (i.e., 21.59% agree and 13.97% strongly agree) were positive and believed AVs would decrease travel time compared to those who did not believe that AVs would decrease the travel time (i.e., 15.56% disagree and 5.71% strongly disagree).

4.1.6 Less Stressful Driving Experience

Around 50% of people believed that AVs would provide them with a less stressful driving experience, and they could enjoy their journeys. Only around 13% of people opposed that AVs would provide them with a less stressful driving experience than human-operated vehicles. However, still there is a large group (43%) who maintained a fair position as they had no idea about this issue.

4.1.7 Requirement of Constant Attention While AVs Driving

28.25% of people believed, and 30.16% strongly believed that they would need to focus when taking AVs on roads. 35.24% of the participants maintained a fair position regarding this issue, and around 6% of participants believed that they could just enjoy their time in the AVs without doing anything.

4.1.8 Capability to Switch to Manual Driving

In case of any unexpected situations, around 57% of people believed that they would have the capability to switch to the manual driving mode, whereas around 33% of people opined neutral. Meanwhile, there were around 10% of participants did not believe that switching to manual driving would be possible.

Table 3 presents the overall summary regarding the respondent's primary perception regarding AVs. Overall, 44% of the participants showed positive attitudes towards AVs, and they felt that it would decrease crashes, operate better than human drivers, decrease travel time, increase productivity, provide a less stressful driving experience, and facilitate the option to switch to manual driving if requires. Only around 15% of the respondents were in oppose to those positive aspects of AVs. In addition, around 59% of participants thought they would have to pay constant attention to the AVs while the vehicle would be in the autonomous driving mode. In addition, the percentage of the participants who opined fair was high (i.e., 38.73%).

4.2 **Public Concern regarding AVs (PC)**

The findings from the descriptive analyses of the Q9 to Q18 regarding the Public Concern regarding AVs (PC) are presented in Table 4 as follows:

4.2.1 Concerns about Driving Performances

The respondents who believed that AVs would drive better than human (24%) are slightly less in number than those who had concerns about the driving performance of AVs (29%). The majority of the respondents (47%) maintained a fair position in this regard.

4.2.2 Concerns about Possible Equipment Failures or System Failures of Autonomous Vehicles

Most of the participants (almost 63%) were concerned that there was a high chance that AVs would face equipment or system failures. A high percentage of the respondents (31%) opined a fair position in this regard. Only around 6% of the participants believed that equipment or system failures would not be an issue for the AVs.

4.2.3 Privacy Concerns of Autonomous Vehicles

Around 50% of respondents had concerns about the privacy in sharing locations while using AVs. Only around 17% were fine with the privacy issues. Still, a significant portion of the respondents (33%) maintained a neutral position in this issue.

4.2.4 Security Concerns of Autonomous Vehicles

The majority of the respondents (around 62%) had concerns that they might face security threats by the hackers while using AVs. Only around 10% were fine with the privacy issues. Still, a significant portion of the respondents (28%) opined neutral in this regard.

4.2.5 Concerns about Dangers When AVs are Interacting with Human Operated Vehicles

A major percentage of the participants (i.e., 27.94% agree and 19.68% strongly agree) believed that there would be potential conflicts when the AVs would come in contact with the human-operated vehicles. Only 14% of participants (i.e., 10.16% disagree and 4.13% strongly disagree) did not think it would be risky. Near 38% of participants hold fair opinions about this concern.

Table 4 Public Concern regarding AVs (PC)

(unit: %)

Question No	Question	1= Strongly Disagree	2= Disagree	3= Fair	4= Agree	5= Strongly Agree
Q9	I am concerned that autonomous vehicles may not drive as well as human drivers do.	8.57	15.24	47.3	19.68	9.21
Q10	I am concerned about possible equipment failures or system failures of autonomous vehicles.	1.27	5.08	30.48	33.65	29.52
Q11	I am concerned about possible privacy issues caused by steady tracking of the exact location and velocity when using autonomous vehicles.	4.13	12.38	33.33	29.52	20.63
Q12	I am concerned about possible security problems caused by hackers when using an autonomous vehicle.	2.22	7.62	27.94	28.89	33.33
Q13	I am concerned that an autonomous vehicle may be dangerous when it is interacting with human operated vehicles on the streets.	4.13	10.16	38.1	27.94	19.68
Q14	I am concerned that an autonomous vehicle may be dangerous when it is interacting with pedestrians and bicyclists	4.13	14.29	40.32	23.49	17.78
Q15	I am concerned about possible poor performance of autonomous vehicles in unexpected traffic situations/unprecedented situations/poor weather conditions.	3.17	6.35	33.33	35.56	21.59
Q16	I am concerned about possible legal liability issues for the driver/owner when a crash is caused by autonomous vehicle itself (the vehicle is drove by its own).	1.9	7.3	30.16	36.83	23.81
Q17	I am concerned about possible high price of the autonomous vehicle.	3.81	7.62	29.52	28.25	30.79
Q18	I am concerned that autonomous vehicles may deprive me from the pleasure of driving manually	9.52	17.78	36.19	18.1	18.41

4.2.6 Concerns about Dangers When AVs are Interacting with Pedestrians, and Bicyclists

When interacting with pedestrians and bicyclists, around 42% of participants agreed that AVs might face potential conflicts with these vulnerable road users, whereas 18% of participants disagreed with this concern. About 40% of participants hold a fair position regarding this concern.

4.2.7 Concern of AV's Performance during Adverse Weather

In the case of bad weather conditions, around 57% of participants (i.e., 35.56% agree and 21.59% strongly agree) believed that AVs would perform poorly under such adverse conditions. About 10% of people opposed this thought and they believed AVs would perform fine in such weather conditions. There were around 33% of participants who opined neutral about AVs performance in such conditions.

4.2.8 Concerns about Legal Liability Issue during Crash

This was a complex, confusing area for many since there were no clear guidelines stating who would take the legal liability for the crash incident. Since an AV would cause a crash by itself and the owners of the vehicles had no control of the vehicle, nearly 61% of participants were concerned about the legal issues involving a crash. Only around 9% of participants (i.e., 7.3% disagree and 1.9% strongly disagree) thought that it would not be an issue, and the rest 30% of participants gave a fair thought.

4.2.9 Concerns about High Price of AVs

There were around 59% of participants (28.25% agree and 30.79% strongly agree) thought that the price of the AVs would be high. Only 11% of participants did not have concerns about the price of AVs, and they thought they could afford AVs.

4.2.10 Concerns about Losing Pleasures of Driving

A mixed perception was obtained regarding this question of whether participants were concerned about missing the pleasure of manual driving. About 37% of participants thought they would be deprived of the driving opportunity by themselves, while around 27% of the respondents thought they would more enjoy the AVs rather than drive by themselves.

Overall, 51% of the respondents had concerns about different aspects of AVs, and 15% of the respondents were fine with the aforementioned concerns, and they believed it would not be a problem for them. There were around 34% of respondents maintained a neutral position regarding these concerns and opined fair.

4.3 **Ownership of AVs (OW)**

Table 5 shows that there were over 44% of participants (i.e., 17.78% strongly agree and 25.71% agree) expressed highly positive attitudes towards AVs in terms of heightening social status. Besides, around 54% of participants thought that they would feel proud of using AVs, and about 36% of participants believed that their close ones would love to get AVs as a gift or people could use AVs to make their close ones happy. Around 69% of the respondents are interested to try new technologies. Overall, 51% of the respondents implicitly were interested to own the AVs despite all concerns. However, around 12% of the respondents were not prepared to own AVs. 37% of the respondents hold fair opinions regarding having the ownership of AVs.

Table 5 Ownership (OW) of AVs

(unit: %)

Question No	Question	1= Strongly Disagree	2= Disagree	3= Fair	4= Agree	5= Strongly Agree
Q19	I think I would be proud to show the autonomous vehicle to people who are close to me.	1.9	7.62	36.51	29.84	24.13
Q20	I think having an autonomous vehicle would make me have a high profile among my friends/colleagues	4.13	12.38	40	25.71	17.78
Q21	I think people whose opinions are important to me such as my parents would like the autonomous vehicle too.	6.67	12.06	45.4	23.17	12.7
Q22	Are you eager to try new technologies?	0.63	3.49	26.98	36.83	32.06

4.4 **Attitude toward AVs (AT)**

Table 6 shows that the majority of participants (around 50%) felt positive about AVs and would be willing to attain a proper license endorsement (approximately 71%). About 44% of the participants were comfortable sharing location and velocity data with the surrounding vehicles. However, around 43% of participants hesitated to use AVs since they were worried as they believed that if there are any mistakes in decision making or technical issues by AVs, such mistakes can not be corrected and may cause a serious safety problem.

Table 6 Attitude toward AVs (AT)

(unit: %)

Question No	Question	1= Strongly Disagree (in %)	2= Disagree (in %)	3= Fair (in %)	4= Agree (in %)	5= Strongly Agree (in %)
Q23	I think using the autonomous vehicle is a good idea	3.81	4.44	42.22	32.38	17.14
Q24	I hesitate to use the autonomous vehicle system for fear of making mistakes I cannot correct.	3.17	14.6	39.05	29.52	13.65
Q25	I would be comfortable allowing my car to transmit encrypted data, such as its current location and velocity, to surrounding cars in order to better coordinate its path with the surrounding vehicles and keep me safe.	8.25	8.89	38.73	27.3	16.83
Q26	I think that an individual should be required to attain a proper license endorsement, through the Department of Motor Vehicles, in order to legally operate an autonomous vehicle.	0.95	2.86	25.08	31.43	39.68

4.5 **Demographic and Driving Information (DDI)**

The findings from the descriptive analyses of the Q27 to Q32 regarding the Demographic and Driving Information (DDI)are presented in **Table 7** as follows:

4.5.1 Gender

Out of 315 respondents, around 56% were male and 44% were female. The respondents who declined to expose their gender groups were removed from the final analyses. The proportion of the respondents for this survey seems to be very reasonable, and the results obtained from the analyses might represent a fair opinion of almost equal male and female groups.

Table 7 Demographic and Driving Information (DDI)

Question No	Question	Distribution	
		Category	%
Q27	Please specify your gender	Female	44.44
		Male	55.56
Q28	What is your age?	18-20	44.13
		21-25	45.08
		26+	10.79
Q29	What is the highest level of education you have completed?	Associate Degree	39.05
		Bachelor Degree	14.6
		High School/GED	42.54
		Postgraduate degree	3.81
Q30	How many years do you have your driver license?	No Driving Experience	4.13
		1 to 7	84.14
		Over 7	11.73
Q31	How many traffic citations did you get within the last five years?	0	60.32
		1	24.76
		2	7.3
		3	3.49
		More than 3	4.13
Q32	How long is your daily one-way travel time on weekdays?	Less than 30 minutes.	57.78
		30-59 minutes.	32.06
		60-120 minutes.	5.71
		Over 120 minutes.	4.44

4.5.2 Age

As the study was focusing on the young, students and more educated people, the age range for this group of people was defined from 18 years to 30 years (Deb et al., 2017, 2018; Haboucha et al., 2017). Respondents outside this age range were removed from the analyses. However, to better understand the respondents clustering within this range, further subgrouping was performed i.e., 18-20, 21-25, and 26-30. The majority of the respondents (around 45% and 44% of the respondents) belong to the age group from 21 to 25 and 18 to 20 years old. Only around 11% of the respondents fall in the 26 to 30 group.

4.5.3 Education Level

Most of the respondents were found to be undergraduate students with either an associate degree (39.05%) or High School/General Educational Development (GED) (42.54%). Besides, the respondents having a bachelor's degree shared a significant proportion (14.60%). The education level found in this survey is reasonable given the fact that the data was collected from the UCF area, where the dominating respondents group were faculty, staff, and students. In addition, our target group of participants was young educated students as well.

4.5.4 Driving Experience

To assess the driving experience, all the respondents were classified into three categories, i.e., no driving experience, 1 to 7 years, and over 7 years (Machado-León et al., 2016). 84.14% of the respondents had driving experiences of 1 to 7 years. Almost 12% of the respondents had driving experiences over 7 years. Only 4% of the respondents had no driving experience.

4.5.5 Traffic Citations

It was found that around 60% of people did not receive any citations in the last 5 years, which is good in the sense that they followed the rules and regulations. However, around 25 % of people received one citation, around 7% of people received two citations, near 3 % of people received 3 citations, and the rest had received more than 3 citations.

4.5.6 Weekdays Travel Time

The majority of the participants traveled for less than 1 hour during weekdays, with 57.78 % between 0 and 30 minutes and 32.06 % between 30 and 59 minutes. Meanwhile, there were around 10% of people traveled longer during weekdays.

4.6 **Structural Equation Modeling (SEM)**

As a preferred method for analyzing the variables of the perception-based studies (Dirsehan & Can, 2020; Hewitt et al., 2019; J. Lee et al., 2019), Structural Equation Modeling (SEM) was constructed to assess the relationship among the variables described in this study. Primary Perception Regarding AVs (PP), Public concern about AVs (PC), Ownership of AVs (OW), Attitude toward AVs (AT), Demographic and Driving Information (DDI) were considered as the latent variables, and their corresponding 32 questions were considered as the observed variables.

4.6.1 Model Description

SEM has two components: Measurement model and Structure model. The Measurement model examines the relationship between the measured items and the latent items while the Structure model estimates the internal relationship between the latent variables. SEM is defined by the following equation (Byrne, 2013; Fan et al., 1999):

$$Y = \Lambda_y \eta + \varepsilon \quad (1)$$

Where, Y is a vector of the observed variable or indicator of the latent endogenous variable; Λ_y is the matrix of the load factor for Y on η; η is the latent variables and ε is the error vector of the observed variable y. Equation (2) is the vector form of equation (1) when a latent variable η_1 is considered as an example:

$$\begin{pmatrix} y_{11} \\ y_{12} \\ \cdots \\ y_{1n} \end{pmatrix} = \begin{pmatrix} \Lambda_{y1} \\ \Lambda_{y2} \\ \cdots \\ \Lambda_{yn} \end{pmatrix} \eta_1 \quad (2)$$

Where, n is the number of latent exogenous variables on the observed one.

The path coefficient $\Lambda_{y1}, \Lambda_{y2}, \ldots, \Lambda_{yn}$ of the latent variable η_1 are standardized and regarded as the weights of the observed variable, while the assigned weights are represented as $a_{y1}, a_{y2}, \ldots, a_{yn}$ shown below:

$$\begin{Bmatrix} a_{y1} = \frac{\Lambda_{y1}}{\Lambda_{y1}+\Lambda_{y2}+\cdots+\Lambda_{yn}} \\ a_{y2} = \frac{\Lambda_{y2}}{\Lambda_{y1}+\Lambda_{y2}+\cdots+\Lambda_{yn}} \\ \cdots\cdots\cdots\cdots\cdots\cdots \\ \cdots\cdots\cdots\cdots\cdots\cdots \\ a_{yn} = \frac{\Lambda_{yn}}{\Lambda_{y1}+\Lambda_{y2}+\cdots+\Lambda_{yn}} \end{Bmatrix} \quad (3)$$

The value of the latent variable can be obtained by the summation of the product of regression weight and the respective observed variable. For example, the value of the latent variable "Convenience and Comfort" can be obtained from equation (4):

$$\eta_1 = a_{y1}y_{11} + a_{y2}y_{12} + \cdots + a_{y1}y_{1n} \quad (4)$$

All other latent variables in this study can be similarly calculated. In this study, R programming language was used for SEM.

4.6.2 Hypotheses

Six hypotheses were considered in this study to perform the SEM. The hypotheses are as follows:

H1: Primary Perception Regarding AVs has a positive impact on Attitude toward AVs

H2: Primary Perception Regarding AVs has a negative correlation with Public concern about AVs

H3: Demographic and Driving Information has a positive impact on Primary Perception Regarding AVs

H4: Attitude toward AVs has a positive impact on the Ownership of AVs

H5: Public concern about AVs has a positive impact on the Ownership of AVs

H6: Demographic and Driving Information has a positive impact on Ownership of AVs

The rationale for considering those hypotheses is described as follows:

H1: In this study, primary perception regarding AVs (PP) refers to the respondent's primary or basic idea, thinking, and knowledge about different aspects of AVs. Particularly in this study, PP refers to eight aspects of AVs i.e., familiarity with AVs, safety potential of AVs, driving performance of AVs, the productivity of AVs, operational benefits of AVs, driving experience of AVs, attention from users during riding on AVs, and AVs performance during an unexpected situation. On the other hand, attitude toward AVs (AT) refers to the opinions/responses/thinking of the respondents regarding different grey zones of AVs. Particularly in this study, AT refers to respondents' responses about whether AVs would be good or bad, what is thinking about the mistakes made by AVs, how much they are willing to share their personal information, and what is their opinions about the license endorsement. The basis for this hypothesis is that PP might directly or indirectly affect AT (Z. Xu et al., 2018). For example, if a person believes that AVs would not prevent road crashes and ensure safety, he might opine that AVs would be a bad idea (Hulse et al., 2018). On the contrary, if a person has a positive perception regarding AVs, he might have a positive attitude towards AVs as well (González & Brown, 2003). For example, if a person believes that AVs would help him to utilize his traveling time productively, and would drive better than humans, he might be more flexible in sharing his personal information as a trade-off of the expected benefits (Mun et al., 2010).

H2: In this study, public concern regarding AVs (PC) refers to respondents' anxiety, concerns, hesitations, and fear of different aspects of AVs. Particularly in this study, PC refers to the respondent's concerns regarding AVs on driving performance, equipment failures or system failures, privacy issues, security problems, interaction with the human-operated vehicles,

interaction with pedestrians and bicyclists, performance in unexpected traffic situations, legal liability issues, price, and driving pleasure. The rationale for such a hypothesis is that PP might have a direct or indirect impact on PC (Z. Xu et al., 2018). For example, those who are already familiar with AVs, know different technological issues of AVs, and have a primary positive perception about AVs might have fewer concerns about AVs compared to those who are not familiar with those aspects of AVs and feel negative perception about AVs (Moody et al., 2020).

H3: Demographic and Driving Information (DDI) refers to the respondent's relevant information that might affect his opinions regarding any aspects (Nair & Bhat, 2021). Particularly in this study, DDI refers to the respondent's gender, age, education, driving experience, traffic citations, and daily travel time. PP might have a direct relation to DDI (Nair & Bhat, 2021). For example, a person who has a positive primary perception about the driving performance of AVs and a person with a bad record of receiving frequent traffic citations might be more willing to accept AVs (Peterson, 2012; Woldeamanuel & Nguyen, 2018) Reversely, if a person is aged, hates technologies, and is lenient to manual stuff might hold a negative primary perception about all the aspects of AVs (Haboucha et al., 2017; P. Liu et al., 2019; Polydoropoulou et al., 2021; Z. Xu et al., 2018).

H4: Ownership of AVs (OW) refers to the respondent's willingness to own or purchase AVs or at least ride AVs, which may be as a shared mode of transportation. In this study, OW is measured indirectly through the responses of the respondents regarding AVs on whether they would feel proud to own AVs, whether it would increase their social status, whether their close ones will be happy, and whether they are interested to try new technologies. AT might have a positive impact

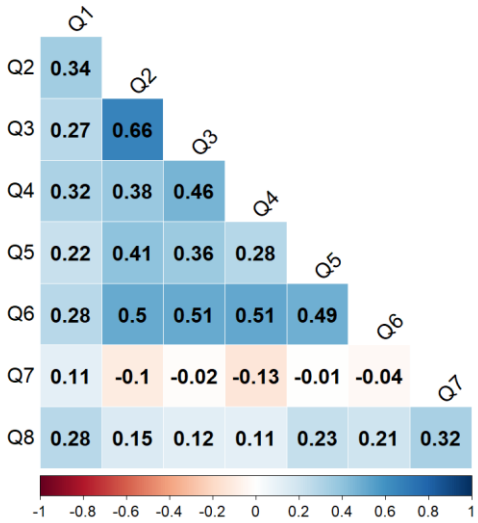
on OW (Wang et al., 2020). For example, if a person feels good about AVs and has no problem sharing his personal information with other AVs users, it is more likely that he feel positive towards new technologies, and will be more willing to accept AVs (Golbabaei et al., 2020; Wintersberger et al., 2019).

H5: PC might directly influence OW (Asgari & Jin, 2019). For example, those people who have any concerns regarding the different aspects of AVs, are more likely to have an aversion to new technologies, and they might feel it would add risk rather than add social status in accepting this new technology (Asmussen et al., 2020; S. H. Kim et al., 2019; Lavieri et al., 2017).

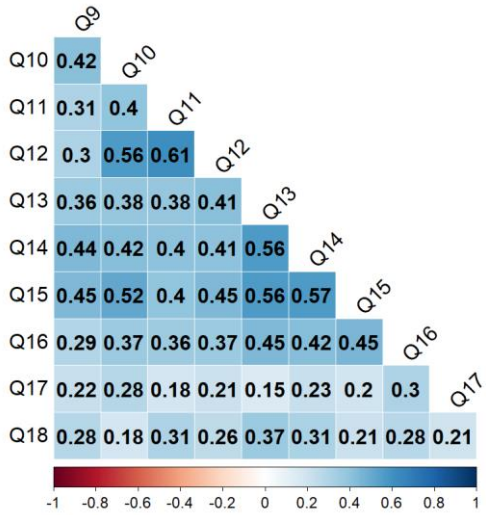
H6: DDI might have a direct or indirect impact on OW (Nodjomian & Kockelman, 2019)(Lavieri et al., 2017). For example, a highly educated person might be lenient to try new technologies, and hence, he would be more willing to accept AVs compared to a person who has less education (Acheampong & Cugurullo, 2019; Gkartzonikas & Gkritza, 2019; Haboucha et al., 2017).

4.6.3 Correlation Matrix

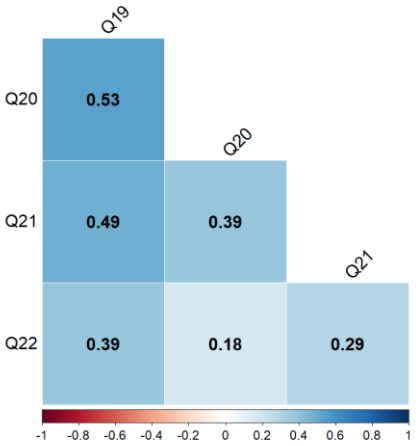
To assess whether the correlations between variables are not extremely large in absolute magnitude, correlation matrix was analyzed. Figure 1 shows the results for each of the considered latent variables used in this study. **Figure 1** shows medium to weak correlations among the variables. Thus, our selection of variables was good.



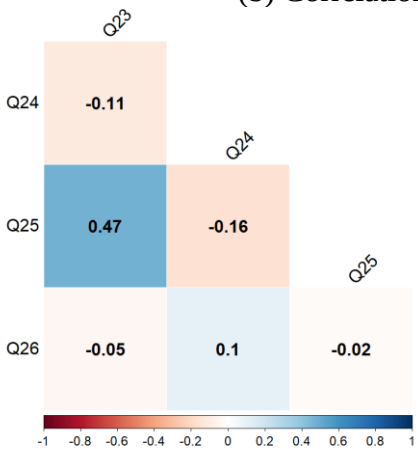
(a) Correlation Matrix for PP



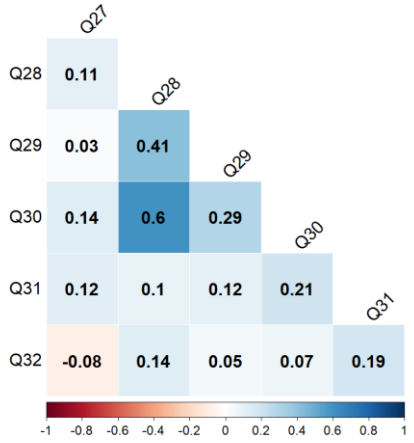
(b) Correlation matrix for PC



(c) Correlation matrix for AT



(d) Correlation matrix for OW



(e) Correlation matrix for DDI

Figure 1 Correlation matrix for latent variables

Table 8 Data Reliability Test

	Cronbach's Alpha	AVE	CR
PP	0.76	0.56	0.98
PC	0.85	0.52	0.99
OW	0.71	0.51	0.95
AT	0.45	0.55	0.94
DDI	0.49	0.50	0.95

(a) Results from Cronbach's-alpha, AVE, and CR

	AT	PP	PC	DDI	OW
AT	**0.741**				
PP	0.421	**0.748**			
PC	-0.372	0.197	**0.721**		
DDI	0.213	0.375	0.541	**0.707**	
OW	0.491	0.221	-0.243	-0.149	**0.714**

*diagonal values are the square root of AVE and other value are correlation value

(b) Correlation Matrix and Discriminant Validity test - Fornell & Larcker criteria

4.6.4 Data Reliability Test

To test the data reliability, Cronbach's-alpha, average variance extracted (AVE), composite reliability (CR), and discriminant validity values were analyzed for each of the latent variables. Results from the data reliability test are shown in **Table 8**.

From **Table 8**, it is evident that the data used for doing SEM is reliable as the AVE, CR, and discriminant validity values are in the acceptable range (Müller, 2019; Yuen et al., 2021).

4.6.5 Path Analyses and Regression Weight of Structural Relationship

Figure 2 shows the path analyses and **Table 9** shows the regression weight of the structural relationship for the SEM. From **Figure 2** and **Table 9** it is evident that AT and PC have a significant relationship with PP, whereas only AT has a significant relationship with OW. This implies that despite the concerns about AVs, people feel positive attitudes towards AVs, and eventually, they would prefer to own AVs.

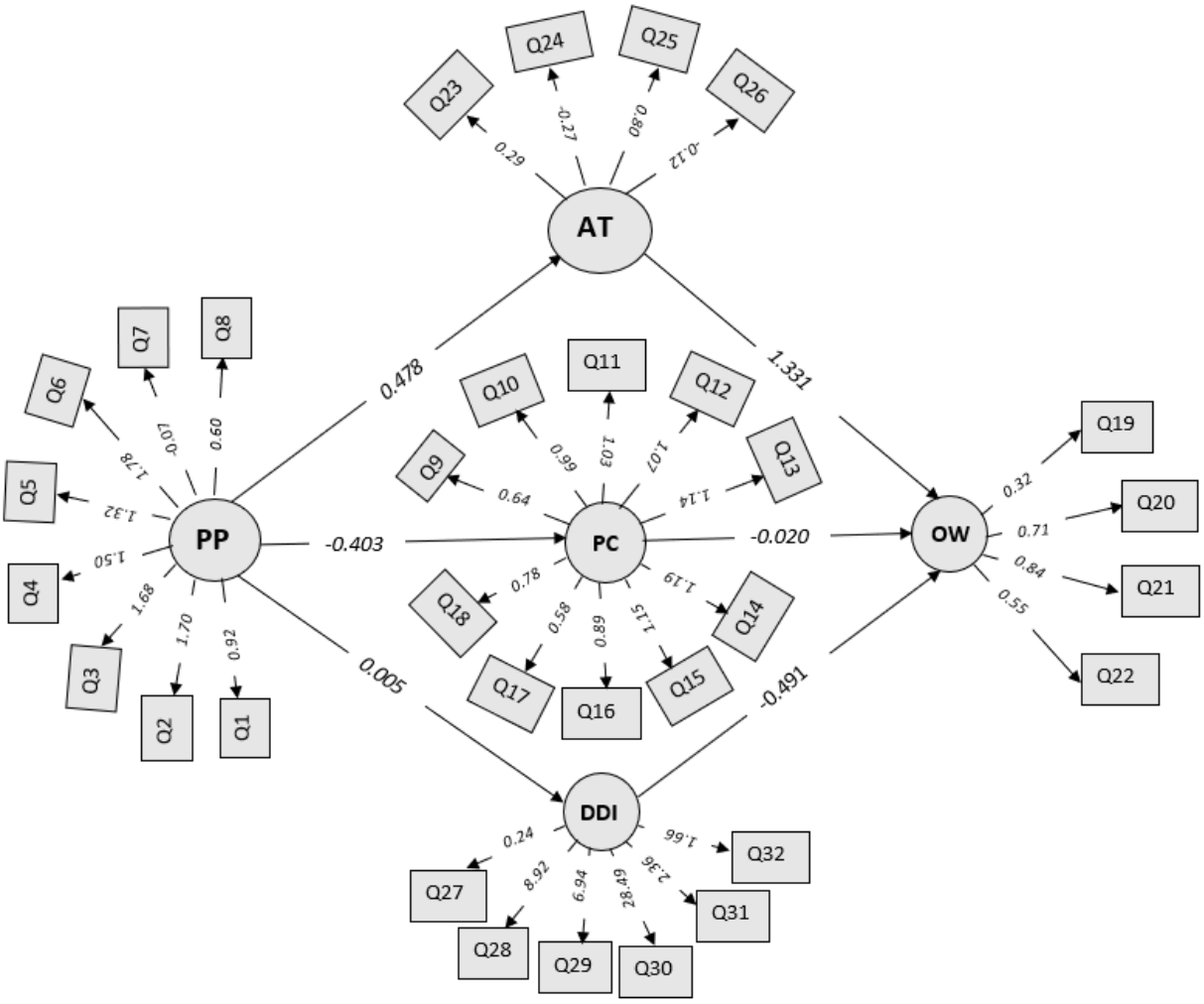


Figure 2 Path Analyses for Structural Equation Modeling

Table 9 Structural Equation Modeling Results

Latent Variable	Observed Variable	Estimate	Standard Error	z-value	p-value
PP	Q1	0.919	0.075	12.173	<0.001
	Q2	1.699	0.238	7.131	<0.001
	Q3	1.682	0.235	7.143	<0.001
	Q4	1.499	0.229	6.547	<0.001
	Q5	1.323	0.208	6.367	<0.001
	Q6	1.779	0.248	7.169	<0.001
	Q7	-0.067	0.135	-0.494	0.622
	Q8	0.601	0.150	4.000	<0.001
PC	Q9	0.642	0.056	11.444	<0.001
	Q10	0.994	0.100	9.925	<0.001
	Q11	1.026	0.112	9.192	<0.001
	Q12	1.066	0.110	9.706	<0.001
	Q13	1.144	0.112	10.229	<0.001
	Q14	1.194	0.114	10.467	<0.001
	Q15	1.147	0.107	10.700	<0.001
	Q16	0.892	0.100	8.964	<0.001
	Q17	0.581	0.105	5.521	<0.001
	Q18	0.782	0.118	6.625	<0.001
OW	Q19	0.321	0.049	6.555	<0.001
	Q20	0.708	0.080	8.860	<0.001
	Q21	0.840	0.080	10.544	<0.001
	Q22	0.549	0.068	8.108	<0.001
AT	Q23	0.285	0.050	5.702	<0.001
	Q24	-0.274	0.078	-3.512	<0.001
	Q25	0.801	0.087	9.182	<0.001
	Q26	-0.115	0.072	-1.595	0.111
DDI	Q27	0.243	0.019	12.503	<0.001
	Q28	8.923	4.251	2.099	0.036
	Q29	6.943	3.356	2.069	0.039
	Q30	28.485	13.475	2.114	0.035
	Q31	2.361	1.474	1.602	0.109
	Q32	1.659	1.076	1.541	0.123

(a) Regression weight of structural relationship

Latent Variable		Estimate	Standard Error	z-value	p-value
PP	AT	0.478	0.074	6.469	<0.001
	PC	-0.403	0.061	-6.570	<0.001
	DDI	0.005	0.006	0.874	0.382
OW	AT	1.331	0.208	6.396	<0.001
	PC	-0.020	0.077	-0.257	0.797
	DDI	-0.491	0.727	-0.676	0.499

(b) Regression weight of structural relationship of Latent Variable

4.6.6 Hypothesis Result

Table 10 shows the hypothesis results from the model run in this study. The first hypothesis was accepted, and it indicates that the primary perception regarding AVs has a positive impact on attitudes toward AVs.

Table 10 Hypothesis Results

Hypothesis	P-value	Results
H1: Primary Perception Regarding AVs has a positive impact on Attitude toward AVs	<0.001	Accept
H2: Primary Perception Regarding AVs has a negative correlation with Public concern about AVs	<0.001	Accept
H3: Demographic and Driving Information has a positive impact on Primary Perception Regarding AVs	0.382	Reject
H4: Attitude toward AVs has a positive impact on the Ownership of AVs	<0.001	Accept
H5: Public concern about AVs has a positive impact on the Ownership of AVs	0.797	Reject
H6: Demographic and Driving Information has a positive impact on Ownership of AVs	0.499	Reject

From **Table 9** it is found that AT has a weight of 0.478 on the total weight of PP. Otherwise, it can be concluded that as more people had positive primary perceptions regarding different aspects of AVs, their attitudes toward AVs will be positively changed. From the second hypothesis, it is found that PC has a weight of -0.403 on the total weight of PP. This implies that as people's perceptions towards AVs get better, people will have less concern regarding the different aspects of AVs. The third hypothesis was rejected, which indicates that whatever the demographic and driving characteristics of the people, these characteristics would not have a significant influence on AVs. The fourth hypothesis with a weight of 1.331 indicates that as the attitude toward AVs becomes more positive, people will feel more positive to possess or use autonomous vehicles. The fifth hypothesis was rejected, which indicates that although people have some concerns regarding the AVs, these concerns will not stop them from having the intention to own the AVs. Hypothesis

six was also rejected, which indicates that demographic and driving characteristics have no significant influence on possessing the AVs. People want to possess the AVs despite their different demographic and driving backgrounds.

4.6.7 Model Fitness

Some model fitness parameters were calculated to check the model fit. Log-Likelihood, Chi-square (p-value), RMSEA, CFI, TLI. AIC, and BIC values were analyzed and are shown in **Table 11**, which indicate an acceptable fit of the model.

Table 11 Model Fitness

Test	Value
Log-likelihood	-13116.664
Chi-square (p-value)	1153.742 (<0.001)
RMSEA	0.069
CFI	0.780
TLI	0.762
AIC	26373.328
BIC	26636.008

4.7 **Discussion**

This section will mainly focus on the implications of the findings of the current study, and how these findings can be utilized for the policy implication and adoption of AVs. Particularly this study focused on a particular user group who might be the most potential users of AVs. Initial descriptive data analyses of the respondent's responses on 32 specific questions helped to reveal the information of this particular user group on their primary perceptions, concerns, and attitudes towards AVs. Also, the in-depth findings illustrated their intention to possess AVs and their demographic and driving characteristics. The findings showed that a large percentage of the respondents were already familiar with AVs and the majority of them had positive primary perceptions regarding different aspects of AVs. Particularly they had faith in the benefits that are

expected from AVs i.e., AVs would decrease the crash risk, operate better than human drivers, would be more productive by allowing them to utilize their driving time for some other work/rest, would reduce their travel time, would offer a more enjoyable trip, and would enable them to take control in any unexpected/complicated situations. However, they had a wide range of concerns regarding the different aspects of AVs. Particularly they had concerns about the driving performance, equipment failures or system failures, privacy and security issues, interaction with human-operated vehicles and non-vulnerable road users, poor performance during adverse situations, legal liability, and price. They also feared that they might lose the pleasure of driving and need to pay constant attention when AVs would be driving. Despite many concerns, the majority of the respondents were willing to possess AVs and they had the feeling that AVs would heighten their social status and bolster their social relationships. Their attitudes towards AVs on different grey zones i.e., sharing locations and velocity information and legal license endorsement were flexible and lenient towards accepting this new technology. Their demographic and driving information also ensured a wider and equal range of opinions from this particular user group. Structural equation modeling-related analyses revealed much important information regarding the relationship among the considered aspects in this study. Particularly the model and hypotheses results showed that primary perception regarding AVs and attitudes towards AVs are strongly correlated and they have a direct influence on each other. For example, if a person has a positive primary perception regarding the expected benefits of AVs, he might be more flexible to accept sophisticated aspects of AVs since his attitudes and perceptions combinedly persuade him to be more lenient towards AVs. In such cases, he would be comfortable sharing his personal real-time information without the hesitation of privacy and security issues. The study also found that the primary positive perception has a direct impact on the concerns of the respondents regarding the

negative aspects of AVs, and it showed that if the respondents feel positive towards different aspects of AVs, their concerns regarding the negative aspects of AVs will be minimized. For example, if a respondent believes that AVs would drive better than humans, then his concerns related to the AVs driving performance will be minimized. Again, if a person believes that AVs would allow him to take over the control in any adverse situations, he might be confident in relying on AVs and hence, minimize the concerns regarding the safety issues of AVs. The study also showed that demographic and driving characteristics do not have a direct influence on the primary perception of AVs. This implies that whatever the backgrounds if somehow the primary perceptions of this user group are positive towards AVs, they would be more lenient towards accepting and adopting AVs, and their backgrounds would have the least impact in such cases. Again, the study showed that the attitudes of the respondents towards AVs would influence the intention to possess the AVs. This implies that if a person feels that he is comfortable in sharing his location information, ready to attain proper license endorsement, and overall AVs would be a good idea, it is highly likely that he feels positive about accepting new technologies and heightening the social status through possessing new technologies. The study revealed that the negative concerns had no influence on the decision of possessing the AVs, and this implies that it is very normal to have doubts and confusion when a new technology or mode of transportation is introduced, however, it is the responsibility of the policy-makers and AVs companies to take initiatives to clarify those doubts so that people feel more confident to use AVs, although their concerns might not affect their decision to possess AVs. Finally, the study also found that the driving and demographic backgrounds would not affect the intention to possess AVs and this implies that this particular user group, despite their age, gender, education, traffic citation records, driving experience, and traveling time will be interested to possess or use AVs in the future.

These findings provide strong messages to the policymakers, AV companies, and all relevant stakeholders associated with the manufacturing, production, publicity, adoption, and implementation of AVs. As any business or commodity targets a particular population, the AV companies should focus on the perceptions, concerns, and attitudes of the likely early adopters of AVs. As the study highlighted these aspects from the views of the young, students, and educated generation, who are expected to be the first user adopters of AVs in the near future, the companies should consider these aspects and make their future plan of marketing and publicity. Although the policy is made for all the population, during making the policy, the thoughts of this particular user group, as revealed in this study, should be given special consideration. This will help to reflect and fulfill the expectations of this potential user group. In addition, there is a strong wide to build a positive vibe and publicity among future users, as the study revealed, the more they feel positive perceptions and attitudes towards AVs, it is more likely that they are going to accept that future mode of transportation. Further, a well-planned program is required to clarify the doubts and concerns of the people regarding the different negative aspects of AVs. Real-life field demonstration, free riding, and other means, which will offer the users to experience the AVs closely, will help to build a more clean image of AVs, and hence minimize the concerns for AVs. Finally, a combined effort from all the stakeholders of AVs will help to build more positive primary perceptions and attitudes and minimize the concerns for successful mass-scale adoption of AVs.

4.8 **Overview**

This chapter discusses the results and interpretation from the in-depth analyses of the data collected from the questionnaire survey to assess the perceptions of the most potential users of AVs.

CHAPTER 5: PROPOSED QUESTIONNAIRE

This chapter proposes two main contents for the proposed questionnaire: a) general content b) special content. The general content is applicable to all studies which seek to assess the perceptions of people regarding AVs. This content consists of 4 main categories i.e., perceptions, concerns, expected benefits, and ownership. Whereas the special content is applicable in addition to the general content for specific types of studies i.e., Shared AVs (SAVs), vulnerable road users' perception studies, after riding perception studies and so on. The purpose of such division of contents was to examine the general scenarios which are applicable to all AVs related studies and analyze the special cases by adding it with the general content considering circumstances that match with special content. **Figure 3** shows the layout of the proposed questionnaire.

5.1 General Content

In the general content, there are 4 main categories on which the perception of the user will be used. These 4 categories along with their sub-categories are described as following:

5.1.1 Perception

This refers to how they think/feel/perceive on certain aspects of AVs (Das, 2021; Hewitt et al., 2019; J. Lee et al., 2019; H. Liu et al., 2019; Yuen, Wong, et al., 2020). Under this category, perception of the respondents will be assessed based on the following sub-categories:

5.1.1.1 Self-Efficacy

Under this category, perception of the respondents will be assessed regarding whether they will be able to operate the AVs by themselves or they will need help from others. Under self-efficacy, following questions are proposed: I can use if someone show me how to use it; I can use without help from others; I can use although I have never used it; I think my learning time will be less to operate AVs.

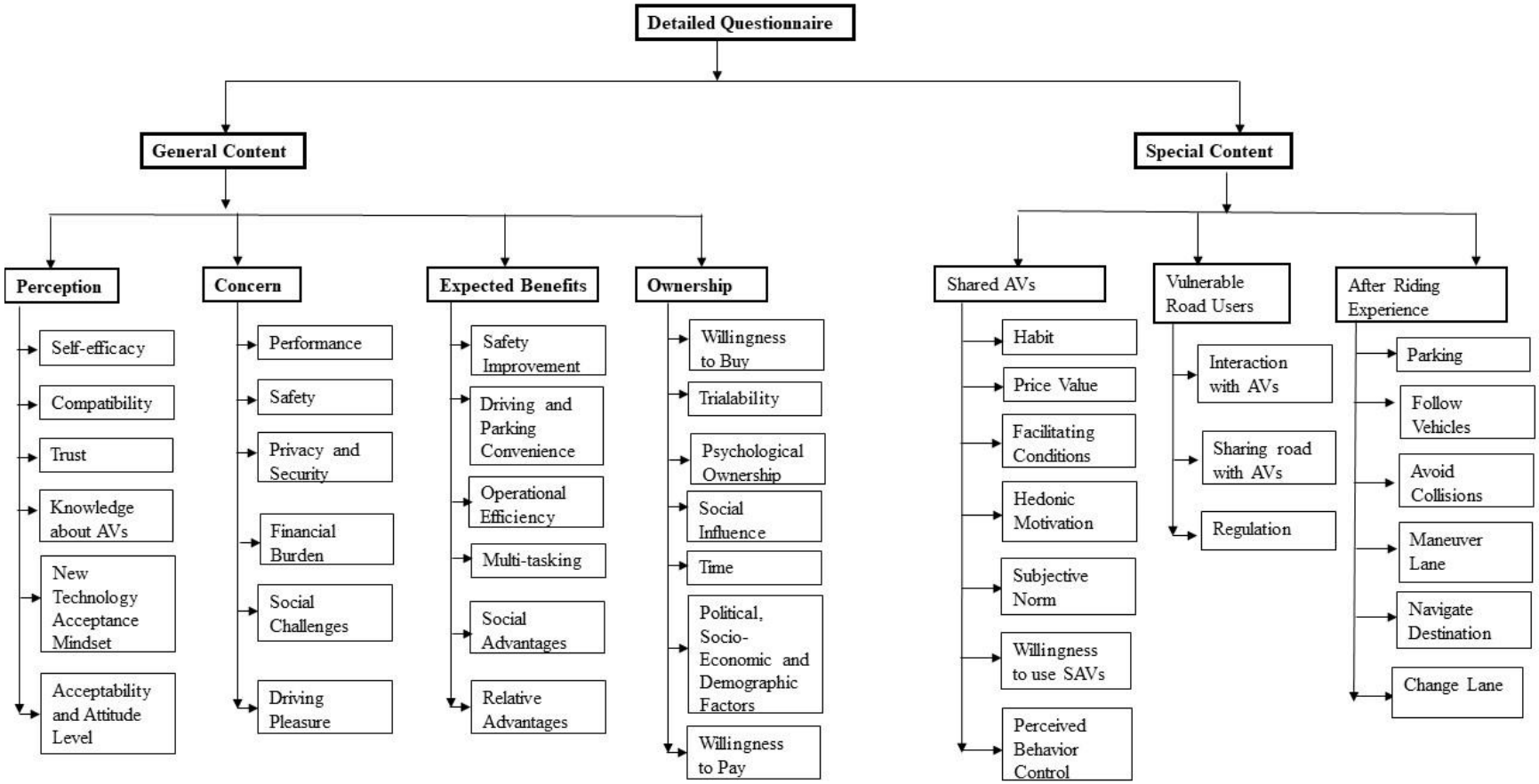


Figure 3: Layout of the proposed Questionnaire

5.1.1.2 Compatibility

How the AVs suit with the respondent belief, driving habit, mobility needs, and everyday life will be assessed under this category. Following questions under this category are proposed: AVs will be in line with my beliefs; AVs will fit well with my driving habits; AVs will be compatible with my mobility needs; AVs will suit me well; AVs will be in line with my everyday life.

5.1.1.3 Trust

Whether the respondents trust the AVs technology, and what's their reliance on such technology will be assessed though category. Following questions are proposed to assess the trust of the respondents on AVs: Are AVs Dependable; Are AVs Reliable; What is your overall trust on AVs; Do you have trust on Driving Skill; Do you think trust on AVs will depend on car manufacturer reputations.

5.1.1.4 Knowledge about AVs

Individual level of knowledge about the AVs technology will be assessed through this category. Particularly following assessments will be done in this category: Are you familiar with technology; Do you know what AV means; Do you think there is influence of mass media and social media in spreading the knowledge of AVs.

5.1.1.5 New Technology Acceptance Mindset

Perception regarding new technology acceptance mindset might have impact on adoption of Avs. Hence, this category has been included under perception. Particularly questions under this category will try to assess how they are interested or willing or habituated to assess the new technology.

5.1.1.6 Acceptability and Attitude Level

Whether the respondents are prepared to accept AVs and how they feel about accepting the AVs will be assessed through this category. Only one question is proposed in this category and that is,

what is the overall acceptability level of AVs to you? Finally, what is the overall feeling/perception/attitude towards AVs will be assessed though this category.

5.1.2 Concern

From the previous literatures, it is found that respondents have many concerns and problems regarding the different aspects of AVs (Cunningham et al., 2019; Hilgarter & Granig, 2020; M.-K. Kim et al., 2019; Lijarcio et al., 2019; H. Liu et al., 2019; Zajc et al., 2020). This section tries to summarize the different concerns of the respondents under specific categories as following:

5.1.2.1 Performance

Respondents have significant concerns about the performance of AVs, particularly following questions are proposed to assess their concern regarding the performance of AVs: AVs may have low performance in poor weather; AVs may not perform like human; AVs might not well and create problems; AVs may not work properly; AVs may perform unstably and incorrectly.

5.1.2.2 Safety

There are huge safety concerns regarding AVs, and most of the previous studies considered this with high importance. Particularly to assess the safety concern, following questions are proposed: AVs won't be able to respond to unexpected situation; There might be safety concern during the interaction with non-self-driving vehicles; During journey, there might be system failures; It is not safe to allow children to ride AVs.

5.1.2.3 Privacy and Security

When the system will be connected and they will have to share their location, speed and other information, general people have a wide range of concerns regarding the privacy and security of the AVs. Particularly following can be assessed: Hackers might get access to their information and hack the AVs; There might be a concern regarding the disclosure of privacy.

5.1.2.4 Financial burden

Since AVs will use modern technology and it is expected that the price will extremely be high to bear for the users, they might have the following concerns to be assessed: I fear the burden of initial purchasing costs; I fear the burden of maintenance costs.

5.1.2.5 Social challenges

As only financially solvent people can buy AVs, it might create social divides. In addition, as it will be a self-driving car, the professional drivers will lose jobs, that might create unemployment. Hence, followings questions are proposed under this category: Legal liability during an accident is not clear; There is difficulty in introducing social system; AVs may create of new social divides; Initial infrastructure to be built for AVs might be costly; The route map for AVs might be confusing; There will increase in unemployment after introduction of AVs.

5.1.2.6 Driving Pleasure

Whether the respondents will miss their manual driving habit, or they are going to enjoy the AVs will be assessed though this category. Only one question is in this category and that whether they are going to lose driving pleasure.

5.1.3 Expected Benefits

General people have a lot of expectations regarding the positive outcomes and relative advantages from AVs (Cunningham et al., 2019; Hewitt et al., 2019; Y.-C. Lee & Mirman, 2018; Yuen, Huyen, et al., 2020). Based on the rigorous literature review, following sub-categories are proposed:

5.1.3.1 Safety Improvement

As approximately 94% crashes occur due to human error (Das et al., 2020), it is expected that with the introduction of AVs safety will be improved significantly. However, people belief on the safety improvement perspective can be assessed using the following questionnaire: AVs will prevent

vehicle crashes; AVs will prevent vehicle failure; AVs will be able to respond adequately to unexpected situations; AVs will be able to monitor driver status.

5.1.3.2 Driving and parking conveniences

How the driving and parking convenience will be improved through the introduction of AVs can be assessed using the following questions: AVs will reduce driving stress; AVs will improve parking convenience; AVs will reduce driving stress; Interaction with AV is clear.

5.1.3.3 Operational efficiency

It is expected that the operational efficiency will be highly increased through the introduction of AVs. To assess the perception regarding operational efficiency, following questions are proposed: AVs will save fuel costs; AVs will reduce insurance rates; AVs will reduce travel time; AVs will reduce repair cost; AVs will decrease congestion.

5.1.3.4 Multitasking

It is expected that people will save their time in car by doing multiple things. People perspective on the following issues can be evaluated through the following questions: I can take break during riding AVs; I can enjoy entertainment; I can do productive work; My driving effectiveness will be increased; I can spend quality time with children; Overall, AVs will be useful.

Table 12 shows the proposed general content questionnaire for assessing people's perception regarding AVs.

Table 12: Proposed Questionnaire for General Content

Major Category	Sub Category under Major Category	Questions to Measure the Responses	Way to Measure Responses
Perception	Self-efficacy	I can use AVs if someone shows me how to do it first.	Likert Scale: 1 = strongly disagree to 7 = strongly agree
		I can use without help from others.	
		I can use AVs although I had not used it before.	
		I would not spend much time to learn how to use	
	Compatibility	AVs would be in line with my beliefs.	
		AVs would fit well with my driving habits.	
		AVs would be compatible with my mobility needs.	
		AVs would suit me well.	
		AVs would be in line with my everyday life.	
	Trust	I trust that AVs can drive without assistance from me.	
		I trust AVs to be safe and reliable in severe weather conditions.	
		I would trust the driving skills of AVs more than my own driving skills.	
		AVs can be trusted to carry out journeys effectively	
		My trust in AVs will be based on the car manufacturer's reputation for safety and reliability.	
		My trust in AVs will be based on the reliability of the underlying technologies.	
	Knowledge about AVs	I know what autonomous veicle means.	
		I am familiar with the AVs technology.	
		I know what different autonomy level means in regard to AVs.	
		Mass and social media help me adequately to know about AVs	
	New Technology Acceptance Mindset	I am usually the first to try out new technologies.	
		I have deeper knowledge regarding new technologies than others	
		I am excited about the possibilities offered by new technologies	
		I am very positive to try out new technologies	
	Acceptability and Attitude Level	I have very positive attitude to accept AVs.	
		Overall, I want to accpet AVs.	

Category	Sub-Category	Questions to Measure the Responses	Scale
Concern	Performance	AVs may have low performance in poor weather.	Likert Scale: 1 = strongly disagree to 7 = strongly agree
		AVs might not drive as well as human.	
		AVs may not perform well and create problems.	
		AVs may not have proper driving control.	
		AVs may perform unstably and incorrectly.	
	Safety	AVs may not smart enough to gurantte my safety.	
		AVs may have unsafe interaction with human-driven vehicles.	
		AVs might not be safe for children.	
		AVs might have equipment and system failure, which may cause accidents.	
	Privacy and Security	AVs might be prone to damage from hacking.	
		There is high probability of disclosure's of driver's privacy.	
	Financial Burden	It will be burden for me to bear the initial purchasing cost of AVs.	
		It will be difficult for me bear the maintenance cost of AVs.	
	Social Challeges	Legal liability in case of accidents or any occurrence is not clear.	
		There is difficulty in introducing AVs in social system.	
		AVs route map might be complex.	
		Infrastures for AVs will be costly and my country might not bear it.	
		Drivers and other people associated with transport sector will lose job due to AVs.	
	Driving Pleasure	I will miss the pleasure of driving by myself.	
Expected Benefits	Safety Improvement	AVs will reduce traffic crashes on roads.	
		AVs will prevent vehicle failure.	
		AVs will respond adequately in unexpected/hazardous situation.	
		AVs will be able to check driving status and take appropriate actions to prevent crashes.	
	Driving Convenience	AVs will reduce mental efforts in driving.	
		AVs will ensure parking conveniece.	
	Operational Efficiency	AVs will save fuel cost.	
		AVs will reduce repair cost.	
		AVs will decrease congestion.	
		AVs will reduce insurance cost.	
		AVs will reduce travel time.	

Major Category	Sub Category	Questions to Measure the Responses	Scale
Expected Benefits	Multi-tasking	I can take break as AV will be driven by itself.	Likert Scale: 1 = strongly disagree to 7 = strongly agree
		I can enjoy entertainment as AV will be driven by itself.	
		I can do productive works as AV will be driven by itself..	
		AVs will enhance driving effectiveness.	
		I can give time to my children/friend/family as AV will be driven by itself.	
		Overall, AVs will be useful and I can utilise my time during riding AVs.	
	Social Advantages	AVs will reduce traffic congestion.	
		AVs will reduce fuel emission.	
		AVs will improve accessibility.	
		AVs will improve mobility.	
		AVs will reduce vehicle emisssions and pollution.	
		AVs will increase disabled mobility.	
		AVs will strengthen respect and co-existence on the road.	
		AVs will reduce overall transportation cost.	
	Relative Advantages	AVs will be advantageous in driving compared to existing vehicles.	
		AVs will enable me to accomplish tasks more quickly compared to existing vehicles.	
		AVs will give effective functions for driving compared to existing vehicles	
		AVs will give greater control of driving compared to existing vehicles.	
Ownership	Willingness to Buy	I intend to ride AVs in the future.	
		I intend to buy AVs in the future.	
		I will recommend family members and friends to ride/buy AVs.	
	Trialability	Before I decide to buy an AV, I would like to test-drive it.	
		Before I decide to buy an AV, I would like to borrow it for a day or two.	
		Before I decide to buy an AV, I would like to try a friend's AV.	
		Before I decide to buy an AV, I would like to view a demonstration of using an AV.	
		Before I decide to buy an AV, I would like to receive training or attend a course.	
	Psychological Ownership	I would think an autonomous vehicle is mine.	
		I would feel very high degree of personal ownership for the autonomous vehicle.	

Major Category	Sub Category	Questions to Measure the Responses	Scale
Ownership	Social Influence	People that I respect may think that I should make use of an AV.	Likert Scale: 1 = strongly disagree to 7 = strongly agree
		People who are important to me may influence my decision about using AV.	
		People whose opinion I value may influence my choice of purchasing an AV.	
		People who influence my behavior may think that I should use an autonomous vehicle.	
	Time	I will consider AVs when they are available in market.	
		I will consider AVs after my friends/close ones start using AVs.	
		I will start using AVs when they are common in roads.	
	Political, Socio-Economic and Demographic Factors	Please specify your Age	These can be open ended questions. Based on the study purpose and context, convenient grouping for each item can be done
		Please specify your Gender	
		Please specify your Income	
		Please specify your political ideology	
	Willingness to Pay	I am willing to pay extra money money to avail AVs.	Likert Scale: 1 = strongly disagree to 7 = strongly agree

5.1.3.5 Social advantages

Although there is concern regarding social divides by the introduction of AVs, there is a high expectation of positive changes in society. People perception on the followings can be assessed: AVs will reduce traffic congestion; AVs will reduce fuel emissions; AVs will improve mobility; AVs will reduce vehicle emissions; AVs will facilitate disabled mobility; AVs will strengthen respect on road; AVs will reduce transport cost.

5.1.3.6 Relative Advantages

People's perception regarding AVs compared to traditional cars can be compared by assessing the following questions: Overall, AVs will be better than traditional cars; AVs will have better control than traditional car, AVs will be quicker than traditional car; AVs will be more effective than traditional car.

5.1.4 Ownership

People willingness to own the AVs is very important (Asgari & Jin, 2019; H. Liu et al., 2019; Mack et al., 2021; Zhang et al., 2020) and their opinions regarding this can be evaluated following the frame proposed below:

5.1.4.1 Willingness to buy

It is necessary to know whether they are really interested to buy the AVs. Following questions are proposed to assess the user's willingness: I intend to use the AVs in the future; I intend to buy the AVs in the future; I recommend family members and friends to buy AVs.

5.1.4.2 Trialability

Before buying, whether the general people are interested to give trial can be assessed using the following questions: I want to give test drive before buying; I want to borrow AVs for a day/two

before buying; I want to try my friend's AVs before buying; I want to view demonstration before buying; I want to receive training before buying.

5.1.4.3 Psychological Ownership

Psychological ownership is important in case of AVs, and the perspectives of the general people can be assed based on the following questions: I think an autonomous vehicle is mine; I feel high degree of personal ownership.

5.1.4.4 Social Influence

Opinion of the close people may influence the intention of buying or not buying the AVs and hence, it is required to know the following: I want to buy AVs if respected people recommend; I want to buy AVs if important people recommend me; I want to buy AVs if valuable people recommend me; I want to buy AVs if influential people recommend me.

5.1.4.5 Time

The respondent intention to buy the AVs after it becomes available to market is important to know.

5.1.4.6 Willingness to Pay

Whether the respondents are willing to pay extra money and how much they will be willing can be an interest in AVs based studies.

5.1.4.7 Political, Socio-Economic and Demographic Factors

Same question might receive varying answers for different political, socio-economic and demographic perspectives. Hence, it is required to analyze the political ideology, geographical location, socio-economic characteristics, personality traits, and demographic characteristics.

Table 13: References for the Variables Used in General Content

References	Perception						Concern						Expected Benefits						Ownership						
	Self-Efficacy	Compatibility	Trust	Knowledge about AVs	Technology	Acceptance &Attitude	Performance	Safety	Privacy and Security	Financial Burden	Social Challenges	Driving Pleasure	Safety Improvement	Driving Conveniences	Operational Efficiency	Multitasking	Social Advantages	Relative Advantages	Willingness to Buy	Trialability	Mental Ownership	Social Influence	Time	Willingness to Pay	Demographic Factors
Kim et al. (2019)							*	*	*	*	*	*	*	*	*	*	*								
Liu et al. (2019)			*			*		*	*	*	*	*												*	
J. Lee et al. (2019)	*						*									*		*	*		*				
Yuen, Wong, et al. (2020)	*	*	*													*	*	*		*			*		
Ge et al. (2019)		*	*			*		*	*		*		*	*							*				
Koul & Eydgahi (2019)								*	*		*								*			*			*
Lijarcio et al. (2019)								*	*	*			*				*	*					*		
Bansal et al. (2016)				*			*	*	*		*		*		*	*	*	*						*	*
Rovira et al. (2019)			*																			*			*
Dirsehan & Can (2020)	*		*											*	*	*	*		*						
Yuen, Huyen, et al. (2020)						*								*	*		*		*				*		
Penmetsa et al. (2019)																									
Das et al. (2020)				*									*												
Gurumurthy & Kockelman (2020)									*															*	
Stoma et al. (2021)				*					*	*	*														
Kyriakidis et al. (2020)													*	*	*	*			*						
Zajc et al. (2020)							*		*		*					*									
Ackaah et al. (2021)				*				*								*			*						*
Hilgarter & Granig (2020)			*			*		*	*		*														

References	Perception						Concern					Expected Benefits							Ownership						
	Self-Efficacy	Compatibility	Trust	Knowledge about AVs	Technology Acceptance	Acceptability & Acceptance	Performance	Safety	Privacy and Security	Financial Burden	Social Challenges	Driving Pleasure	Safety Improvement	Driving Conveniences	Operational Efficiency	Multitasking	Social Advantages	Relative Advantages	Willingness to Buy	Trialability	Mental Ownership	Social Influence	Time	Willingness to Pay	Political, Socio-Economic and Demographic Factors
Hewitt et al. (2019)	*		*				*	*					*	*	*				*	*		*	*		
Das (2021)				*					*				*												
Moody et al. (2020)				*				*					*										*		
Cunningham et al. (2019)							*	*	*	*			*	*	*	*	*	*					*	*	
Pyrialakou et al. (2020)				*					*				*					*							*
Woldeamanuel & Nguyen (2018)			*	*	*	*		*		*	*														
Wang et al. (2020)			*	*		*	*		*					*										*	
Jing et al. (2019)				*		*			*										*						
Y.-C. Lee & Mirman (2018)							*														*				
Zhu et al. (2020)	*			*					*										*			*			
Mack et al. (2021)	*						*	*	*	*	*		*	*	*		*		*						*
Nair & Bhat (2021)				*			*	*			*								*						*
Rahman et al. (2021)	*			*				*			*						*	*							
Hussain et al. (2021)						*		*	*				*	*	*				*						*
X. Xu & Fan (2019)						*			*										*					*	*
Al Barghuthi & Said (2019)							*	*	*		*														
Asgari & Jin (2019)														*	*	*	*		*					*	*
Zhang et al. (2020)			*						*									*	*			*			
Kassens-Noor et al. (2021)																			*						*
S. S. Ahmed et al. (2020)								*	*				*												*

References	Perception						Concern						Expected							Ownership						
	Self-Efficacy	Compatibility	Trust	Knowledge about AVs	New Technology Acceptance Mindset	Acceptability and Attitude Level	Performance	Safety	Privacy and Security	Financial Burden	Social Challenges	Driving Pleasure	Safety Improvement	Driving and Parking Conveniences	Operational Efficiency	Multitasking	Social Advantages	Relative Advantages	Willingness to Buy	Trialability	Psychological Ownership	Social Influence	Time	Willingness to Pay	Demographic Factors
Zhang et al. (2019)	*		*			*			*			*	*	*	*	*	*		*						
Hulse et al. (2018)	*						*																		*
Hegner et al. (2019)			*				*	*	*					*	*	*	*	*	*				*		
Tennant et al. (2019)																									
Choi & Ji (2015)	*		*				*			*						*			*						
Yuen et al. (2021)	*	*												*	*	*	*	*	*	*		*	*		
Guo et al. (2021)	*	*						*	*	*			*	*				*	*						
Park et al. (2021)	*															*			*			*			*
Z. Xu et al. (2018)	*		*										*	*		*			*						
Raue et al. (2019)			*	*				*											*						
Manfreda et al. (2021)					*		*	*	*	*	*		*	*	*	*	*		*						
Islam et al. (2022)	*	*		*	*		*	*	*			*	*	*	*	*		*	*			*			*

*denotes that this particular variable was chosen from the corresponding reference

The references of the above general questions under different proposed categories and sub-categories are shown in the **Table 13**.

5.2 Special Content

In addition to the general content, additional assessment should be made in special cases. Based on the review of the 50 mentioned papers in this study, the following special cases have been observed (Cunningham et al., 2019; Das et al., 2020; Penmetsa et al., 2019; Tennant et al., 2019; Yuen, Huyen, et al., 2020), for which extra response from the respondents might be required.

5.2.1 Shared AVs (SAVs)

SAVs are the focus of policymakers since it can provide the maximum societal benefits. However, there are issues that need to be assessed separately. Following sub-categories are described as following:

5.2.1.1 Habit

Since people are not habituated to use the SAVs, so how is their perceptions about the followings need to be assessed: I believe sharing AVs with others would become my habit; I can use SAVs without thinking; Using SAVs would become my part of daily routine; I can be addicted to SAVs.

5.2.1.2 Price Value

Whether the SAVs would be a cheaper option compared to privately owned AVs need to be evaluated using following questions: SAVs will save more money; SAVs should have Cheap deals; SAVs will provide better value for money; SAVs should have some promotional offer.

5.2.1.3 Facilitating Conditions

SAVs facilitating conditions are different from the privately owned AVs. Hence, it is important to assess the following questions: Government is active to promote SAVs; SAVs would be more safer; SAVs would be compatible with other modes of transportation; Others can help in case of emergency while using SAVs.

5.2.1.4 Hedonic Motivation

What will be the feelings of the respondents when they will be offered SAVs instead of traditional public/private transport or AVs can be assessed using the following questions: SAVs will be fun; SAVs will be enjoyable; SAVs will be pleasant.

5.2.1.5 Subjective Norm

People might be biased in making decision regarding SAVs, and hence, their perception regarding the following should be assessed: I will travel if my friends do; : I will travel if travel if family does, : I will travel if others refer; SAVs will be norm on road.

5.2.1.6 Willingness to use SAVs

How much people might be interested to use SAVs in different payment and delay conditions as well as at night should be assessed. For example, they might be willing to share at particular rate without delaying for others, whereas, they might be interested to share in a different rate with delaying for others.

5.2.1.7 Perceived Behavior Control

How people will react regarding SAVs in the following circumstances might be analyzed using the following questions: I will use SAVs if I have the necessary resources; I will use SAVs if I have the necessary knowledge; It is completely up to me whether I will use it or not.

Table 14 shows the proposed special content questionnaire for assessing people's perception regarding AVs.

Table 14: Proposed Questionnaire for Special Content

Major Category	Sub Category	Questions to Measure the Responses	Way to Measure Responses
SAVs	Habit	Using SAVs would become a habit for me.	Likert Scale: 1 = strongly disagree to 7 = strongly agree
		Using SAVs would be something I do without thinking.	
		Using SAVs would be a part of my daily routine.	
		I would be addicted to using SAVs.	
	Price Value	I could save money by using SAVs.	
		I would like to search for cheap deals in SAV services.	
		SAVs would offer better value for money.	
		SAVs would offer valuable promotions for me.	
	Facilitating Conditions	Government is active in setting up facilities for SAVs.	
		Advances in technology will enable safer SAVs.	
		SAVs would be compatible with other forms of transport I use.	
		I would be able to get help from others when I have difficulties using SAVs.	
	Hedonic Motivation	Using SAVs would be fun.	
		Using SAVs would be enjoyable.	
		Using SAVs would be pleasant.	
	Subjective Norm	I will travel in a SAV if my friends does the same.	
		I will travel in a SAV if my family does the same.	
		SAVs will be the norm on our roads in the future.	
	Willingness to use SAVs	I will use SAVs if I don’t need any additional time for others.	
		I will use SAVs if I need 5 minutes maximum additional time for others.	
		I will use SAVs if I need 30 minutes maximum additional time for others.	
		I have no problem use SAVs at night.	
		I am willing to pay during using SAVs.	
	Perceived Behaviour Control	I will have the necessary resources, time and opportunities to use SAVs.	
		I will have the necessary knowledge to use SAVs.	
		Whether or not I use SAVs when traveling is completely up to me.	

Major Category to be Measured	Sub Category under Major Category	Questions to Measure the Responses	Way to Measure Responses
Vulnerable Road Users	Interaction With AVs	Interaction with AVs while using sidewalk and crosswalk will be safe.	Likert Scale: 1 = strongly disagree to 7 = strongly agree
		Interaction with AVs while riding bycycle will be safe.	
		As a pedestrian or byclist, I will feel safe to interact with AVs.	
	Sharing road with AVs	AVs can safely share road with human-driven vehicles.	
		I am in favor of apporving AVs to use public roads.	
		As a pedestrian or byclist, I will feel safe to share road with AVs.	
	Regulation	There should be specific speed regulation for AVs.	
		There should be specific data sharing regulation for AVs.	
		AVs should not be allowed in active school zone.	
After Riding Experience	Parking	AV can park the vehicle properly.	
	Follow Vehicles	AV can follow the vehicle ahead at safe distance by itself.	
	Avoid Collision	AV can avoid collision with other vehicles and road users (e.g., pedestrian) by itself.	
	Manuever Lane	AV can stay within the lane by itself.	
	Adjust Speed	AV can automatically adapt its speed to changing speed limit.	
	Navigate Destination	AVs can navigate itself to desired destination (find location and follow route).	
	Change Lanes	AV can change lanes by itself.	

5.2.2 Vulnerable Road User Perception

Pedestrians and bicyclists are considered to be the vulnerable road users. Their perception on interacting with AVs, sharing road with AVs and regulation in sharing data, speed, school zone and safety potential should be assessed.

5.2.3 After Riding Perception

If it is possible, after riding perception might be assessed since several studies reported that perception vary with time and first-time perception of interacting with anything might be different than the later time perceptions.

The references of the above special questions under different proposed categories and sub-categories are shown in the **Table 15**.

5.3 Overview

This chapter presents the details description, references and justification for proposing the organized questionnaire.

Table 15: References for the Variables Used in Special Content

References	Shared AVs							Vulnerable Road Users			After Riding Perception						
	Habit	Price Value	Facilitating Conditions	Hedonic Motivation	Subjective Norm	Willingness to Use SAVs	Perceived Behavior Control	Interaction with AVs	Sharing Road with AVs	Regulation	Park Properly	Maintain Safe Distance	Avoid Collisions	Within the Lane	Adapt with Speed	Navigate to Proper Destination	Change Lane Properly
Ge et al. (2019)					*												
Bansal et al. (2016)	*	*		*		*											
Rovira et al. (2019)									*								
Yuen, Huyen, et al. (2020)	*	*	*	*	*		*										
Penmetsa et al. (2019)			*					*	*								
Das et al. (2020)			*					*	*	*							
Gurumurthy & Kockelman (2020)		*				*											
Zajc et al. (2020)					*												
Hilgarter & Granig (2020)											*						
Hewitt et al. (2019)	*		*	*													
Das (2021)								*	*	*							
Cunningham et al. (2019)											*	*	*	*	*	*	*
Pyrialakou et al. (2020)					*		*										
Woldeamanuel & Nguyen (2018)								*	*								
Wang et al. (2020)	*	*	*	*													

References	Shared AVs							Vulnerable Road Users			After Riding Perception						
	Habit	Price Value	Facilitating Conditions	Hedonic Motivation	Subjective Norm	Willingness to Use SAVs	Perceived Behavior Control	Interaction with AVs	Sharing Road with AVs	Regulation	Park Properly	Maintain Safe Distance	Avoid Collisions	Within the Lane	Adapt with Speed	Navigate to Proper Destination	Change Lane Properly
Jing et al. (2019)					*		*										
Zhu et al. (2020)					*												
Rahman et al. (2021)								*	*	*							
Asgari & Jin (2019)	*																
Kassens-Noor et al. (2021)	*							*									
Tennant et al. (2019)	*											*					
Park et al. (2021)	*																
Z. Xu et al. (2018)											*						

CHAPTER 6: CONCLUSIONS AND FUTURE RESEARCH DIRECTIONS

This chapter summarizes the overall study and delineates the limitations of the current study and guides the future directions of research to accelerate the adoption and deployment of the AVs.

6.1. Conclusions

This study was conducted to assess the perception of the most potential user group of AVs. To obtain the opinions of the young, students, and more educated people, the University of Central Florida was chosen as the study area. Data analyses showed that respondents had positive attitudes toward AVs, and they felt that it would decrease crashes, operate better than human drivers, and decrease travel time. Besides, they thought they could use their traveling time productively, have a less stressful driving experience, and easily switch from the autonomous driving mode to the manual driving mode. However, around 59% of participants thought they would have to pay constant attention to the AVs while the vehicle would be in the autonomous driving mode. The study also found that around 51% of the respondents were concerned about some negative aspects of AVs. They thought that AVs would drive worse than human drivers (around 29%), might face system/equipment failures (approximately 63%), might harm their privacy and security (nearly 56%), and that particular danger might occur when it would come in contact with human-operated vehicles or any unexpected situations (about 48%). Also, they were worried about the aftermath of crashes and the price of AVs. The majority of participants (around 50%) felt positive about AVs and would be willing to attain a proper license endorsement (approximately 71%). Most participants (about 44%) had no problem with the privacy issues regarding AVs. Over 44% of the participants (i.e., 17.78% strongly agree and 25.71% agree) expressed highly positive attitudes

towards AVs in terms of heightening social status. Besides, around 54% of participants thought that they would feel proud for using AVs, and about 36% of participants believed that their close ones would love to get AVs as a gift or people could use AVs as means of making their close ones happy. Most importantly around 69% of the respondents were willing to try new technologies. Structural equation modeling (SEM) was performed to assess the relationship between five latent variables. Model results showed that as more people fell primary positive perceptions about AVs, their attitudes toward AVs become more positive, and their concerns get reduced. Finally, people want to possess AVs despite their different demographic backgrounds.

On the other hand, this study was an attempt to propose a uniform questionnaire for collecting data to assess the public perception of AVs. Particular focus of this study was to develop or propose a questionnaire for collecting response from the stakeholders of AVs, and to point out the research gaps for more advanced studies on this topic. Hence, 50 articles were reviewed, and after rigorous assessment, general content and special content of the questionnaire were proposed. General content is for all studies those are seeking to assess the perception of all stakeholders of AVs, and the special content, was in addition of the general content, was proposed particularly for the special purposes. General content consisted of four major categories i.e., perception, concern, expected benefits and ownership. Special content considered the vulnerable road users, shared AVs, perception after riding AVs and so on. Finally, the study pointed out the research gap in current literatures i.e., uniform content, capturing varying perceptions with time, regional and geographical consideration, potential user group focused studies and so on. This study will guide towards a more resilient uniform and advanced studies on assessing the public perceptions of AVs.

6.2 Future Research Directions

This study could have potentially important implications for all the stakeholders that are relevant to the autonomous vehicles development, policy, and adoption. Since this study is limited to one educational institution, future studies can incorporate other educational institutions from different geographical and demographic contexts, and attempt to connect the current study with user acceptance work for AVs (e.g., TAM, UTAUT).

On the other hand, there is a strong need of considering the vulnerable user's perception for making better and relevant policies regarding AVs legal and regulatory issues. There are almost no studies on perceptions of special professional group i.e., policymakers, lawyers, manufacturers, government funding organizations to assess their views. Since they will be the key stakeholders, it is of urgent need to assess their perceptions. Finally, more studies are required incorporating cross-country perspectives, special users (e.g.,, old, disabled), shared AVs and so on. Findings from their perceptions might have a significant contribution in making policies regarding AVs.

APPENDIX: IRB APPROVAL

UNIVERSITY OF CENTRAL FLORIDA

Institutional Review Board
FWA00000351
IRB00001138, IRB00012110
Office of Research
12201 Research Parkway
Orlando, FL 32826-3246

EXEMPTION DETERMINATION

June 7, 2022

Dear Md Rakibul Islam:

On 6/7/2022, the IRB determined the following submission to be human subjects research that is exempt from regulation:

Type of Review:	Initial Study, Initial Study
Title:	A survey to understand the public's opinion about the autonomous vehicle
Investigator:	Md Rakibul Islam
IRB ID:	STUDY00004374
Funding:	None
Grant ID:	None
Documents Reviewed:	• Faculty Review, Category: Faculty Research Approval; • Earlier IRB Approval, Category: Letters of Support; • HRP 255SR, Category: IRB Protocol; • Questionnaire, Category: Interview / Focus Questions;

This determination applies only to the activities described in the IRB submission and does not apply should any changes be made. If changes are made, and there are questions about whether these changes affect the exempt status of the human research, please submit a modification request to the IRB. Guidance on submitting Modifications and Administrative Check-in are detailed in the Investigator Manual (HRP-103), which can be found by navigating to the IRB Library within the IRB system. When you have completed your research, please submit a Study Closure request so that IRB records will be accurate.

If you have any questions, please contact the UCF IRB at 407-823-2901 or irb@ucf.edu. Please include your project title and IRB number in all correspondence with this office.

Sincerely,

Jonathan Coker
Designated Reviewer

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