Innovation Drivers for Autonomous Vehicles and Mobile Connective Technologies in the UK: A Study of Technology Acceptance Factors

A Thesis Submitted for the Degree of Doctor of Philosophy

by

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February 2023

Abstract

Traffic levels have increased such that congestion is a major occurrence in many urban areas, creating uncertainty around journey times as well as more incidents with significant damage and accidents, placing lives at major risk. The research focuses on the development of mobile connective technology, such as vehicle-to-vehicle (V2V) or vehicle-to-infrastructure (V2I), where vehicle manufacturers have begun to devise real-time travel information systems that may reduce traffic delays and the possibility to improve road safety and travel for vehicle users. Transport fleets have increased over time, leading to increasing damage and accidents, placing lives at major risk and creating uncertainty. Given this context, there is interest in using autonomous vehicles (AVs) to improve efficiencies and safety in the transport sector for commercial journeys and passenger vehicles.

While there is a growing body of literature on the acceptance of autonomous vehicles, the study of users' acceptance of emerging autonomous vehicles and connected technology is still in its infancy. This research is an important and timely contribution to this field, as it will explore the user perspective regarding relevant factors and the potential of connected technology to address the limitations of sensors for autonomous vehicles during adverse driving conditions. The study supplements the Technology Acceptance Model (TAM) with driver context (from pervasive computing studies) and technology attributes (compatibility, trust, and safety) with some personal attributes to investigate non-professional and professional drivers’ perspectives.

The study's findings have significant implications for developing and implementing connected technology in the transport sector. The study, which utilized an online survey to collect data from 203 users in the UK and analysed them quantitatively using statistical package for social sciences (SPSS) and Structural Equation Modelling (SEM). The study results indicated that the factors that most influence users' perceptions of AVs were shown to be perceived usefulness, driver context, and trust, which demonstrates that TAM is still relevant to understanding users' attitudes towards AVs. In addition, it signifies the relevance of pervasive computing as a field of study that contributes to user perceptions of connected technology in terms of driver context. The practical implications of these findings are vital, as they can guide the development and implementation of connected technology in the transport sector.

It is strongly recommended that further research be conducted into individual attributes such as personal innovativeness to gain a more comprehensive understanding of users' attitudes towards connected technology and mobility. The generalisability of this study is limited by sample- and UK-specific attributes. Therefore, future research should aim to replicate this study in various geographical regions to assess the generalisability of the results. This ongoing research is crucial for keeping up with the rapid advancements in the field of autonomous vehicles and connected technology.

Acknowledgement

Firstly, I would like to express my sincere gratitude to Dr. Rebecca De Coster, my supervisor. The completion of this research would not have been possible without her endless support, guidance, and belief in this study from the very beginning to the end. I am also thankful to Dr. Qingping Yang for his invaluable direction throughout my PhD journey.

In addition, I would like to express my heartfelt appreciation to my parents and siblings for their constant love and unwavering support. Their confidence in me has been a source of strength during challenging times.

A special thank you goes to my wonderful wife for her enduring patience, invaluable assistance, and emotional support throughout the years of my research. Her belief in me has made this accomplishment a shared success.

I am deeply appreciative of my uncle; whose encouragement played a crucial role in the completion of my research. I am also thankful to his family for their consistent support and motivation, which has been a driving force in achieving my goals.

Dedication

I dedicate this thesis.

To my brother-in-law, Fathi

May he forever rest in peace

Declaration

I hereby declare that this thesis is my original work and has never been submitted for a degree in this or any other university.

I also declare that all information in this thesis has been acquired and presented under academic rules and ethical conduct

Mazen Mossa

Publications Associated with This Thesis

Journals

- Mossa, M. and De Coster, R. (2023). Driver Perceptions of V2V and V2I for Autonomous Vehicles: A Study of Technology Acceptance Factors. International Journal of Intelligent Computing Research (IJICR), Volume 14, Issue 1, ISSN: 2042 4655 (Online).
- Mossa, M. and De Coster, R. (2024). The Potential of Autonomous Vehicles to Improve Road Safety and Sustainability: An Empirical Study of Driver Acceptance of Connected Technology in the UK. International Journal of Sustainable Energy Development (IJSED), Volume 12, Issues 1, ISSN: 2046-3707 (Online),

Conferences and Doctoral Seminars

- Zhao, Y., De Coster, R. and Mossa, M. (2024). An Empirical Study of the Adoption of Autonomous Vehicles by Chinese Tourists, British Academy of Management conference (BAM 2024), September 2024, Nottingham, UK.
- Mossa, M. and De Coster, R. (2023). An Empirical Study of V2V and V2I Regarding Technology Acceptance for Autonomous Vehicles, International Conference on Information Society (i-Society 2023), October 2023, Dublin, Ireland (Online).
- Mossa, M. and De Coster, R. (2023). Empirical Study of Autonomous Vehicles and V2V for Driver Acceptance in the UK, International Conference on Information Society (i-Society 2023), September 2024, Cambridge, England (Online).
- Mossa, M. and De Coster, R. (2023). Autonomous Vehicle Technology from Pervasive Computing Applications Perceptive, Mechanical and Aerospace Engineering Doctoral Symposium, March 2023, Brunel University London.
- Mossa, M. and De Coster, R. (2019). Self-Driving Vehicles (SDV) Technology Applications from the Pervasive Computing Applications Perspective, Design Doctoral Symposium, December 2019, Brunel University London.

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Chapter 1: Introduction

1.1. Overview

Due to increasing innovation and technological improvements, vehicle manufacturers have begun to devise major ways to improve safety and reduce the possibility of traffic delays through the adoption of connective technology. Transport fleets have increased dramatically, resulting in significant damage and accidents, placing lives at major risk and creating uncertainty (Jameel et al., 2019). This has resulted in the onset of the development of connecting technology, such as vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I), as shown in Figure 1.1. This study will focus on autonomous vehicle (AV) applications and seek to find some special features that can be provided to the yet-to-be-explored AV applications and establish a framework where users can accept this technology.

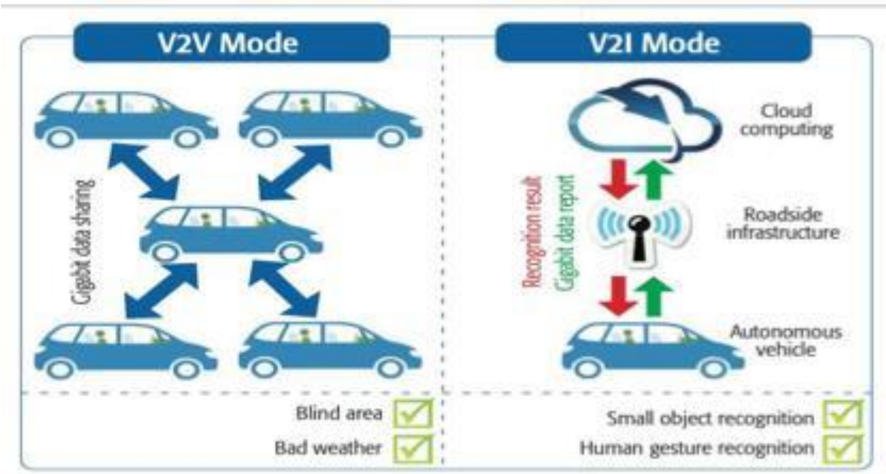


Figure 1-1: The Framework of Vehicular mmWave System adapted from (Kong et al., 2017)

Broadly defined by SAE (2014), "Automated vehicles, also termed autonomous, driverless, self-driving and robotic vehicles, are vehicles capable of sensing their environments and navigating without human input, thus fulfilling the capabilities of a traditional vehicle". In addition, an autonomous vehicle can observe its surroundings, define a road on the destination route, and manage it can serve as a definition for a fully autonomous vehicle. In other words, autonomous transport is smart cars or robocars that are used to obtain some or all of the control functions from various operators, computer processors, and databases (such as operators). There are some advantages to cars equipped with this real-time technology. This can lead to reduced accidents, energy consumption and significant pollution (Rajasekhar and Jaswal, 2015).

As reported by Yan et al., (2016), data collected from radars, LiDAR, ultrasonic sensors, GPS, and many other sensors is not sufficient for safe automated driving, especially on highways and city streets where many rules and regulations apply. For autonomous traffic to be separated from human drivers, it is necessary to remove road signs and lanes visually. The onboard camera system provides visual identification of the environment via automated control technology. The identification lane includes lines, road signs and lights, vehicles and pedestrians. As demonstrated in Figure 1.2, after mixing data with other sensors, the vehicle can improve its driving mode and routes and plan safely (Yan et al., 2016 and Liu, 2023).

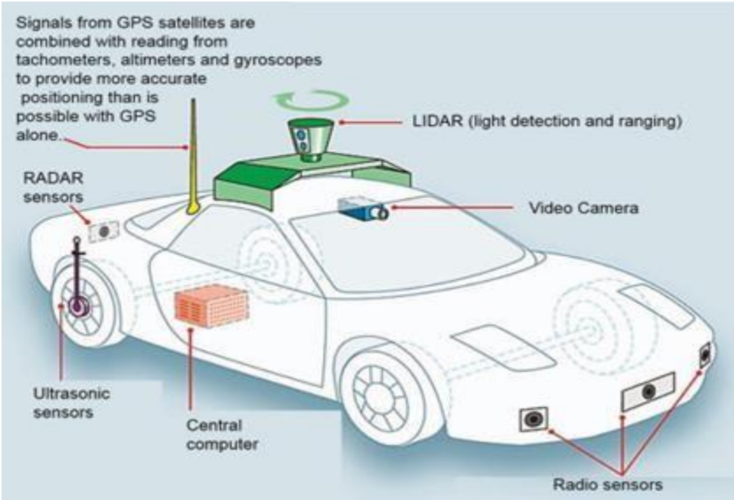


Figure 1-2: Autonomous Vehicles adapted from (Rajasekhar and Jaswal, 2015).

The ability to wirelessly exchange information from one vehicle to another regarding the location and speed of the vehicles around them is needed because these types of autonomous vehicles help avoid accidents and ease congestion. These benefits can be achieved if all vehicles can communicate with each other through this technology. This communication type enables vehicles to identify speed and exchange addresses with other vehicles (Han et al., 2019). According to Kong et al., (2017), V2V communication: by using mmWave radar, vehicles can exchange sensor data in the transmission range in real-time. In this way, the blind spot and adverse weather conditions can be resolved. In particular, when a vehicle's blind spot is detected in the sensing zone, LiDAR data or cameras from neighbouring cars are requested to compensate. Although the LiDAR sensitivity range is drastically reduced in adverse weather, the mmWave propagation range is not affected. Using shared sensor data, the transport can reconstruct the state of 3D sources by modal analysis of multiple sources.

Within this study, the technology used in the V2V model enables vehicles to collect one-way messages. Vehicles that have V2V software could be used to receive messages from surrounding vehicles that will help them avoid any potential collision. V2V communications have a range of about 350 meters. Sensors will enable vehicles to identify and avoid hazards. In addition, Vehicle-to-infrastructure (V2I) is another type of communication framework that enables various vehicles to share information with devices implemented in the highway system. Through devices such as signs, cameras and streetlights. Software and hardware networks enable this infrastructure. V2I technology uses two-way wireless systems to improve the level of road safety (Xu et al., 2020). Identical V2V and V2I are dedicated to short-range communications. The sensors used in the V2I are based on the intelligent transfer system. This will help capture data and problems that vehicles encounter on the road (Xu et al., 2020).

Due to the need for road safety and the increase in vehicles supporting V2V and V2I technologies, there has been a growing interest in developing autonomous vehicle technologies. These technologies include emergency vehicle alerts, emergency braking, roadside alerts, lane change assistance, stop warnings, and blind spot warnings. In this context, many works have focused on designing mechanisms and methods that improve road safety and help reduce the number of accidents and deaths (Zeadally et al., 2020). Several studies differed from those conducted to search for common factors for AV technologies, particularly V2V and V2I. Most studies have focused on factors related to the benefits of AV; however, there is a restricted range of research conducted on how technology acceptance towards AV technology in the market. As a result, this study focuses on understanding users' perceptions of AV and connective technology through factors considered when designing AV. This research will initially attempt other significant recent studies concerning V2V and V2I. However, there still needs to be more information on these technologies regarding their processes and implementation.

Urban areas are becoming increasingly congested with delays and longer travel times, polluting the environment. Due to increasing innovation and technological improvements, vehicle manufacturers have started strategising significant approaches to improve journey efficiency and safety by adopting connective technology (Jameel et al., 2019). This has resulted in the development of technology real-time information and connective applications, such as V2V and V2I, emerging networking applications that are inherently ubiquitous (or Pervasive) computing for both professional and non-professional drivers. Given the interest in autonomous vehicles by the transport sector and manufacturers, it is crucial to understand the factors affecting their adoption. Jansson, (2011) emphasizes the importance of examining user adoption behaviour in the automotive industry during the diffusion of innovation. Similarly, Litman, (2017) argues that it is too early to assume widespread public support for autonomous vehicles, as many factors may discourage people from adopting the technology. This underscores the need for further research and understanding in this area, which can help government institutions and the automotive industry to drive the widespread adoption of this technology (Lukovics et al., 2020).

The acceptance and utilisation of a system are crucial factors in assessing the success of information systems (Urbach and Müller, 2012). The Technology Acceptance Model (TAM), created by Davis in 1989, is extensively utilised to clarify the technology adoption process across various contexts, cultures, and user factors. However, there is a pressing need for further research to enhance the TAM's applicability to virtual reality. Davis (1989) suggested that future studies on technology acceptance should consider additional factors that may influence the TAM. Research addressing the influence of social connections on technology acceptance is currently insufficient. Therefore, expanding the TAM to investigate how social connections affect consumers' perceptions about the acceptance and spread of new technologies is urgent.

With its unique user-centric approach, the TAM is a significant theoretical framework in technology adoption. It focuses on users' opinions and behaviours towards new technological items, often overlooking product attributes and social influences on emerging technologies. This unique approach has made it one of the most significant theoretical frameworks in technology adoption, engaging various fields in its investigation. Empirical research, predominantly employing quantitative analysis, has been instrumental in studying the acceptability of emerging technologies. The TAM's potential to elucidate the process of adopting new technologies, including autonomous vehicles, is a topic of great interest.

Several researchers have examined and validated the constructs of Perceived Usefulness (PU) and Perceived Ease of Use (PEOU), concluding that they effectively predict individual adoption of diverse information technologies. Nevertheless, based on the particular technological situation, supplementary explanatory variables may be required in addition to the constructs of PU and PEOU (Moon and Kim, 2000). User acceptance is the observable readiness within a user group to utilise information technology for its intended tasks. This definition emphasises the deliberate applications of technology. It indicates that individual perceptions of information technologies will probably be affected by the system's attributes and interactions with other users (Lee et al., 2003). Consequently, an individual's view of the system is affected by the evaluations and utilisations of the system by those in their surroundings.

When examining user adoption of technology, it is crucial to consider social connections. These connections, characterised by the frequency and type of interactions among persons, significantly influence individuals' perceptions of technology. As mentioned by Lee et al. (2003), individuals' perceptions of technology are influenced by their communicative associates' perspectives, facts, and behaviours. This influence is often more pronounced than objective and independent evaluations of technical attributes, product and societal determinants. Therefore, social connections play a crucial role in shaping attitudes towards technology, which should be a key consideration in technology adoption studies.

The TAM is well-established framework for assessing user acceptance (Venkatesh, 2000). Multiple studies have adapted it to consider various technologies (Choi and Ji, 2015), as well as user demographics (Venkatesh & Morris, 2000). Proposed extensions to the TAM involve factors from associated models (e.g., subjective norm, perceived behavioural control), supplementary belief factors (e.g., triability, content richness), and external variables (e.g., demographic characteristics, computer self-efficacy) (Marangunić and Granić, 2015). External variables may serve as antecedents or moderators of PU and PEOU. These extensions attempt to enhance the predictive capability of the TAM by incorporating variables tailored to specific technologies, situations, and users.

In addition, these models are established in the theory that peoples' beliefs and perceptions of technology can influence its acceptance, with the behavioural intentions to use technology and actual usage of behavioural indicators of acceptance (Zhang et al., 2019). The investigation will, therefore, adapt to the fundamental assumptions of the original TAM given by (Davis et al., 1989). The research will adjust to the basic premises of the original TAM given by Davis (1989), which is presented from H1 to H6. Moreover, the findings are consistent with earlier consumer acceptability studies in this area, such as the models offered by (Ghazizadeh et al., 2012; Choi and Ji, 2015 and Müller, 2019), expanding their findings in the field of AV technologies.

Additionally, academic research is increasingly focusing on pervasive computing (PC), which is also emerging as a key element in the commercial world (Delaney et al., 2008). The growing number of pervasive computing has significantly impacted the workplace by facilitating enhanced communication channels. Therefore, it is applied in many fields and has a variety of applications. PC finds utility across various domains, including smart offices, transportation, and entertainment systems (AbdulSattar and Al-Omary, 2020). The period of centralised computing, which occurred during the 1970s and 1980s, was characterised by utilising mainframe technologies. Subsequently, distributed computing emerged during the 1990s. The primary focus is on distributed client-server technologies. The popularity of technology increased with the introduction of the Internet in the 2000s (AbdulSattar and Al-Omary, 2020).

According to Farooq et al., (2015), the rapid development of the Internet and web technologies has led to the development of a potential innovation known as the Internet of Things (IoT). This is a growing global computing network where all individuals and objects will be connected to the Internet. IoT is currently generating significant attention from scientists and industry experts. Progressively more compact and intelligent devices are being used in various IoT sectors, such as housing, infrastructure monitoring, and autonomous vehicles. In smart cities, there is a growing tendency to enhance safety and control throughout the autonomous vehicle ecosystem. Ultimately, this transforms road usage into a more sustainable and efficient one, which in turn is more beneficial to the environment.

Rajasekhar and Jaswal (2015) gathered user opinions on AV, including the United Kingdom, where less than half of the surveyed trusted AVs 45%, which is relatively lower than Canada (52%), the USA (60%), China (70%), and Brazil (95%). Since the UK is the global centre for scientific and technological innovation, the achievements in the acceptance of autonomous driving technology have international influence. Through leading market research and policy development, the UK can take a leading position in the global market for autonomous vehicles. Collecting data and analysing consumers' intention and acceptance of AVs in the UK would be essential and significant to improve the industry. In addition, the results of this study, in particular the user behaviour, need to be interpreted considering the UK cultural values such as collectivism and high uncertainty avoidance trends. However, it may not represent and explain other countries with different cultural values, issues, or trends.

1.2. Thesis Statement

The existing literature on the pervasive computing acceptance of autonomous vehicles has been developed. However, the study of users' acceptance of emerging technology, particularly connecting technology, is still in its infancy. Additionally, autonomous vehicle sensors such as LiDAR, ultrasound, radar, and cameras have their limitations to improve road safety and help reduce the number of accidents and fatalities. Consequently, it is claimed that to fill the aforementioned gaps in this research, this study aims to investigate the potential of connecting technologies to address these issues to overcome the shortcomings of sensors. In addition, this study will evaluate how V2V and V2I technologies can assist the autonomous vehicle industry in fulfilling its potential, as well as how users accept this technology.

This study introduces a research model that utilises TAM and PC variables to affect user perspectives in V2V and V2I positively. Although different factors of the study framework model that result from AVs are identified, The TAM focuses on well-established adoption factors, including perceived usefulness and ease of use, attitude towards using and behavioural intention. Secondly, the professional setting comprises key contextual factors concerning autonomous driving, and this group is concerned with the effects of driver context and compatibility variables. Thirdly, personal attributes take into consideration user characteristics and technology attitudes. Likewise, this group illustrates applications based on trust and innovativeness variables.

As a result, extant literature has highlighted that this study, which was conducted in the United Kingdom, demonstrates that firstly, it is found that the three group of the theoretical framework identified differences in the adoption factors for AVs towards V2V and V2I technologies. The importance of the factors for the different technologies will help automotive manufacturers focus on the key areas that concern users and need to be addressed during car design.

1.3. Aim, Objectives and Research Questions

1.3.1. Aim

To examine driver perception factors and adoption attitudes which influence the acceptance of connected technologies (V2V and V2I) in facilitating AV adoption in the UK.

1.3.2. Objectives

1. To conduct a comprehensive literature review on connecting technology for AVs.
2. To develop a theoretical model that outlines the needs of the study, highlights the characteristics of autonomous vehicle technology, and investigates their implications for the technological acceptance model.
3. To demonstrate that the framework built during this study can support the performance of connecting technologies such as V2V and V2I.
4. To place the findings in the relevant literature, present the theoretical and management implications of the main findings, and provide recommendations for future research.

1.3.3. Research Questions

Q1. To what extent does Pervasive computing theory influence users 'perceptions of AVs?

Q2. Which group factors have the most influence on user perceptions regarding AVs?

Q3. What factors most influence users 'attitudes towards V2V applications?

Q4. What are the key determinants of user adoption of V2I as an emerging application?

1.4. Research Problem

The rapid development of autonomous vehicles, driven by their significant advantages over standard automobiles, promises a brighter future for the automotive industry. These advantages, such as enhanced traffic safety, reduced pollution, improved fuel economy, and the potential for car sharing, paint an optimistic picture of the potential benefits of autonomous vehicles, instilling a sense of hope and positivity in the audience.

Although they have potential benefits, autonomous vehicles also present challenges that must be addressed to ensure a successful market introduction. Rapid progress has resulted in an intense appreciation for technology, while more attention needs to be given to focuses, including user acceptance. Rosenzweig and Bartl (2015) also argue that a small percentage of papers on autonomous driving specifically address the concern of acceptance by users. Despite the existing studies on ethical decision-making (Bonnefon et al., 2016) and user acceptance (Bjørner, 2015; Choi and Ji, 2015; Nees, 2016; Payre et al., 2014), some outstanding concerns remain. This is further clarified by demonstrating that various identified variables have been discovered through an online survey.

Nonetheless, the fundamental reasons for these variables' significance remain unclear. Furthermore, the potential consequences of these factors for other automobile industry sectors have yet to be examined. These concerns are particularly significant for highly automated driving systems, likewise classified as fully automated vehicles.

Obtaining a comprehensive understanding of the determinants of users' adoption and their impact on the automotive industry in relation to autonomous vehicle technologies is of utmost importance. This understanding will help address potential concerns and ensure a grasp of the positive social impacts associated with this technology, especially V2V and V2I. The primary goal of our study is to identify influential variables through an online survey and integrate these outcomes with the current literature. By doing so, this study aims to underscore the significance of our work in shaping the future of the automotive industry.

1.5. Research Methodology

An extensive literature evaluation will be undertaken concerning pervasive computing and autonomous vehicle technology. This review will focus on understanding the impact of such technologies as V2V and V2I on user attitude and intention. Subsequently, various hypotheses will be developed, and a theoretical model will be formulated. A positive methodology is employed to improve the predictive comprehension of V2V and V2I (Davis et al., 1989; Ghazizadeh et al., 2012; Choi and Ji, 2015, and Müller, 2019). Quantitative validation and empirical verification will be conducted using the theoretical framework. A survey instrument is developed based on the relevant scholarly works and research methodology. 203 responses were received from professional and non-professional drivers in the United Kingdom. Moreover, the data will be utilised statistical package for social sciences (SPSS) version 20 and structural equation modelling (SEM) using AMOS version 28.0.

1.6. Thesis Structure

- Chapter One: Introduction: This chapter serves as an introduction to the research, providing the background and research problem and highlighting the importance of autonomous vehicle technology in the United Kingdom. Moreover, it presents the aim, objectives, research questions of the study and the structure of the thesis.

- Chapter Two: Literature Review: An in-depth review of the research literature that defines the field of this research, which includes autonomous vehicle technology and pervasive computing.

- Chapter Three: Theoretical Model: In this chapter, the limitations and research gaps in this field are studied by formulating a theoretical framework, and extracting relevant factors from connecting technologies and autonomous vehicles, especially V2V and V2I. In addition, hypotheses related to the proposed framework were formulated.

- Chapter Four: Methodology: This chapter defines the research strategy used to validate the proposed model. It presents the research philosophy, approach, questionnaire design, and research design. In addition, it describes the results of the survey about the demographic profile of responses and briefly explains data analysis approaches.

- Chapter Five: Data Analysis and Results: In this chapter, the study's analysis and results are presented. Initially, a preliminary examination of the data was conducted by identifying outliers, checking for normality, and performing linearity tests. Furthermore, multiple regression and reliability analyses are conducted. Moreover, the chapter explains how to use the analysis of ANOVA and T-test to evaluate the influence of model factors. Additionally, this chapter analyses the research modelling based on confirmatory factor analysis (CFA), validity, and SEM. This will be carried out using AMOS to evaluate the overall fit of the proposed model and validate the hypothesised relationships.

- Chapter Six: Discussion: This chapter provides an extensive examination of the hypotheses. Following, it examines the analysis of the results of the research model within the relevant literature.
- Chapter Seven: Conclusion: Provides a comprehensive summary of the research and includes a description of the main limitations, as well as potential areas and approaches for future research.

Chapter 2: Literature Review

Considering the current landscape of the AV industry in the UK, this research, though in its exploratory stage, has the potential to significantly impact future studies. It is primarily focused on uncovering the factors that influence consumers' intention to adopt this new technology. This emphasis on intention aligns with the research objectives and paves the way for more in-depth research into the actual adoption behaviour of users towards AVs. Additionally, this thesis concentrates on identifying and understanding specific psychological or social factors that influence behavioural intention.

The actual behaviour of adopting new technology may be delayed; users often take some time after forming an intention to adopt before they do it. Therefore, this study tends to study intention first rather than actual behaviour immediately. Thus, this research chooses application intention as the research object to obtain preliminary results in this field. In addition, the tradition of analytical intent as a mediating variable is well adopted in technology adoption research. For example, theoretical frameworks such as TAM emphasize the central role of intention in explaining and predicting behaviour.

2.1. What is “Acceptance”?

Although the significance of acceptability is acknowledged, an accurate and standardised method for measuring it is needed. Limited research has been conducted on acceptance theory in driver assistance. Several studies attempted to evaluate acceptance, although barely a small number of these research studies have clearly defined the concept. Regan et al., (2002) stated that although adaptability is significant, studies need more understanding of its definition and measurement. Ausserer and Risser, (2005) defined acceptability as the degree to which potential users are willing to utilise a specific system. Chismar and Wiley-Patton, (2003) and Ausserer and Risser (2005) discuss the system's acceptance and use. However, neither indicates the need to demonstrate actual behaviour, which is necessary to expect a positive impact on traffic safety.

There are also indications that there exists a variety of acceptance. Goldenbeld, (2002) distinguished between acceptance and encouragement, with acceptance referring to the willingness to comply with something, while support refers to the enjoyment or preference. Similarly, Franken and Lenz, (2004) made a significant distinction between attitudinal and behavioral acceptance. Attitudinal acceptance refers to cognitively accepting the system, while behavioral acceptance is achieved through actual actions, such as purchasing a car equipped with Intelligent Speed Adaptation (ISA; effectively reduces traffic speeds). This distinction enlightens us about the fact that the level of acceptance of a particular behaviour can be high even if the level of acceptance of the attitude towards that behaviour is not high, as long as some significant incentives or deterrents motivate the driver to use a support system, even if they do not personally approve of it. Similarly, attitudinal acceptance can occur without behavioural acceptance.

None of the definitions proposed by Chismar and Wiley-Patton, (2003), and Ausserer and Risser, (2005), the attitudinal acceptance (Franken and Lenz, 2004), or support (Goldenbeld, 2002) necessitate any influence on the actual utilization of a system. If a support system does not impact its practical efficiency, it does not affect traffic safety. Therefore, while considering road safety, it is crucial to prioritize the acceptability of desired behaviours (Franken and Lenz, 2004). This is not just a theoretical concept, but a practical necessity for ensuring the safety of our roads.

2.2. User Acceptance and Influencing Factors

It is crucial to clearly define user acceptance before addressing the issue. This research adopts the definition provided by Dillon (2001), who describes user acceptance of technological innovation as the observable desire of users to utilise technology for the specific tasks it aims to facilitate. User acceptance is a multifaceted concept that covers many different factors. According to Davis (1985), two more constructs, namely perceived usefulness and perceived ease of use, impact users' acceptance of technologies. This study aims to discover analogous constructs, referred to as variables, that impact the user acceptance of autonomous vehicles as defined by Dillon (2001).

Huijts et al. (2012) emphasise distinguishing between consumer acceptance and citizen acceptance, two distinct yet interconnected forms of acceptance. The former relates to the desire to use the technology itself, while the latter concerns the integration of the technology into one's environment. As these two forms of acceptance are interrelated and cannot be considered separate issues, they both form integral components of the term "user acceptance" in this research. The focus of this study is primarily on professional and nonprofessional drivers, with a particular emphasis on user acceptance due to its significant impact on the success of the technology.

2.3. User Acceptance of New Technological Innovations

As the advantages of autonomous vehicles cannot be assumed that users will readily accept them, as several variables may deter people from embracing this technology. Given the potential positive impact of AVs on society, accurately determining the factors that influence acceptance of this technology is highly valuable for the automotive industry. This is particularly important considering the historical challenges associated with this task. The complexity of technology acceptance becomes apparent when examining examples such as pervasive computing, which defied many people's assumptions and achieved significant success. This research section will explore the adoption of V2V and V2I technologies, the factors contributing to their acceptance, and how they can be developed.

2.3.1. Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM), a vital tool in understanding technology adoption, was introduced by Davis in 1989. It has been widely used to explain technology acceptance across various settings, cultures, and user factors. However, there is a clear need for more research on applying TAM to the virtual world. Davis (1989) suggested that future studies on technology acceptance should consider additional factors that may influence TAM. For instance, more research is needed on how social connections impact technology adoption. Therefore, expanding the TAM to investigate how social connections impact consumers' views towards adopting and spreading emerging technologies is essential and presents a promising area for future research.

In a study by Choi and Ji (2015), the TAM is a theory that explains how consumers adopt and use technology in information systems. The Theory of TAM clarifies the link between an individual's thoughts, opinions, and intention to engage in a specific behaviour. According to the TAM, perceived usefulness (PU) and perceived ease of use (PEOU) determine the willingness to embrace technology. Multiple empirical studies have shown that since its development, TAM has been a practical and reliable model for understanding technology adoption behaviours in different information systems, reinforcing its value in academic and professional research.

TAM believes that a user's intention to use any technology is influenced by its PU and PEOU. Previous studies have demonstrated that intentions can affect the impact of other potential factors on a user's actual conduct, as observed in the TAM study. Using behavioural intention (BI) as the dependent variable instead of actual usage is particularly useful for studying the initial acceptance of technological systems their perceptions of PU and PEOU influence users' desire to utilise a system. Davis also defined PU as the level at which individuals perceive that using a specific system will enhance their work efficiency. Consistently, PU emerges as the main driving force behind the widespread adoption of technology. PEOU refers to an individual's perception of how easy it would be to use a particular technology (Davis et al., 1989). The Technology Acceptance Model (TAM) has been employed in many research studies investigating the acceptance and utilisation of driving assistance technology. PEOU and PU have been identified as significant technological factors influencing the acceptance of autonomous vehicles.

The TAM is now the most commonly employed framework for assessing user acceptance (Hsiao and Yang, 2011). The model is both simple and extensively applicable. Several researchers have expanded the application of this concept to various technologies (Choi and Ji, 2015), contexts (Huang, et al., 2013), and user groups (Elias et al., 2012). The TAM has been expanded with various extensions, as discussed in Marangunić and Granić's review in 2015. These extensions incorporate factors from associated models, such as subjective norm and perceived behavioural control, and further belief factors, such as triability and content richness. Furthermore, external variables, including demographic characteristics and computer self-efficacy, are also considered. External variables can serve as antecedents or moderators of PU and PEOU. These extensions aim to enhance the predictive capability of the TAM (Chow et al., 2012: Choi and Ji (2015) by incorporating additional factors adapted to specific technologies such as AVs.

The TAM, introduced by Davis in 1989, has been extensively validated and widely used, making it one of the most significant theoretical models in technology adoption (Venkatesh et al., 2003). TAM's research encompasses many fields, including empirical research and quantitative analysis. This method is extensively employed in studying emerging technologies and their acceptability, directly related to the present research. The TAM can be applied to clarify the procedures for adopting new technologies, such as autonomous vehicles. The TAM research focuses on the user's subjective attitude and conduct towards new technology items, disregarding the product's qualities and societal aspects.

2.3.2. Unified Theory of Acceptance and Use of Technology Use (UTAUT)

The UTAUT was established by Venkatesh et al., (2003) to enhance existing models for accepting information technology (IT). While the eight existing models accounted for 17 to 53 per cent of the variation in user intention to use IT, the UTAUT model, which combines these eight models, surpassed the current models by explaining 70 per cent of the variation. Table 1 presents the eight models utilised in developing the UTAUT model and its key components. The previous section also featured the Technology Acceptance Model. Venkatesh et al., (2003) used empirical data to compare eight models and identify the constructs that significantly influenced usage intention.

Nordhoff et al. (2016) utilised the UTAUT in AVs. They integrated it with other theories to develop a conceptual framework for understanding acceptance. Similarly, the TAM work differentiates between individual and societal acceptance. It additionally examines the variations in acceptance that occur before, during, and following encountering AVs (Nordhoff et al., 2016). Despite acknowledging that the model may be biased towards automobile users who have not experienced driverless vehicles, the authors assert that the suggested model is helpful for this research (Nordhoff et al., 2016). This research examines the rationale and underlying causes for the significance of several factors as shown in Table 2.1. Consequently, this model provides an initial insight into the potential involvement of specific factors. Furthermore, this study examines the impact of several moderating factors, such as gender, age, and experience. The following chapter will further clarify these aspects, particularly during the ANOVA test. The research will meticulously control these variables to enhance the validity of the findings.

Table 2-1: Models of Individual Acceptance adapted from Venkatesh et al. (2003)

Model	Core Constructs
Theory of Reasoned Action (TRA)	Attitude Toward Behaviour/ Subjective Norm
Technology Acceptance Model (TAM)	Perceived Usefulness/ Perceived Ease of Use/ Subjective Norm
Motivational Model (MM)	Extrinsic Motivation/ Intrinsic Motivation
Theory of Planned Behaviour (TPB)	Attitude Toward Behaviour/ Subjective Norm
Model of PC Utilization (MPCU)	Job-fit/ Complexity/ Long-term Consequences/ Affect Towards Use/ Social Factors/ Facilitating Conditions
Innovation Diffusion Theory (IDT)	Relative Advantage/ Ease of Use/ Image/ Visibility/ Compatibility/ Results Demonstrability/ Voluntariness of Use
Social Cognitive Theory (SCT)	Outcome Expectations/ Performance/ Outcome Expectations/ Personal Self-efficacy/ Affect/ Anxiety

2.4. Acceptance of Autonomous Vehicles

Most of the models for assessing technology acceptance in the previous section were introduced to get a better overview of the acceptance of IT applications, meaning that the models may not apply to autonomous vehicles. However, several studies in the existing literature have taken these models as a starting point and have adapted them to suit AVs.

An example is the work done by Choi and Ji (2015), who combined the TAM with prior research on trust in automation. The research model's results identify ten constructs that significantly affect acceptance. Nees (2016) seems to use already extended versions of the TAM to set up a 24-item measurement scale called the Self-driving Car Acceptance Scale (SCAS), which is then used to assess acceptance. Payre et al., (2014) also mention the TAM and extend it to include other constructs. Nordhoff et al., (2016) use the UTAUT in their work. While the existing studies have made significant progress in understanding user acceptance and have identified many influencing factors, the field of AV acceptance is far from being fully explored.

The potential for future research to uncover new variables and deepen our understanding of AV acceptance is promising. For instance, Choi and Ji (2015) suggest that constructs such as personality characteristics, which are not included in their model, could be valuable additions. Nees (2016) argues that a closer look should be taken at age and driving experience and that the results show that yet-to-be-determined factors will account for most of the variance in the acceptance of AVs. Payre et al., (2014) note that the pleasure of driving and the participant's interest in the technology should be included in future research, but also that one of their included factors, external driving locus of control, had no significant correlation to the acceptance of AVs. Nordhoff et al., (2016) agree with the notion that determinants of user acceptance of AVs are largely unknown, and state that the involvement of all users is important in the acceptance and therefore success of AVs. This means that more needs to be clarified about why certain factors play a role. Since this report argues for the importance of a deeper understanding of these factors, some of the future research areas recommended, such as the flow model of Renninger (2014), are not addressed. Instead, through interviews, it is attempted to add to the list of current factors found by discovering why these factors play a role. By doing so, it automatically becomes more accessible to investigate the strategic implications for key players in public transport and the auto industry, a recommendation for future research made by Nordhoff et al., (2016). By conducting a survey and using open questioning to ask interview candidates about the factors that play a role in their acceptance, one finds out whether the factor is mentioned in a positive or a negative context and whether people are aware of many of the factors. On top of that, the factors found can also be seen as confirmation of previous researches.

2.5. What Drives the Acceptance of Autonomous Driving from a User Perspective?

This research attempts to address the research topic and minimise limitations by initially gathering data on user approval using an online survey, followed by analysing and enhancing the results through quantitative data collecting (Nastjuk et al., 2020). Therefore, this research is enhanced by revealing the variables influencing technology acceptability from the user's perspective (Wu et al., 2021). Furthermore, this research develops by defining motivational patterns related to autonomous driving usage while clarifying the relationships among these various factors. This approach has not been utilised in previous research on autonomous driving acceptability, offering an essential alternative to studies that identify acceptance variables through literature review.

Employing an exploratory methodology with a research framework, this research conducted an online survey to identify pertinent criteria for autonomous driving adoption from the user's viewpoint. Utilising the established TAM given by Davis et al. (1989) and Mullar (2019), this research presents a Theoretical model to address the specified study objective and the hypothesised relationships obtained through an online survey. Eventually, this research examines the findings with an emphasis on their implications.

2.6. Autonomous Vehicles Overview

There is currently an era of high technology and automation in almost all types of activities; computers have begun to do a significant part of people's work, both in everyday life and in the professional fields. All this undoubtedly simplifies the lives of people, so the developers do not stop and more often surprise people with new projects (SAE, 2014). To date, various autonomous vehicle designs have become very popular. Kong et al., (2017) studies defined an autonomous vehicle as a vehicle that can see its surroundings and navigate without any human intervention. To achieve autonomous vehicle capabilities, AV initially perceives its surroundings via sensors installed on the vehicle. In addition to enhancing the sensing accuracy, the AV is equipped with a minimum of two separate systems: the sensing system as the main component and the communication system as the additional assistant component.

In recent times. at the beginning of the twenty-first century, as revealed in Figure 2.1, autonomous cars were officially introduced to the market (Bertoncello and Wee, 2015). Since then, several major automotive manufacturers have already tested automotive systems without a driver such as Tesla, Mercedes Benz, Audi, Toyota, and General Motors. In addition, Johnson (2017) have stated that many well-known companies took up the development of such cars. Vehicles of this kind have an automatic control system that allows people to drive a car without human intervention. It is understood that these vehicles should reduce the level of incidents on the roads; that is, the likelihood that a person makes a mistake will be minimised. In addition, such developments will save people from the need to sit behind the wheel for a long time, for example, in truckers.

Figure 2-1: Autonomous Vehicle Evolution Path adapted from (Bertoncello and Wee, 2015)

An autonomous vehicle, often known as a self-driving or driverless car, is a vehicle that, upon startup, operates without human involvement, utilising computerised systems to detect and gather information on the surrounding environment (such as traffic lights, road, signage and obstacles). The information will be analysed and then used to regulate the vehicle's response actions (such as steering, acceleration, and braking) for safe navigation (Hulse et al., 2018).

Moreover, most safety work has focused on reducing the number of road accidents primarily by discovering the ideal distances for automatic braking, regulating vehicle speed, and detecting lane changes. However, the next step is to develop standards that define and coordinate the required data to allow for a harmonious exchange of information between nearby vehicles (which are manufactured by different car manufacturers) so that each vehicle interacts in the same way and thus reduces the likelihood of accidents (Hwang et al., 2017). However, Krasniqi and Hajrizi (2016), divided autonomous cars into two types:

- Semi-Autonomous

Cars can increase speed, slow down and get a steering wheel, keep the distance in front of the car, and hold the road at 130 km/h; however, the driver is still needed and still in full control.

- Fully Autonomous

Transport can go from point A to point B without driver intervention. This mode of transport is expected to be released over the next decade.

2.6.1. Advantages and Disadvantages of AVs

Several researchers (Silberg et al., 2012; Davidson and Spinoulas, 2015; Fagnant et al., 2015) attempted to find out the possible advantages as well as negative effects of autonomous technologybased transports. The main objectives of autonomous transport is to improve the quality, safety, efficiency and comfort of roads. Chehri and Mouftah, (2019) noted that autonomous vehicle is designed to improve road safety and reduce traffic congestion, gas emissions and fuel consumption. This data is not yet encrypted because it is difficult to estimate; however, some are available. Thus, the application of the new transport technology would reduce fuel consumption, for example, adaptive cruise control (ACC), eco-navigation and inter-transport communication with partial vehicle acceleration and braking control by 2% to 4%.

When the autopilot is started, the driver is replaced by a computer system to improve certain safety, speed, environmental, and cost-effectiveness controls. Some modelling works have shown that with a high degree of automation, transport safety can be improved. Indeed, the distance between motor vehicles is more respected than manual control. Similar results were found only for ACS applications compared to manual control (Chehri and Mouftah, 2019).

Additionally, this research estimated (as recent studies also clarify) that autonomous technologies will also increase mobility for people who cannot or are unwilling to drive. At level 4 autonomous technology where the vehicle does not need a driver, it would provide transportation for the blind, disabled or underage drivers. According to Anderson et al., (2014), this would bring numerous benefits to many groups of people which would give them more independence and access to essential services. Secondly, AVs could reduce pollution by enabling the use of different fuels. At level 4, where there are no human drivers, the cars could drop off owners at a location and then recharge on their own. One of the weaknesses of electric vehicles is the lack of recharging infrastructures. Thirdly, autonomous vehicle technology can improve fuel economy, improving it by accelerating/decelerating easier than a human driver (Anderson et al., 2014). Similarly, improvements could be reducing the distance between vehicles and increasing roadway capacity. Autonomous vehicles will likely decrease the cost of congestion and increase fuel economy.

However, Krasniqi and Hajrizi (2016), have stated the possible disadvantages of autonomous vehicles. Initially, the potential impact on business and the economy through public transport, car insurance, and services. For example, an association of insurance companies in the United States warned that autonomous cars could seriously affect their business. In addition, the possibility of increasing traffic congestion due to lower driving costs. Moreover, the possibility of increasing the cost of car prices for users. As road maintenance services will be improved, and costs will be raised. In addition, it would affect employment as many jobs will become unnecessary without drivers. For instance, it would affect income of taxi and bus drivers. Furthermore, if car crashes decline significantly, it would affect other industries such as insurance companies (Anderson et al., 2014; Jensen, 2018 Stilgoe, 2021). To conclude, Jensen, (2018) and Stilgoe, (2021), have provided arguments regarding the safety of these cars, particularly in the case of the Tesla model, which combines features of AV and human intervention. Such technology, as Google indicated, is not intuitive leading to further accidents.

2.6.2. Classification of Autonomous Vehicles

Automated driving capabilities are classified into five levels from basic driver assistance (L0) to fully automatic (L4) by the Society of Automotive Engineers (SAE). The SAE is a global standards development and professional association of engineers and technical experts in mobility engineering. This is an industry convention for categorising automated capabilities provided by Original Equipment Manufacturers (OEMs) in assisting drivers. The latest version of these automation levels, released by SAE International in December 2018, highlights clear differences between the levels (SMMT, 2019). Table 2.2 provides important information for this research regarding autonomous vehicles distinguish levels of AVs, for example, when the vehicle is almost semi-autonomous or completely fully autonomous.

As mentioned by Hecht (2018), level 1 automatics are described under cruise control (“feet off”); level 2 (“hands off”), Tesla “Autopilot”; system and when the driver is ready to take operational control; Up to level 3 (“mind off”), which can suspend control if necessary and become fully automated. Whereas level 4 vehicles do not require a driver at all. Levels 3 and 4 create a well-organised grid of autonomous car development and achieve difficult goals such as monitoring the environment, increasing safety and reducing traffic jams. This information will be useful in terms of this research in terms of how each level is attainable in an autonomous vehicle.

Table 2-2: Levels of Automation adapted from Kun et al., (2016)

Level	Description	Example
0	The car has no automation.	None.
1	The driver can disengage from either the pedals or the steering wheel.	(Adaptive) cruise control.
2	Driver can disengage both from either pedals or steering wheel.	Automated parking.
3	The car takes over full periods and notifies the driver to reengage when needed.	Highway driving automation.
4	The car is fully automated; no driving is required.	Google X autonomous vehicle without pedal or steering wheel.

- **Level 0, No Automation:**

The driver always controls the main controls of the car - the brakes, wheel, throttle and driving force completely and independently (Davidson and Spinoulas, 2015).

Level 0 shows that the driver is alone at all times and is responsible for its safe operation along the road and all control elements of the transport. Examples of this include systems that provide only warnings (e.g. collision warning, path departure warning, blind spot control) as well as additional automated control systems such as wipers, headlamps, turning signals and hazardous lights (NHTSA, 2013).

- **Level 1, Automation of Functions:**

According to Rajasekhar and Jaswal (2015), level 1 is the automation of specific functions such as cruise control, route and automated parallel parking control. Drivers are completely involved and responsible for overall driving (hands on the steering wheel as well as a foot on the pedal at all times). However, the vehicle still has some features that can help a controlled driver such as citing the aid stage nonetheless helping an individual during their driving.

One or more specific control functions of automation are included in level 1. This level includes electronic stability controls or pre-charged brakes, (where a car driver will help brake), allowing the vehicle to regain control or stop faster than it would be possible to do by acting alone (Davidson and Spinoulas, 2015). This research is consistent with these studies and found to be extremely useful in providing in-depth information to describe level 1 as a second step for vehicles to be autonomous.

The National Highway Traffic Safety Administration (NHTSA) is an agency of the US federal government which is part of the Department of Transportation. In 2013, NHTSA stated that if several functions are automated, they work independently of each other. The driver has overall control and is responsible for safe operation; however, they can choose limited primary control authority (such as cruise adaptive controls), and the transport can have limited primary control authority (like constraint management) automatically. However, an automated system can provide additional control for the driver to assist within certain driving or distressing conditions (e.g. support dynamic braking in emergencies). Furthermore, according to NHTSA, the vehicle may have several capabilities combining personal driver support and accident response technology. Nevertheless, it does not replace driver vigilance and does not bear transport responsibility from the driver. An automated transport system helps or increases the control driver with one of the main controls or brake/throttle control (but not both).

As a result, vehicle control systems can't work together, allowing the driver to keep their hand off the steering wheel and pedal behind the wheel at the same time and separate the vehicle from the physical control. As the table highlights, this might be a difficult thing to implement when developing autonomous vehicles, and from a research perspective, if this can be achieved, then it means that the vehicle can become fully autonomous. Examples of automated systems functions are cruise control, automatic braking and lane retention (NHTSA, 2013).

- **Level 2, Layer-Automation of Integrated Functions:**

This means that several integrated control functions are automated, such as adaptive cruise control using band centring. Drivers are expected to be responsible for traffic control and can always be controlled, though in certain cases, vehicles such as critical safety cases can be stopped (Rajasekhar and Jaswal, 2015).

As Davidson and Spinoulas (2015) have noted, level 2 includes the automation of two main management functions designed to synchronise drivers to facilitate their management. An example of combined features that include a level 2 system is adaptive cruise management combined with band centralisation. This research clarifies the point that there needs to be more safety controls and a more efficient way to keep drivers informed that the car is still under control for the full automation of vehicles to become a reality. Vehicles of this level of automation may enjoy when the driver refuses to transfer active primary control under certain restricted driving conditions. The driver is still responsible for the safety and security of the road and can be controlled at all times and at a moment's notice. The system can opt out of control without prior notice, and the driver must be ready to provide safe transport control.

The main difference between the first level and the second level is that the operating state of the system on the second level as an automated mode of operation is activated, whereby the driver's hand is now disconnected from the physical control of the vehicle (NHTSA, 2013). These NHTSA studies are an important and useful source of knowledge which suggests how a car might go about creating ideal levels to achieve the primary goal of making a vehicle fully autonomous.

- **Level 3, Limited Self-Driving Automatics:**

Drivers may, in certain cases, take all dangerous functions and follow the change in conditions requiring the vehicle to be brought under the control of the driver (Rajasekhar and Jaswal, 2015).

Vehicles of this level of automation allow the driver to fully control all functions ensuring safety under certain traffic or environmental conditions, in which case the vehicle can be trusted to monitor changes in conditions requiring a transition to driver control. The driver can be controlled randomly, yet the passage time is sufficient. Google's car is an example of limited self-driving automation (Davidson and Spinoulas, 2015). The limitation of this research is that these authors modelled levels 3 and 4 with little or no input from the human driver instead, they looked at the short to mid-range introduction of autonomous vehicles as there would be a combination of hand-driven vehicles (with growing degrees of restricted autonomy) as users are currently seeking to create fully autonomous vehicles. According to NHTSA (2013), the car is designed to ensure a safe automatic control mode. For example, there may be an automated or AV, specifically a switch-over alarm system for a control assignment, ensuring that the system cannot support automation from an already underway construction zone and then be passed to the driver. Figure 2.2 shows an appropriate amount of transient time is needed to safely restore manual control. The main difference between level 2 and level 3 is that the level 3 vehicle is not designed to constantly track the road while the driver is driving.

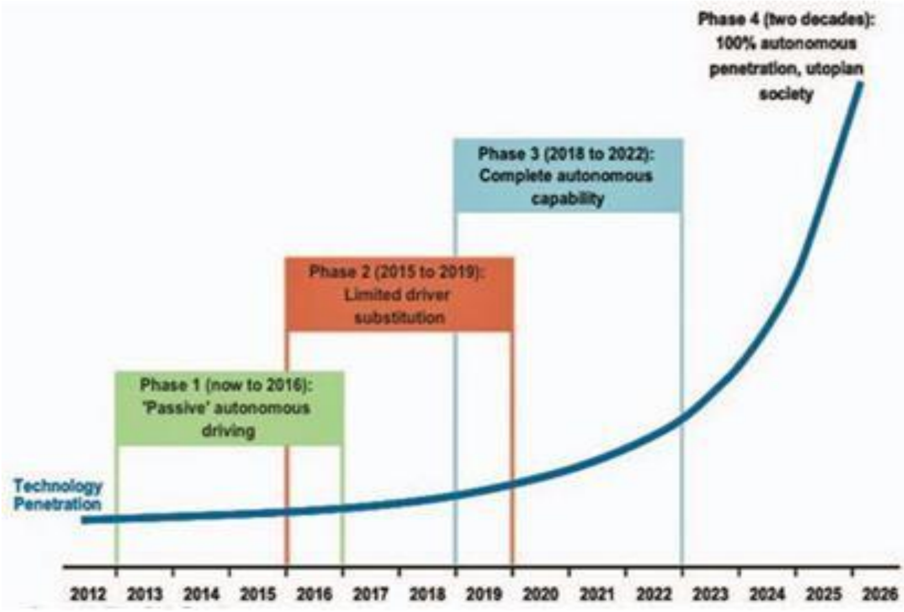


Figure 2-2: Timelines for Adoption adapted from (Rajasekhar and Jaswal, 2015)

- **Level 4, Full Self-Driving Automation:**

The car is designed to perform all safety functions and monitor the situation on the way until a destination is reached. Such a design assumes that the driver is designed to provide navigation access, yet they are not available to control it at any time during the journey (Davidson and Spinoulas, 2015).

As Rajasekhar and Jaswal (2015) stated, vehicles can perform all driving functions and monitor the situation on the road, therefore that they can work with people who cannot drive and move without assistance (such as disabled people). However, many automotive manufacturers have begun to test their prototypes; despite this there remains a long way to go before autonomous vehicles can be fully relied upon for unparalleled accuracy and reliability. Autonomous vehicles have a long-term impact on society, which leads to fundamental changes in our work such as saving time and improving safety. However, the transition from normal to an autonomous car should take place gradually for people to be able to trust the technology which will lead to it being used on a much wider scale. Half of the consumers in the world have confidence in a car that works without a human driver, as reported by Rajasekhar and Jaswal (2015). Cisco Systems, a leading global technology conglomerate surveyed more than 1,500 consumers in 10 countries and drew attention to the experience of buying and driving cars. This research refers to these studies as having demonstrated useful knowledge and meaningful benefits for level 4 that can be used for specific reasons such as disabled people. Additionally, Rajasekhar and Jaswal demonstrated an example of a positive impact (to do with safety, the environment and society) through a Google car they then gathered user opinions on AV including the United Kingdom where less than half of surveyed trusted AVs at 45% as shown in Figure 2.3.

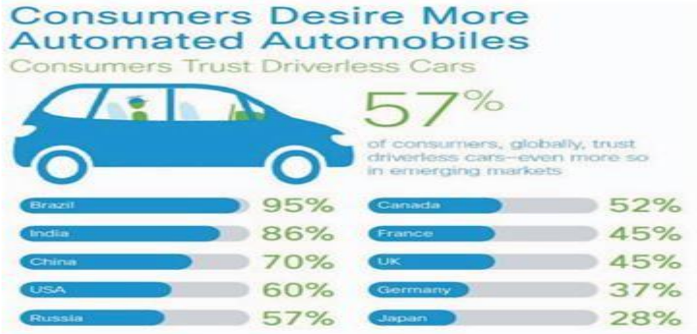


Figure 2-3: Cisco Surveys for Autonomous Vehicles adapted from (Rajasekhar and Jaswal, 2015)

2.6.3. Development and Deployment of Autonomous Vehicles

Autonomous transport is currently being developed and many modern cars have Level 1 and 2 technology such as cruise control, hazard warning and automatic parallel parking. Tesla's autopilot offers automatic control and acceleration under limited conditions, although this is a delay in evolution after the accident in 2016. Several companies have Level 3 pilots who experience motor vehicles under certain conditions, however, despite these advances, many technical Improvements still need to be made. Under normal conditions, cars must operate efficiently before they can become autonomous.

In addition, Litman (2017) noted that autonomous vehicle technologies are widely commercial, reliable and affordable. Therefore, several stages are necessary for the wide distribution of vehicles. Considering vehicles can have a large impact on costs, such as congestion and accident risk, their testing and regulation standards are higher than many other technological innovations. In particular, personal computers and mobile phones as reported by SAE. Testing and fixing in optimal conditions takes several years, because if the technology is not reliable and becomes dangerous, then even autonomous cars will either cause or be susceptible to fatal accidents. Different jurisdictions will be different depending on the country and the company.

According to Litman (2017), the new technologies generally correspond to the S-curve development model revealed in Figure 2.4. Where the original concept usually experiences "development, testing, approval, commercial output, product improvement, market expansion, differentiation, improvement, and eventually saturation and decline". Autonomous automotive technology follows this method.

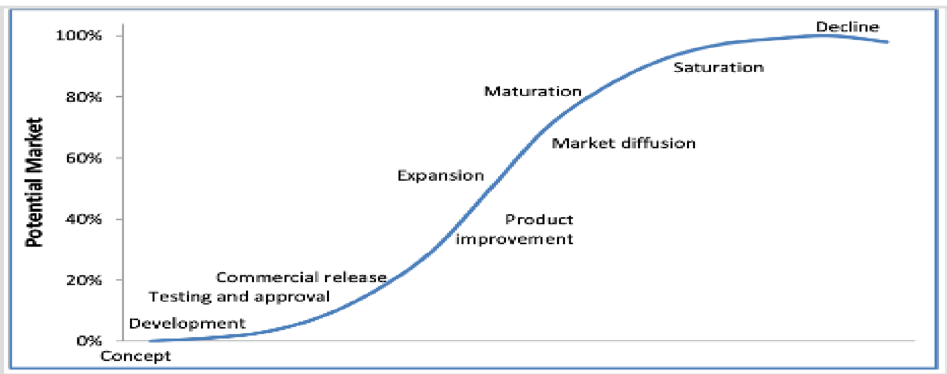


Figure 2-4: Innovation S-Curve for Autonomous Vehicles adapted from (Litman, 2017)

Even though modern technologies operate in autonomous mode on highways allocated for cars, 95% (in good weather) achieve efficiency (cannot reach the remaining 5% of necessary routes). Therefore, achieving 99.9% efficiency will be difficult. Litman's research contains useful, primary information about autonomous vehicles and helpfully created a model (the S-Curve) to demonstrate the best way to conduct a process to obtain potential success in AVs.

2.6.4. Autonomous Technology Overview

The common convergence of the IoT and pervasive computing is autonomous vehicle technology. Kong et al., (2017), pervasive computing provides navigation based on GPS, a map service and road conditions. An autonomous vehicle can determine its driving strategy by assessing the microelement of dynamic environmental sensors. As Heutger and Kückelhaus, (2014), noted over the years, autonomous technology has been used in many different types of applications. The use of autopilot technology by air campaigns as standard equipment in the field of aviation is considered to be a common occurrence. Moreover, globally, in many cities and airports, international societies can see the work of fully automated trains which allows people to gain familiarity with AVs.

In addition, many modern cars have autonomous functions such as an anti-lock braking system and cruise control. In addition, the primary control element can also be controlled by many advanced functions in addition to auxiliary ones. Adaptive cruise control is the clearest example that has recently been installed in modern cars (Heutger, and Kückelhaus, 2014). This technology helps keep the distance between a conventional or uncontrolled vehicle in front (see Figure 2.5).

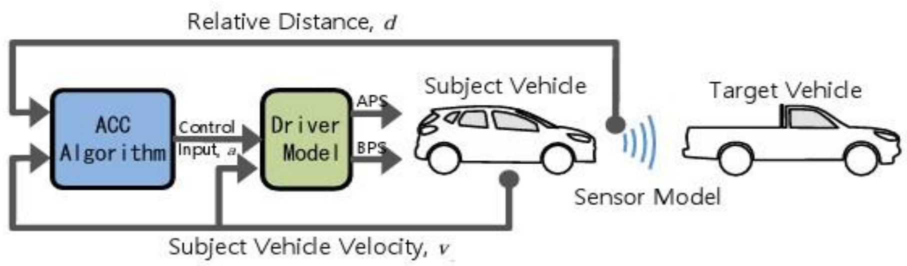


Figure 2-5: Adaptive Cruise Control System adapted from (Park and Lee, 2017)

These technologies do not fully work autonomously, nevertheless, they are very important and useful for drivers. Heutger and Kückelhaus, (2014), identified important functions for fully autonomous control: navigation and situational analysis. These functions are described below.

2.6.4.1. Navigation

Autonomous navigation is a technology that does not require any human intervention and can be used independently in a static and dynamic environment for the safe movement of vehicles, which can be land, sea, air or deep space. This method helps to improve movement planning, and route forecasting, in dynamic environments. The effect of this is to achieve optimised fuel use and driver comfort (Rahiman and Zainal, 2013). Moreover, navigation is considered to be the main method of planning a journey. It works by recounting a digital map, which allows users to get information about the place, details of roads and even weather forecasts. Vehicles are currently using GPS to complete route planning. However, navigation in a fully autonomous vehicle is improved by incorporating V2V connectivity and V2I (further information will be provided about this and new technologies).

GPS and other satellite-based navigation systems rely on signals within the vehicle between the receiver and multiple systems satellites. Inevitable environmental factors such as dense trees, steep roads, tall surrounding buildings, or thick clouds can interfere with the radio signals used to support a GPS. To support a stable connection between signals and satellites, autonomous transports require stronger receivers and powerful infrastructure. In addition to this, in order to communicate with other vehicles in front of them, the use of V2V technology is effective and helps them get more accurate routes (Liu, 2023).

2.6.4.2. Location Data

Providing information about the situation on the ground it is called the user to the GPS, which is considered as a set of the satellite. In the early 1970s, the US Department of Defense developed this navigation system. Initially, the purpose of its use was only intended to be used within the military sphere, however, its use for civilians has now become available. Anywhere in the world, a user using GPS can get accurate information about location, position and time. In this case, the user will only be able to receive information, yet cannot send information back, which makes this system one-way. The reason is that it is necessary for safety, as well as for the unrestricted use of people (Rahiman and Zainal, 2013). The most important advantage of GPS is that the subsequent data are not dependent on the previous ones, thus, errors decrease over time. The drawback, a GPS depends on the number of satellites and the certain environment.

As Rahiman and Zainal (2013), stated during testing, there was a problem when the GPS could not receive signals inside the building**.** Based on this, it was revealed that this was not because of the model; it was because of the GPS antenna, which should have a view of the sky. For vehicle localisation, GPS can provide accurate real-time data updates. There are several reasons not to rely on this, such as problems associated with multipath propagation, which means that the signal is deposited from the building while making more noise. In addition, sky-viewing requirements will not allow the GPS to work indoors (Shaoshan et al., 2017). This is considered to be one of the many problems in autonomous vehicles that need to be addressed.

Additionally, Shaoshan et al., (2017) stated, that autonomous vehicles receive assistance from the system's GPS and an Inertial Measurement Unit (IMU) for localisation since the system is reported as an inertial update singular, as well as on the global assessment of locations at high speed. GPS is considered an accurate system for determining localisation, nevertheless, because its update rate is low, it is not able to provide real-time updates. On the other hand, the accuracy of the IMU decreases with time, because of this, location updates for long periods are not provided. Consequently, the integration between the GPS and IMU can provide real-time accurate updates for localisation of the autonomous vehicle. However, relying on them is not possible because of: 1) the accuracy is about one meter; 2) problems with the multipath propagation of the GPS signal, which is reflected from buildings, creating noise; 3) GPS requires a clear sky view, which means in some places it does not work.

2.6.5. Sensors for Autonomous Vehicles

To ensure that an autonomous system knows about all the relevant objects and their movements, a situational analysis tracks the environment in which the vehicle is moving. This is about the ability of the vehicle to monitor the environment, including all relevant objects and their movements. This function requires the use of various sensors usually visual images, radars, LIDAR and ultrasonic. The final goal is to gather the collected data so that the car is constantly aware of its surroundings and can decide what to do (Tang et al., 2021; Subitha, et al., 2022 and Liu, 2023).

In the words of Shaoshan et al., (2017), autonomous vehicles consist of several major sensors. Indeed, since each type of sensor has its advantages and disadvantages, in autonomous vehicles, data from multiple sensors must be combined to improve reliability and safety.

The combination of different sensors (radars, LiDAR, ultrasonic and cameras) provides a better range and accuracy than the human visual ability and hearing can provide when collecting environmental data. Typically, a person can only pay attention to objects close to a 60-degree angle, and sensor systems, as shown in Figure 2.6, have a full 360-degree temporal field of view of the day (Liu, 2023).

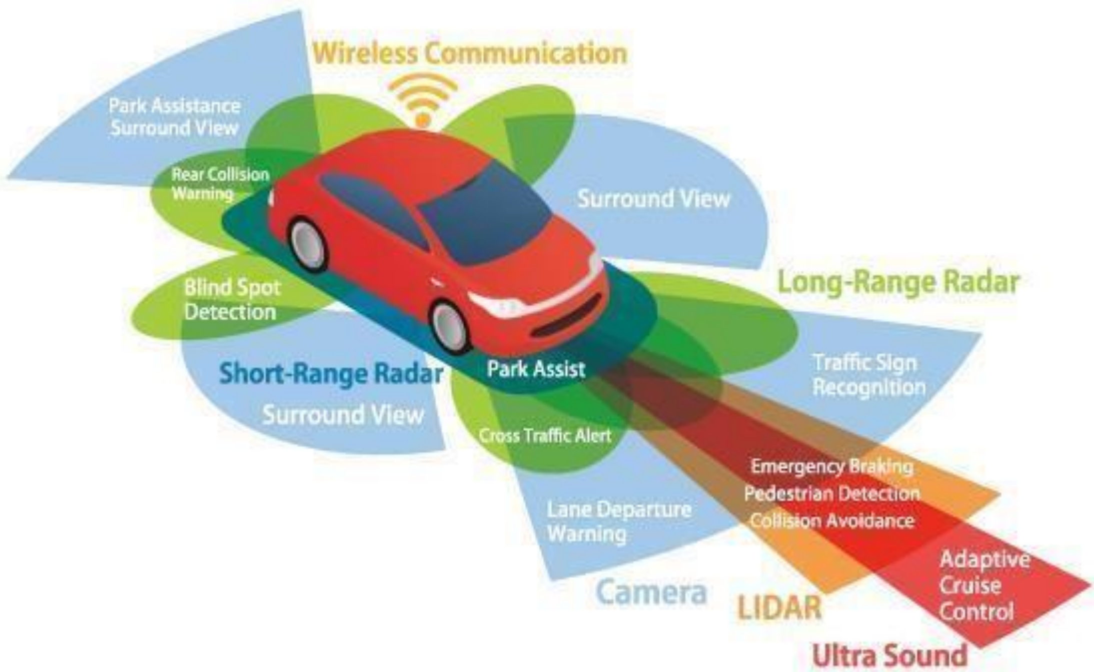


Figure 2-6: The Technologies Behind Autonomous Vehicles adapted from (Chehri and Mouftah, 2019)

2.6.5.1. Radar

On the topic of" Radio Detecting and Ranging" radio waves and their reflections are used to determine the range, angle, and speed of radar objects. Tang et al., (2021) and Subitha, et al., (2022), mentioned that the accuracy of a radar is often not affected by environmental conditions such as fog, rain, wind, or light, but its ability to determine shape depends on its reflected force, its size, distance from radars, the absorption of radio waves, characteristics, reflection angle, and transfer force of the object. The car has a large number of reflections that can be detected, still, the system must identify pedestrians, bicycles, and motorcycles that may not be visible, as well as solid or metal parts that indicate radar signals. Waves may be lost from a bicycle in a difficult situation on a cargo transport; people near the vehicle may be unknown to the radio receiver. In contrast, the metal-like substance may not match the actual size of the radar image, which may cause the control system to make an incorrect decision.

According to (Liu, 2017), Radar and ultrasonic systems are mainly used as the final line of protection to prevent interference. The data obtained by radar and ultrasound reflect the distance to the object in front of the highway. If an object is detected in the vicinity, there may be a risk of collision, and the autonomous vehicle must turn or deploy the brakes to prevent obstacles. Therefore, data triggered by radar does not require more processing and is usually sent directly to the control processor, so to perform "urgent" functions such as deceleration, or stretching, rather than through the main computing pipes (Liu, 2017).

2.6.5.2. Ultrasound Diagnostics

As stated by Bagloee et al., (2016), this is a detection system based on transmitting/receiving acoustic (sound) energy in the form of waves with a frequency exceeding the auditory ability of a person. The operation is similar to radar, however high-frequency acoustic waves are transmitted and received. These sensors provide accuracy over a short distance (1-10m). Given the relatively low price compared to other sensors, ultrasonic capabilities are important for backup warning systems and Parking support systems

Because of the low cost, ultrasonic sensors are widely implemented in modern cars for parking assistance systems, though other sensors are designed for a high-end feature. Car manufacturers (such as Tesla) can opt out of LiDAR, whereas developers of autonomous vehicle prototypes (such as Google and Stanford) can use sensors. Besides, different from LiDAR, ultrasonic sensors only think about the nearest obstacles. This means that only the first justified upgrades are processed, and the following options are not completely ignored. Thus, to be effective, false transformations must be ahead of real people, i.e. false measurements can only be taken (Yan et al., 2016).

2.6.5.3. Camera

Camera-based systems are inexpensive devices that ‘‘see’’ and involve a very long distance. It is necessary to explain the rich data collected from the Cameras due to low accuracy (Bagloee et al., 2016). For example, Tesla uses a forward-facing camera to recognise lanes and road signs. Features based on this technology include automatic centralisation and lane change, trackless warning, and speed limit display (Yan et al., 2016 and Liu, 2023).

Moreover, Shaoshan, (2017) stated, that to improve autonomous vehicle safety, current programs usually install eight or more cameras around the vehicle, so autonomous vehicles can use cameras to detect, recognise, and monitor objects in front, behind, and on both sides of vehicles. Additionally, Chehri and Mouftah, (2019) noted, that vision systems cameras and radars are used to monitor the road and the environment. Each of these sensors has internal characteristics that limit its operation, so there is an idea of combining information sources. Chehri and Mouftah’s example is that cameras provide relevant information at the scene of an accident however are very sensitive to changes in brightness and contrast. The ability to detect cameras in adverse weather conditions (such as fog, rain, snow, etc.), is affected by a sudden change of light and a dark area (i.e. the entrance or exit to a road tunnel). To address these shortcomings, camera vision systems are often associated with an effective radar in adverse weather.

2.6.5.4. LiDAR

As Liu, (2023) mentioned, LiDAR operates on the same principles as radar however instead of radio waves, LiDARs use laser pulses. According to Waymo’s actual sheet, the LiDAR laser hits millions of pulses at a very high speed in one second and measures how long it takes to reflect that laser surface. This creates a real, three-dimensional image of a person, vehicle, cloud, or mountain. Compared to the radar, LiDAR has significantly improved at creating 3D images as displayed in Figure 2.7, which helps the system determine not only objects nevertheless but also the direction of movement of objects. However, LiDAR is also more expensive, has a short range, and has a higher risk of particle failure than radar.

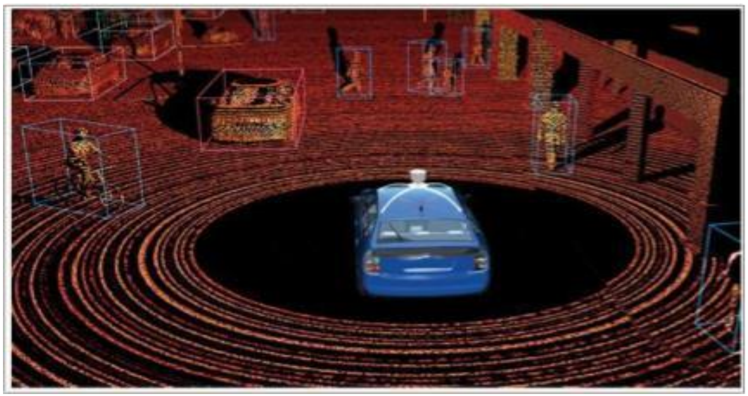


Figure 2-7: LIDAR for Autonomous Vehicle adapted from (Chehri and Mouftah, 2019)

Furthermore, LiDAR is used to create a map, localise it, and prevent obstacles. It works by rotating the surface of the laser radiation and measuring the reflection time to determine the distance. Due to its high accuracy, it is used as the main sensor in most autonomous vehicles. LiDAR can be used in the production of high-resolution maps, and localisation of vehicles in motion, to identify obstacles ahead. However, there are two main problems with LiDAR, first, measurement can be very noisy when there are a lot of raindrops and dusty particles in the air. Second, LiDAR installation is very expensive (Shaoshan et al., 2017).

Additionally, Kong et al., (2017) reported, that a vehicle's sensor system is not sufficient only for car cruising. Firstly, due to limited vision, there are blind spots in LiDAR and other sensors (for example, vehicles cannot overtake the car ahead, this can overcome difficulties). Secondly, the sensors do not work perfectly in bad weather. The LiDAR sensitivity range is often reduced in heavy rain or snow. Thirdly, it is not easy to determine the harmlessness or absence of a small object; for example, with proper accounting for plastic bags or small protection devices, driving efficiency can lead to a decrease. Fourthly, LiDAR can identify a person although not accurately, or recognise a person's actions; for example, sensors have difficulty distinguishing between "Go" and "Stop" police movements. In addition, there are some major issues associated with the technology, such as not seeing it behind a solid surface, otherwise, the progress with LIDAR continues, which takes time until this technology is fully operational. Recently, Chehri and Mouftah, (2019) noted that major technology companies like Google have started using LIDAR for autonomous cars.

Examples of a Critical Situation in AVs

Kong et al., (2017); Jensen (2018); Nees (2019); Stilgoe (2021) and Liu, (2023), studies reported that engineers have been trying to generate a suitable combination between sensors to detect the environment surrounding vehicles. Some defects must be considered to reduce them for the sake of vehicle safety. The next part of this research will show some cases of accidents caused by these defects.

The first problem is that the sensors do not detect information around the car. Each sensor has its specific characteristics: a limitation of GPS is needed a clear view of the sky; cameras work with sufficient light; further LiDAR unable to work in fog, and radar is not exactly accurate. There cannot be another sensor with different capabilities. It is known in the industry that the ideal set of sensors for autonomous transport is currently unknown and the solution (as a limiting factor in the quality of costs and processing capacity) can no longer be included.

The second serious problem arises when the car is faced with a situation that the people who wrote its software did not plan. For instance, when the truck driver does not see the shuttle and does not return to it. Similar to human drivers, autonomous vehicle systems must make hundreds of decisions every second, adapting to new information coming from the environment. When an autonomous vehicle experiences something that it is not programmed for, it usually stops or pulls over and waits for the situation to change. The UK shuttle was reported to be waiting for the truck to get out of the way before moving on, nevertheless, the truck continued to approach. The shuttle may not have been programmed to signal or reverse in such situations, or perhaps it did not have room to do so.

Essentially, this research is consistent with the above studies, as this serious problem can have a major impact on autonomous vehicles. As high-quality sensors require a large amount of money, my research will try to discover the best way to reduce this to obtain high-quality autonomous cars with high-quality sensors. this study will also seek to demonstrate possible solutions regarding other issues such as bad weather conditions and sensor data capacity. Thus, these studies state that these issues must be looked at to generate potential success in advance for AVs.

However, previous scholars, reported every sensor in the suite has its strong and weak points. Ultrasound is useful for detecting nearby parking facilities, however, the sensor's range is too limited for it to be used on an autonomous vehicle successfully. The cameras show the local environment, yet they do not measure the distance. The radar measures distance and speed although within the limited resolution. LiDAR detects the distance of cloud points from the local environment, except it has a limited range and is expensive. Hence, expanding the range of the LiDAR and declining its costs, is a major challenge to make self-driving a daily reality. Consequently, scholars did offer a possible solution: autonomous vehicles need to use 5G to overcome sensor deficiencies and achieve high-quality sensors that can help with bad weather. The above studies also showed how sensors can be helped to compensate for the lack of data capability to generate maximum functionality for sensors in terms of safety, which is useful for this research because it will lead to the great success of AVs in industrial operations.

2.6.6. Vehicular Communication Systems

To meet big data needs in autonomous cars, Kong et al., (2017) and Quyoom et al., (2020) created created the new mmWave car system. The ideal transport system provides services based on V2V and V2I technologies, Figure 2.8 shows where any vehicle can connect to another vehicle or roadside infrastructure. The suggested system consists of three main points:

- Each autonomous car is equipped with a mmWave radio, LiDAR, cameras and other simple sensors.
- Roadside infrastructure consists of an HD camera, a wave radio and a wired connection to the cloud.
- Cloud computing has a strong computing power for data analysis and path planning.

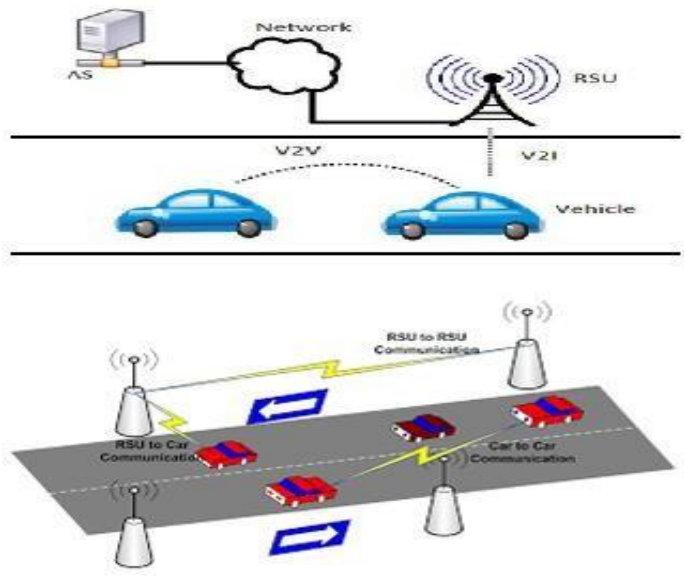


Figure 2-8: mmWave System for V2V and V2I adapted from (Quyoom et al., 2020)

Essentially, as stated earlier, 5G mmWave attempted to resolve all sensor faults and in some cases offered a potential solution. As described above, researchers have tried to examine some important issues, especially poor weather conditions and lack of sensor data capacity. Kong has clearly shown how the V2V can help the sensors to continue their work by sharing data with LiDAR and cameras and providing a clear view of autonomous vehicles to prevent any possible accidents. In addition, of particular use to this research was their discussion on how they used V2I to predict people's random movements by giving support data to sensors to generate high safety standards and prevent road traffic accidents from occurring (Kong et al., 2017 and Quyoom et al., 2020).

Moreover, El-Said et al., studies (2017) were equally useful due to their analysis of other critical situations on the roads when an accident occurred and their suggestions of how to avoid the situation without any risk. El-Said et al., (2017) noted that information will be collected by sensors such as radar, cameras, and LiDAR to identify objects by sending a laser beam to determine the distance between the vehicle and nearby things. Therefore, it is important for road safety to share the information collected with other vehicles through V2V. In bad weather, the driver's vision ranges from 0.1 km to 1 km. Thus, to ensure driver safety in this range of visibility (0.1 km to 1 km), nearby drivers must be informed of the bad weather conditions.

In this section, the autonomous vehicles will be concerned with the possibility of making the right decision when an accident occurs on the road which El-Said et al., (2017) considered in their studies. In the study it was noted that when the road was involved in an accident that autonomous vehicles will send messages to each other to avoid any bad situations. These suggested strategies are also supported by Kong’s research since the ability to be able to warn autonomous vehicles before an accident happens is of the highest priority. However, this study is concerned with how sensors can be prioritised and how the priority of data can determine which sensor data can be transmitted.

Consequently, V2V messages are designed to support a communication range of approximately 0.3 km that exceeds the capacity of the sensor systems. For these short communications, various technologies such as DSRC and mmWave will be required. Although DSRC is the preferred technology for V2V communications today, El-Said et al., (2017), have argued that DSRC may not be an effective solution for V2V connections to support high-speed data rates for raw data exchange between vehicles generated by sensors. Therefore, mmWave will be a viable solution in the future. This research is consistent with the El-Said et al., (2017), argument that considered mmWave to be the best choice for autonomous vehicles as it supports various strategies such as V2V and V2I by providing missing data in critical situations.

As shown in Figure 2.9, V2V based on mmWave communication technology can connect various advanced driver assistance systems such as car crashes at a rate of 1,000 messages per second, which is faster than any other autonomous vehicle sensors. Thus, it is important to enhance short-range communication technologies (radars, cameras and LIDARs) with V2V technologies (mmWave) in order to provide an effective solution for disseminating information instead of using only one approach.

Figure 2-9: Road Hazard Warning Message adapted from (El-Said et al., 2017)

2.6.7. Autonomous Vehicle Applications

2.6.7.1. Vehicle-to-Vehicle Applications (V2V)

V2V technology was developed to support connected mobility through sharing and data exchange among vehicles. It enhances the potential for short-range communications and increases safety and awareness applications between interconnected vehicle systems and sensors. V2V enables vehicles to access information based on speed, distance, and efficiency from another V2V application accessed from a 5G connection (Ni et al., 2018). The aim is to alert drivers of other V2V-connected vehicles, which could reduce the possibility of accidents.

Table 2-3: Vehicle-to-Vehicle (V2V) Applications

Applications
Breakdown of equipment location, cruise control system and identification of overlaps
Navigation
Forward collision warning
Blind spot warning and lane change
Electronic emergency brake light system

As shown in Table 2.3, the applications included equipment breakdown, dedicated short-range communications technology and V2V sensors being applied in smarter navigation. The V2V cruise control system aims to detect hazardous traffic and road conditions and identify challenges that may arise within 300 meters of the vehicle. This presents drivers with the possibility of understanding and analysing the conditions and behaviour of other vehicles under adverse driving conditions. It also included definitions of overlaps that analyse the potential behaviour of other drivers who might alter routes with no notice (Han et al., 2020). The application defines how the previous vehicle can interact and maintain speed and distance from other cars without causing any damage or noticeable accidents. Additionally, the V2V application has also been developed and divided into three separate categories for more modern applications such as lane change, electronic emergency brake light and forward collision warning (Martinez et al., 2010).

Initially, lane change assist is the most similar to the original application, as it also focuses on providing detection and avoidance systems when the vehicle attempts to move from one lane to another. Additionally, Harding et al., (2014) stated that blind-spot warning and lane-change warning systems are used to alert the driver to the host vehicle while attempting to change lanes if the blind spot area to which the host vehicle intends to switch is occupied or will soon be occupied by another vehicle travelling in the same direction. Besides, the application of V2V provides the host vehicle driver with guidance information stating that the vehicle is in an adjacent lane placed in the vehicle's "blind spot" area when no lane change is attempted.

Furthermore, studies by Martinez et al., (2010), stated that the electronic emergency brake light uses messages from vehicles in front of the driver in the same lane to determine whether they are braking. This was developed to mitigate the issue where the brake lights in front of the vehicle were not on display due to dimming. Through these three technologies, vehicles provide warnings about the left and right vehicles near them when merging, warnings about the vehicle in front, and warnings about the vehicles ahead, providing a more comprehensive set of detection and avoidance technologies.

To conclude, a forward collision warning tries to use short-range information from the vehicle ahead to help avoid a collision with that vehicle. If this vehicle stops suddenly, the forward collision warning system is expected to notice it and initiate braking to help the driver avoid this collision (Martinez et al., 2010 and Chen et al., 2006). Furthermore, Harding et al., (2014), believed that based on current technology, forward collision warning systems using radar or cameras cannot provide a warning fast enough for high-speed rear collisions. By contrast, the V2V has that capability based on its further range (300 meters). Consequently, fatal rear accidents are one area where this study believes V2V could provide some benefits that are likely not covered by radar and camera-based systems.

2.6.7.2. Vehicle-to-Infrastructure Application (V2I)

The vehicle-to-infrastructure application is the most advanced and developed concept of autonomous vehicle technologies that can connect to modern traffic infrastructure. It aims to obtain data and information related to traffic congestion and conditions including weather, and bridge clearance as well as it is important to be aware of several safety utilities (Outay et al., 2019). It also includes intelligent traffic lights that are powered and developed by applications of V2I technologies. Bento et al., (2019) have already adopted smart traffic signals and have implemented them in the installation of technologies, which are linked to AVs and thus help them to understand the consequences of traffic situations and road conditions. Similarly, the purpose of Nguyen et al., (2020), study was to analyse connected and tracked computer networks and thus enable systems to account for vehicles connected to technology, information instructions and traffic data to other vehicles, and thus inform them of roads and congestion. This is enabled with the help of traffic navigation systems.

Table 2-4: Vehicle-to-Infrastructure (V2I) Applications

Applications
Collision reduction system
Smart traffic light
Congestion control
Parking spot locator

Infrastructure data systems are implemented and developed by V2I technologies that allow autonomous vehicles to record the data they send to local forecasts about current road conditions, accidents and weather conditions. Table 2.4 shows the road collision systems registrations and Lidar sensor installations made it possible to record fatalities and accidents according to traditional data and information initiation techniques, and vehicles developed and implemented using V2I technologies (Xu et al., 2020). Besides, the researchers mentioned that the benefits that would be offered to drivers if V2I technology was installed in their vehicles would allow them to determine the response to V2I warnings that start with smart traffic lights. Interactions between applications started from intelligent transportation systems, thus initiating warning systems for potential drivers connected to V2I technologies (Stefanovic et al., 2018).

Congestion control application will broadcast a message to all vehicles behind the monitored congestion spot so that they can be warned about their presence and take steps to avoid getting into congestion as well. This may differ from what other technologies may know about the situation in that it will have a much faster response time, with the ability to begin notifying vehicles behind the accident almost as soon as it occurs. This may allow drivers to be better informed and be able to respond faster to avoid certain sections of the road, thus reducing the number of vehicles stuck behind backups (Toh, 2007). This will provide several potential benefits, including reducing the amount of energy consumed by vehicles left behind backups, reducing the average time it takes for vehicles to reach their intended destination, and making it easier for emergency responders to reach the scene (Kumar et al., 2013) and (Martinez et al., 2010). Lastly, autonomous vehicle systems also provide a convenient platform for creating new parking technologies (Kumar et al., 2013 and Arif, et al., 2020). The devices can use communications from AV systems to monitor the number of vehicles inside the car park (Kumar et al., 2013 and Mathur et al., 2009). This can allow passing vehicles to be notified of whether the parking lot they were driving in front of is full or not and can reduce the potential for users to waste time entering an already full car park. Additionally, this can be used to create a comprehensive list of nearby parking areas where parking spaces remain, allowing users to easily navigate to the closest available location (Lee et al., 2008).

Consequently, the recent studies of constructed autonomous vehicle applications that were examined earlier are beneficial for this research in terms of the fact that they provide information on the different areas and types of V2V and V2I applications that will need to be addressed and placed into AV which led to o achieve vehicle targets such as improving safety and high security. Therefore, this research believes that they are important applications that can influence AV technology to enhance road safety. To do so, this research will attempt to examine the development of a conceptual framework for understanding the adoption drivers of autonomous vehicle technologies such as V2V and V2I using TAM. Additionally, the purpose is to learn the fundamentals of autonomous vehicles in the context of the technology acceptance model. The initial goal of the current study is to create an immersive experience on TAM to compare the state of the AVs before and after the experience, specifically in terms of V2V and V2I technologies.

2.7. Role of Automotive Industry

The models for evaluating technology acceptance presented in this study demonstrate that technology acceptance is a multifaceted issue. This is not distinct from the situation with autonomous vehicles, as evidence suggests that many individuals are cautious about controlling a computer and have concerns about the technology (Quain, 2016). Although most of the models examined focus on the acceptance of potential technology users, it is also essential to include car manufacturers. Nordhoff et al. (2016) claim that it is crucial to integrate the perspectives and expectations of manufacturers who may be involved in the use, operation, or decision-making process regarding the implementation of AVs. They additionally note that this area has not been given the necessary attention.

The introduction of AVs has the potential to bring about numerous societal benefits. Therefore, it is imperative for the government and legislators to play a proactive and integral role in encouraging the adoption of technology. This can be achieved by implementing intelligent infrastructure, supporting automotive companies in their research and development efforts, and, most importantly, addressing public concerns through legislative reform. For instance, the government could mandate that car manufacturers allow the driver to make the final control decision if a significant number of individuals are apprehensive about fully trusting the vehicle's autonomy (Khan et al., 2012). Addressing these concerns is not just a task, but a responsibility that we must all commit to, as it is crucial for the successful adoption of AVs. However, with the introduction of any new technology, unforeseen situations are likely to arise. For example, pedestrians may change their behaviour when crossing a street if they know that autonomous vehicles will eventually stop operating. The extent of these changes will depend on the market situation and the level of automation (Khan et al., 2012).

It is evident that the majority of the advancements in AV technology have been initiated by technology developers, with minimal evidence of a genuine market demand for autonomous vehicles (Khan, 2017). Therefore, automotive companies will be required to take on the responsibility of meticulously managing the expectations that accompany the introduction of AVs. This is because having excessive expectations of the technology before its implementation could undermine trust in the technology (Beggiato and Krems, 2013), further diminishing the demand for the technology. Additionally, car manufacturers must engage with all users to identify critical values that must be effectively integrated into the technology. This engagement is not just a task but a way to show that users are valued and integral to the process. It is frequently a challenging endeavour, as the majority does not always dictate the design of values, and the opinions of minorities may contain pertinent values (Taebi et al., 2014). It can be highly beneficial for manufacturers to have a comprehensive understanding of the desires and requirements of potential users, as this information can assist them in targeting a specific demographic in their marketing campaigns. AVs are anticipated to be costly during their initial development, which means that the technology will likely only include affordable vehicle models frequently purchased for driving. By identifying the factors that may contribute to the acceptance of AVs, it is possible to avoid targeting the incorrect demographic and to more effectively target early adopters and technology enthusiasts.

2.8. Pervasive Computing

By definition, pervasive computing is considered to be a vision of imperceptible computing power which is built into the world around us and that can be accessed through intelligent interfaces. As Weiser noted, “Its highest ideal is to make a computer so embedded, so fitting, so natural, that humans use it without even thinking about it”. This can mean that the transition to computer centres is aimed at working for people and adapting to their every need and desire, as well as losing the barrier between them and technologies. Moreover, people’s attitudes to Information and Communications Technology (ICT) can change and move to a new level of interaction with networking computing systems, the use of which will connect not only to the Internet or other computers, but also to places, household objects, and things that surround people (Saha and Mukherjee, 2003).

Such an achievement can transform people’s lives and affect some of its aspects. While Weiser worked on ubiquitous computing, as far back as 1991, it seemed impossible to implement his vision of installing computing power into objects, places, and devices. To date, Ley (2007), said that various elements of pervasive computing data are being developed and are useful like sensors, they save time, increase safety and improve communication, as an increasing number of devices and objects have a unique identifier that allows devices to be connected wirelessly.

According to Satyanarayanan, (2001), “The most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it”. With these words, Weiser began his work in 1991, describing his vision of ubiquitous computing, known as pervasive computing.

After Weiser’s work, computer technology went beyond pervasive computing. Advances in sensors, wireless communications, large-scale networks, and improvements in hardware have been able to advance Weiser’s viability concept in the technical and economic fields (Saha and Mukherjee, 2003). As mentioned by Taib et al., (2016) the term "pervasive" refers to something which "exists everywhere," implanted, mobile, flexible, everlasting and effective.

As Ley, (2007) and Taib et al., (2016) said the internet and web technologies have evolved rapidly, the fate of many ubiquitous computing applications cannot be predicted, however, there is a possibility that these technologies could reach a critical mass. Weiser witnessed three waves of computing: the era of mainframes, (when many people shared a computer); the wave of a personal computer, (one computer per person); and the transition to the pervasive computer wave where everyone uses many computers. The current state of the internet can be evaluated as a transitional stage between the PC and the pervasive waves as can be seen in Figure 2.10.

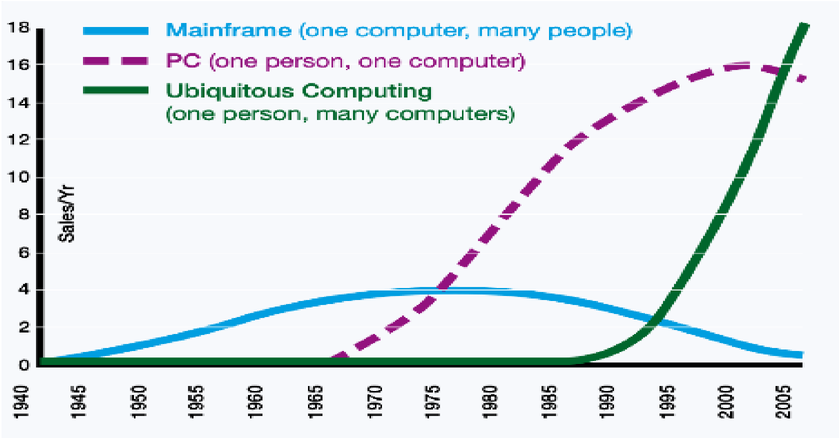


Figure 2-10: The Three Waves of Computing adapted from (Ley, 2007

As mentioned by Satyanarayanan, (2001) and Ley, (2007), pervasive computing refers to the emerging trend towards different computing devices that are easily accessible and can connect, such as network infrastructure. As result of this trend it creates new opportunities and challenges for companies involved in the development of information technology. It is a reality that within the next few years will be possible to place computers and sensors integrated into all devices and pieces of equipment such as those found in buildings, houses and the workplace. There is a possibility in the near future that developers and companies will offer portable and embedded devices that use low-cost systems, memory and input/output settings to run complex software applications. In this way, effective pervasive computing will be able to represent user interfaces distributed across numerous, small, and even invisible devices. Naturally, this may require new methods of measurement, software testing, frequency space management, and human-computer interaction. According to Rosenthal and Stanford (2000), the inability to develop such technologies and devices can be a problem for companies because of the high cost.

2.8.1. Pervasive Computing: Purpose of Use

The goal of ubiquitous computing is considered to be the nonintrusive accessibility of computers throughout the physical environment, which is virtually invisible to the user.

Compared to virtual reality, pervasive computing can incorporate information displays into everyday physical environments. Proponents of this computing note the real-world distinctions and are attempting to improve them. Furthermore, pervasive computing can connect to devices with cheap wireless networks, which allow people to access information easily at any point, to such an extent that eventually there will be no need to carry a personal digital assistant PDA (Satyanarayanan, 2001 and Ley, 2007).

Pervasive computing takes place mainly in the background, unlike an intimate computer that responds to a human voice and plays the role of a personal assistant. According to Weiser (1993), while an intimate computer fulfils the orders of the technology owner, the ubiquitous computer will allow him/her to feel that the owner himself/herself has done one or several tasks. The use of video and audio, voice communication in a wide field, can make electronic interfaces interpersonal. As Weiser (1993), points out hundreds of small displays in the future will replace the thousands of words that currently exist in workplaces, including on walls, telephone messages and company documents. As well as this, they can be easily assimilated into the work environment, thereby improving the everyday activities of people.

2.8.2. Evolution of Pervasive Computing

Pervasive computing is an evolutionary step in the technological world. It first began in the mid1970s at a time when the computer was more interactive in society. As mentioned by Saha and Mukherjee, (2003), key academics in the field of pervasive computing believes that the idea of making a computer personal is technologically misplaced. Moreover, Saha and Mukherjee, (2003), reveal the weakness of the computer, that it keeps computing separate from our lives. However, the personal computer has not reached its full potential for its users, it was the first step to pervasive computing. It is also an important factor in the development of graphical user interfaces.

2.8.3. Pervasive Computing Applications in Vehicle Technology

The application of comprehensive computing to automotive technology is essential since cars have become an integral part of modern life. At present, computers are largely built into cars, such as the automatic reflection system for airbags, the anti-lock braking system (ABS) system, and a central locking system. Moreover, with the development of such technologies, (including communication innovations), the computing power that exists within one chip is excelled, because it allows the car to have more opportunities and facilitate the activities of drivers, allowing them to enjoy better performance, comfort, and safety.

As Zhang (2001), indicated there can be up to 50 microprocessors in a vehicle today. As shown in Figure 2.11 almost every modern car has integrated processors for each subsystem of the car, including the engine, suspension system, transmission system, and other auxiliary subsystems. In addition, Zhang (2001), notes that shortly there will be many installed microprocessors in the car, as engines require sophisticated control due to emissions and fuel economy, including the convenience requirements.

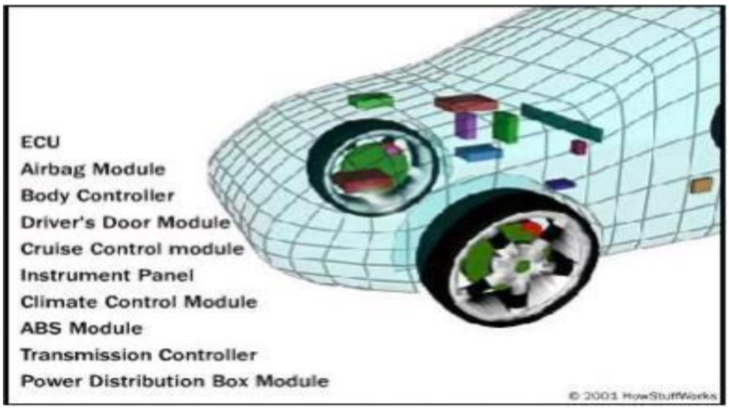


Figure 2-11: Computers Inside a Vehicle adapted from (Zhang, 2001)

2.8.3.1. Security

As for the safety of the car, everyone knows that a modern vehicle is expensive, and people are willing to spend thousands of pounds to buy one because people know modern (and therefore more expensive car) will have better technology and safety equipment, people know this because the technology industry is transparent with their research and they openly provide their results in magazines and on television. Modern cars have also improved as have automated air conditioning and automatic windscreen wipers that can detect rain on the windscreen. Furthermore, for some middle-class people, buying a car becomes an important and expensive investment, which makes the car attractive to thieves. To prevent this, car manufacturers usually install a security system.

As Zhang (2001), indicates three key functions are considered to be the main parts of any security system: a warning, an alert and the provision of assistance. If the car is in danger or is being vandalised, this system will attempt to warn the owner by blinking the LED car lights or making some kind of emergency sound. The second function works when someone tries to force entry into a car and steal something. Traditionally, the owner of the car is made aware of the intrusion by a siren or voice response that the car's security features trigger. This system can sometimes be installed on mobile phones and other devices such as tablets and laptops. Creating convenience for the driver through a central door locking system, electric windows, and keyless ignition systems meets the last function. Zhang's work is relevant to this research because this study now knows the three key factors of auto components, which will be a central concern when looking at autonomous vehicles.

Automotive security systems have been on the market for a long time. Examples of companies that provide them are Ungo, Viper, and Clifford, which are considered leaders in this field. The security system of these companies (as suppliers) includes various sensors integrated into the windows, wheels, and engine of the machine all of which are controlled by computers. Because pervasive computing is defined as the interaction between a human and a computer, the first step in creating autonomous vehicles relies on this system and it is interesting in terms of this research because of the involvement of computers. However, Zhang's work fails to talk about autonomous vehicles in any capacity, therefore his work is only relevant to this research in terms of how he discusses the process of and use of pervasive computing in human-controlled cars (Zhang, 2001).

2.8.3.2. Safety

Figure 2.12 shows the presence of ABS is commonly desired by car buyers. ABS was considered to be the most exclusive privilege that only luxury cars had, and now it has become a standard configuration in a middle-class car although several expensive cars such as Porsche, Bugatti and Ferrari also put ABS into their cars. Perhaps the main privilege of an ABS is that drivers can stop the car faster and drive in the event of a breakdown, which is necessary when driving on slippery surfaces. This is important to note for this research because it is now known that an automated vehicle needs ABS to be considered safe in the event of snowfall and icy roads or if it breaks down and needs to go to the nearest garage.

Speed sensors, a pump, valves, and a control computer are components of the ABS. The control computer component controls the speed sensors, when there is a sudden slowing of the car, this component starts to reduce pressure so that it does not cause the car to rotate. After that, the car and its tyres are decelerated at the same speed, which allows them to activate the explosive power of the airbag to protect drivers (Zhang, 2001). This is relevant in terms of this research because it predicts that this type of technology (such as airbags) will be essential during the manufacture and operation of autonomous vehicles.

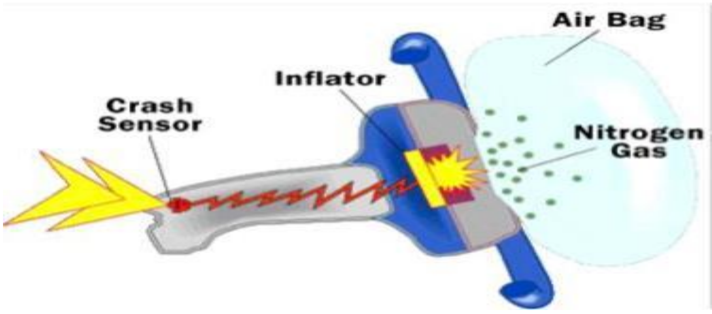


Figure 2-12: An Airbag System adapted from (Zhang, 2001)

2.8.3.3. Convenience

The primary objective of car manufacturers is to ensure that driving is a relaxing and an enjoyable experience. Over the years, there has been a growing trend of incorporating innovative advancements in automotive technology to enhance driving. Manufacturers may incorporate an unlimited number of new technologies into vehicles with the assistance of digital devices. As Zhang, (2001) cited, an important aspect of an automobile is its navigation system, which offers real-time location information for the vehicle. The in-vehicle navigational system contains a GPS receiver that obtains location information from GPS satellites circling the earth. The GPS receiver is essentially an embedded computer that offers sufficient computational capability. By utilising a preinstalled digital map within the GPS receiver, drivers can accurately determine their location at any moment.

2.8.3.4. Telematics

People all over the world spend a significant amount of time in their cars (especially in big cities) which inevitably creates traffic jams. However, road congestion also frequently occurs in big towns due to their proximity to the motorway. If an accident takes place on the motorway, then the result is usually a traffic jam in and around the surrounding towns which, of course, affects the potential productivity of the individual since they are stuck in the vehicle. However, this is rectifiable, since communication technologies are forever being enhanced and improved and so it is now possible to listen to music, make appointments, answer emails, schedule and plan work or order products on the Internet during a traffic jam.

In 1996, General Motors's (GM) OnStar system became the first integrated information service platform, as shown in Figure 2.13. This system is a service network that can connect cars to a service centre and uses a variety of wireless technologies. In this case, the connection with the support centre is facilitated via the cellular network using data voice and the OnStar system Tense which estimates the position of the car using global positioning. Thus, the telephone operator acts as the main control subsystem that determines the location of the driver so that it can direct them to the right place. Companies such as General Motors believe that this technology is an important part of the widespread computing of automotive development that will lead to vehicles becoming autonomous. This is relevant to my research because it is now apparent how exactly an autonomous vehicle creates a routine and constantly monitors its location and how these can be combined with other sensors to achieve success.

Figure 2-13: OnStar Technology in Lexus Link adapted from (Zhang, 2001)

In addition to information services, many security applications are provided by OnStar. For example, a sensor built into an inflatable bag will be able to inform the service centre about every airbag deployment, which indicates a car accident. In this case, the call from the car transmits the location information and connects with the OnStar consultant. After receiving voice contact with the driver, the OnStar consultant will be able to offer assistance to the driver and contact the right organisations.

Companies like Ford Motor and DaimlerChrysler are developing similar services, as shown in Figure 2.14. For example, a Ford 2000 Windstar Solutions car uses Home Connection technology. In this case, the driver can connect to technologically advanced household appliances. With the help of this system, they activate the video surveillance system at home which can turn on and off appliances that can connect. The Home Connection system works on speech activation technology, similar to the OnStar system. Zhang's work serves as a basic guide to a car's composition, and it only proves what the author already knows to be fact without proving any further objectives in his research.

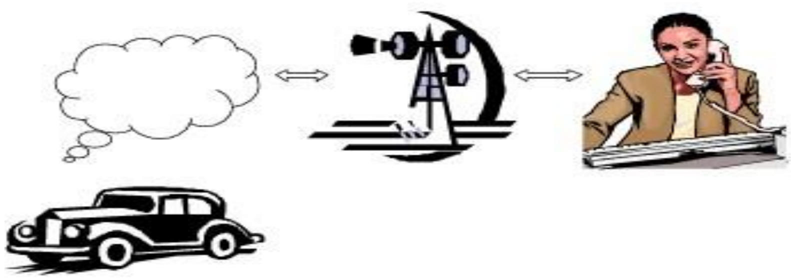


Figure 2-14: OnStar System in Operation adapted from (Zhang, 2001)

Technological developments for cars are not only created by the car manufacturer but third-party developers due to the growth potential of the market. For example, Cross Country Automotive Services has developed its Close Loop system to assist drivers while driving. This system operates based on text to-speech technology, which allows it to automatically contact drivers who need assistance (Zhang, 2001).

This research looks deeply into the work of Zhang and regards it as a constructive source that will in turn assist the study to determine how these technologies have changed. In addition, any new technologies that have been developed specifically for autonomous vehicles.

2.8.4. Intelligent Vehicles and Roads

As noted by Wang et al., (2006), modern cars have many different digital accessories like sensors, systems of various programmes and communications, and processors. Shortly, to improve safety and comfort for the driver, modernising cars will become a common process. Also, improvements in road infrastructures are possible, although this takes a certain amount of time.

Currently, there are already technologies that offer cars more and more information to improve safe operation and performance. These include technologies in the form of remote control, location systems with messages, traffic signs with built-in bar codes, and road sensors. Developments of this type directly use pervasive computing, and some can create equipment that needs innovative solutions.

2.8.5. Travelling in Intelligent Spaces

Intelligent spaces are considered an environment in which the driver can control, process and monitor what is happening through, continuous communication, where certain decisions are made, through which you can solve a particular problem.

Making automobiles the same as intelligent vehicles is a natural process. The current use of technology in cars (such as GPS and sensor networks) is already considered a breakthrough. Cars of the future will possibly be representatives of these intellectual spaces. Instead of using traffic lights, it will be possible to use co-driving technology to control traffic at intersections. In addition, it is well known that developers in this area seek to prevent deaths (Wang et al., 2006).

2.8.6. Key Factors of Pervasive Computing

2.8.6.1. Identification

According to Ley (2007), to make various objects and devices part of the exchange of information on an intelligent network, a driver needs to have a unique identity. This process facilitates the connection between a significant number of things, and these objects will be able to become resources and interfaces for others. Technologies like radio frequency identification tags (RFIDs) and visual barcodes are the most important identification methods because they are cheap and easy.

It is known that RFID is a type of automatic identification system and is considered a technology where radio waves are used to identify objects, places or people. RFID is considered a general term and is not a specific technology. This is an important step and useful information provided by (Ley, 2007) as his research attempts to consider this study for current autonomous vehicles that have specific sensors. Certainly, the change must be significant from 2007 to the present so these sensors must be developed and become more useful to distinguish between obstacles surrounding vehicles, as well as whether conditions for high safety and time-saving.

2.8.6.2. Location

The fact that objects and devices can provide location information is one of the significant elements of artificial intelligence. This ability can determine the location of people, objects, and necessary resources for location.

This is significant for this research because if someone is in an autonomous vehicle and collapses or gets involved in an accident, the location technology must work efficiently to help that person. In 2010, it was predicted that the number of phones with a Global Positioning System (GPS) would reach seventy or more million in Europe. As it is now 2023, this research shows how this prediction was correct due to the large use of GPS devices in vehicles. significant, technological devices that determine location play a huge role as a safety feature in cars.

2.8.6.3. Sensing

As there is information about the location, it is essential that through the use of applications and devices, the availability of recognition by creating a system of intelligent networks, can collect various data and respond to certain cases. It provides visuals of the car from its surroundings and helps it detect the speed and distance of nearby objects (Ley, 2007).

2.8.6.4. Sensor

To collect and analyse as much information as possible and improve awareness of pervasive networks, sensors are attached to RFID tags and wireless nodes (Ley, 2007). This process means that a network without human intervention can detect the environment that it is in and work independently of it. Wireless sensors are built into memory cards, and batteries, and sensors can measure pressure, speed, voltage, temperature and the quality of various phenomena.

This research argues that this concept is one of the most significant factors for a successful autonomous technology. By using these sensors to detect obstacles close to the vehicle to achieve vehicle targets such as improving safety, saving time and high security. These sensor networks are developing very quickly, and to integrate them with other IT systems, they use web services. For several years, many of the sensors have been renewed easily or recharged, since they require little energy.

2.8.7. Implications

The movement towards comprehensive computing, ubiquitous connectivity and adaptable interfaces is due to the demand of time, increased performance and minimisation of processors, memory, displays, sensors network and communication technologies.

As revealed by Ley (2007), many objects and devices already have built-in processors and sensors. For instance, in some cars, there are sensors for monitoring wheel slippage and turning on the brakes to stop in time. Cruise control is controlled by a radar which keeps a distance between the car in front automatically. Nevertheless, these embedded systems are considered autonomous and may not always interact with other installed devices. For example, washing machines have built-in complex electronic programs, although they must be controllable. With the help of tags that are built into clothing in the field of ubiquitous computing, the washing machine selects and determines the appropriate cycle.

Therefore, the above can be exemplified by the fact that connections are increasingly developing. This is evident not just between people and computers, but between people and things, and can even be emphasised between things themselves. This process has been called the "Internet of Things" by the International Telecommunication Union (ITU). Obviously, with the help of such connections, the possibilities of new interactions and access to large amounts of information appear extended. The network (providing the necessary information, assistance and services), became an entire system from the virtual space. Thus, if the information is used in the right way, it will allow people to make appropriate decisions, making them more informed.

Ways to use these technologies can be implicit or explicit. Essentially, explicit interactions occur as a result of any conscious action by the user. On the contrary, implicit interactions are considered automatic when the user does not directly intervene. Ley (2007) indicated, however, that invisible or implicit interactions contribute to the development and the use of computer systems, allowing us to benefit from them.

As Farooq et al., (2015) stated, the concept of the Internet of Things (IoT), began in 1982, when it was necessary to obtain information about the level of cooling drinks in a modified Coke machine connected to the Internet. In 1991, Mark Weiser was the first person to provide a modern definition of IoT in terms of pervasive computing. Nonetheless, Farooq et al., (2015), suggested the connection of the internet device in their taxonomy of the Internet. In the same year, the term "Internet of Things 'was also used to describe interconnected device systems.

Regardless of the means of communication, even if through RFID, the Internet of Things is considered an understanding of things as everyday objects that are readable, recognisable, and addressed through devices like perceiving and managing information over the Internet. Certainly, Figure 2.15 displays everyday objects are those things that people use daily (products, household goods, furniture), and not just appliances, electronic devices, and cars (Govindraj et al., 2017). The phenomenon of IoT can be called revolutionary, since objects become smart by gaining intelligence and creating opportunities for decision-making at a certain point, due to the transfer of information about yourself.

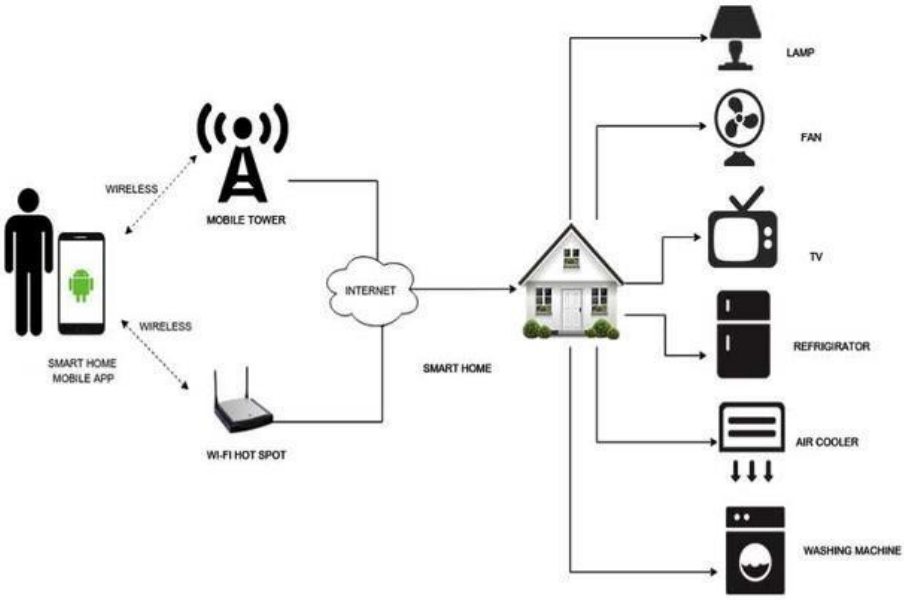


Figure 2-15: The Concept of Home Applications Using IoT adapted from (Govindraj et al., 2017)

In the words of Krasniqi and Hajrizi (2016), the automobile industry is moving fast towards autonomous vehicles, brought about by the fast-developing technology of IoT. The potential of this innovation is getting to be established. IoT-related technologies allow for the future development of the automotive industry. This research agrees with these studies that autonomous vehicles may play a significant role in society from road safety to the economy. This may introduce a change from a society of products to a society of users' technology acceptance. Autonomous vehicles are not some futuristic auto technology and are far from reality; in fact, there are already cars with some AV features on the road, such as Google, Tesla and Nissan.

2.9. Chapter Summary

This chapter has introduced and demonstrated the significant aspects of connected technologies and their role in enhancing security, safety, and comfort for drivers of AVs through the integration of IoT with automotive technology. Furthermore, the literature chapter of this research has reviewed several technology levels, sensors, and applications of various features that enhance complete vehicle automation by utilising real-time information capability. While each sensor has limitations in getting accurate data, certain ones are crucial for successfully implementing autonomous vehicle technology. Hence, this chapter highlighted the significance of V2V and V2I technologies and their potential to facilitate an application that can improve road safety. The following chapter in this study aims to analyse the development of a conceptual framework to comprehend the factors influencing the acceptance of autonomous vehicle technologies in the United Kingdom, such as V2V and V2I.

Chapter 3: Theoretical Model and Hypotheses Development

The perceived attributes of an innovation play a significant role in its adoption rate, initially in the industrial sector. This section will outline the key attributes of innovation that influence the adoption of autonomous vehicle technologies. The rate at which an innovation is embraced varies, and Rogers (2003), highlighted the main theories that influence this adoption rate:

Innovation Diffusion Theory (IDT): The diffusion theory of innovation, proposed by Rogers in 1962, explained the process by which new technologies spread through society and believed that the diffusion of technology was influenced by technological characteristics such as comparative advantage, compatibility, image, visibility, compatibility, results demonstrability, and voluntariness of use.

Theory of Planned Behavior (TPB)： Ajzen developed TPB in 1985. It contended that consumers' behavioural intentions were influenced by their attitude toward behaviour and subjective norms.

Technology Acceptance Model (TAM)： Davis proposed the TAM in 1989, a cornerstone in the field of technology acceptance. It posited that a user's intention to use any technology was shaped by its perceived usefulness (PU) and perceived ease of use (PEOU).

Unified Theory of Acceptance and Use of Technology (UTAUT)： Venkatesh and Davis (2003) established UTAUT to enhance existing models for the acceptance of information technology (IT). Nordhoff et al. (2016) utilised the UTAUT in AVs. They integrated it with other theories to develop a conceptual framework for understanding acceptance.

3.1. Basis of the Research Model

TAM, the most commonly employed framework for assessing user acceptance (Hsiao and Yang, 2011; Venkatesh, 2000), is a classic theoretical model verified in many technical fields and has accumulated a wealth of empirical support. In AV research, using TAM as the basic theory can rely on these mature research methods and tools to ensure the reliability and validity of the study. TAM provides an intuitive and pragmatic framework to help researchers understand and predict user technology adoption behaviour.

The TAM is a theory that explains how consumers adopt and use technology in information systems (Choi and Ji, 2015). It is one of the most classic models of consumer adoption of new technologies. Since TAM (Davis, 1989) was proposed, being fully verified and widely used, it is considered to be one of the most influential theoretical models in the field of technology acceptance, highlighting its importance and impact (Venkatesh et al., 2003). The TAM is now the most commonly employed framework for assessing user acceptance (Hsiao and Yang, 2011; Venkatesh, 2000). The model is both simple and extensively applicable. The research of TAM covers most disciplines, where empirical research with quantitative analysis is the most widely used method in the field of studying emerging technologies and their acceptance. TAM could be used to explain the process of new technology adoption, such as AVs adoption.

As reported by Al Kurdi et al., (2020), due to its adequate explanatory ability and popularity, the TAM has been employed in considerable research within the literature on the technological acceptance and deployment of autonomous vehicles (Al-Maroof et al., 2021: Zhang et al., 2008 and Choi and Ji, 2015). However, TAM has intrinsic difficulties, such as inconsistencies in prior studies and its inadequacy in justifying the societal influence on technological acceptance (McCoy et al., 2005; Tarhini et al., 2013). The study will address these limitations by enhancing the TAM to include additional components (Salloum et al., 2019 and Al-Maroof et al., 2021). The main objective of this investigation is to address the previously mentioned limitations. The study emphasises explicitly the elements influencing the acceptance of autonomous vehicles in the UK.

While previous studies have identified several variables that influence user adoption of autonomous vehicle technologies, it is commonly acknowledged that there remain several unknown factors. In addition, these factors have been identified through surveys, indicating that the underlying reasons for their inclusion still need to be well-known. This research attempts to comprehend the reasons behind the influence of specific variables, employing survey questionnaires as the chosen method. This enhanced comprehension facilitates the examination of the strategic implications for the automotive acceptance sector, an area of research that remains unexplored, as pointed out by (Choi and Ji, 2015; Nordhoff, 2016; Müller, 2019).

This study will evaluate how these technologies can assist the autonomous industry to fulfil its success potential, as well as how users accept the technology. To do this, this study will attempt to expand the TAM model by including the externalities (hypothesised or constructed), including the TAM with driver context (from pervasive computing studies) and technology attributes (compatibility, trust, and safety) with some personal attributes to investigate non-professional and professional drivers' perspectives.

3.1.1. Related Work

Initially, the research model and assumptions are based on the (Davis, 1989), original TAM concept. In reference to Davis', a user's attitude towards the system is a function of two constructs or factors: PU and PEOU (how useful they are to find the system and how simple it is to operate). PU is in turn causally affected by PEOU. On the other hand, the automation acceptance model (AAM) presented by (Davis et al., 1989), incorporated trust, and compatibility into TAM. Hence, the original TAM relationships persist in AAM, where Trust and Safety (TR&SF) and Compatibility (COM) influence behavioural intents and attitudes through perceived usefulness and perceived ease of use. There is a clear relationship between trust and behavioural intention (Ghazizadeh et al., 2012). Although AAM provides a theoretical framework for the adoption of modelling automation, the model has not been validated.

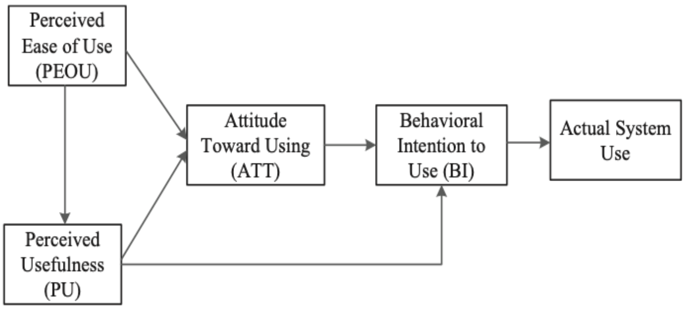


Figure 3-1: Original TAM Proposed by Davis et al., (1989)

Davis' technology acceptance model was established to enhance knowledge of user acceptance of computer-based information systems; and, it has since served as a foundation for further adaptations of the model utilised in different fields. This is illustrated by the work of Choi and Ji (2015), who extended the model to study user acceptance of autonomous vehicles (AVs). This model is useful for this study since it provides a robust explanation for the phenomena of user acceptance. While seeking answers for why various aspects play a role, it is crucial to recognise that this is frequently explained by PU and PEOU.

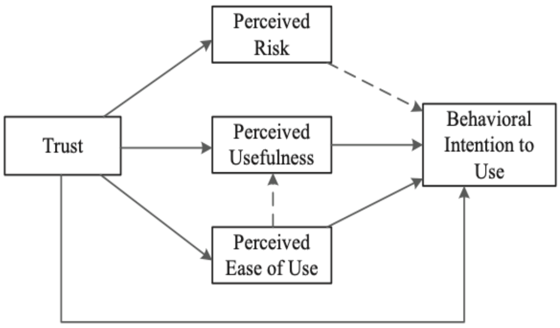


Figure 3-2: TAM (AVs) Proposed by Choi and Ji (2015)

Despite the fact that these articles have been partially successful in explaining the variation in user acceptability and have discovered several aspects that play a role, it is generally agreed upon that not all significant variables have been identified and that additional studies are necessary. The results show that unidentified factors will account for most of the variation in acceptance of autonomous vehicles, as mentioned by Choi and Ji (2015), which construct similar personality characteristics, which were not included in their model, are likely to be valuable additions. On the other hand, Nees (2016), argues that a closer look at age and driving experience should be considered. In agreement with the idea that the factors that will determine whether people would accept autonomous vehicles are mostly unknown, likewise, Nordhoff et al., (2016) argue that all users must have a say in whether or not autonomous vehicles will be widely adopted.

It is crucial to consolidate the existing research on AV acceptance, as it provides a solid foundation for future studies and guides the direction of research. The current literature acknowledges that many factors related to AV acceptance are still unknown. Considerations and suggestions for further study are summarised in Table 3.1, which includes the results of empirical survey research, providing a comprehensive overview of the current state of research in this field.

Table 3-1: Factors and Recommendations for Future Research

Items	Recommendations	Adapted
Perceived reliability/Trust/ Cost/ Appropriateness of automation/ Compatibility/ Enjoyment of to-be-automated task/ Perceived/ usefulness of automation/ Perceived ease of use of automation/ Experience with automation/ Intention to use automation/ Exposure to articles	More research is needed on age, driving experience	Nees, (2016)
Socio-Demographics/Mobility Characteristics /Contextual /Characteristics /Locus of Control /Sensation/Seeking/ Trust/Performance Expectancy /Effort Expectancy/Social Influence /Pleasure/Dominance /Efficiency /Effectiveness /Equity/Satisfaction/Willingness to Pay /Social /Acceptability	Involve users who will not only use but also decide on and operate autonomous vehicles.	Nordhoff et al., (2016)

Besides, Müller (2019), built on the study and included other components such as perceived enjoyment (PE), objective usability (OU) and attitude towards environmental protection (ENV) in his research report to corroborate the fundamental assumptions of the technological acceptance model in the context of autonomous vehicles. This demonstrates how powerful societal norms and individual experiences are in terms of technology acceptance in society. Likewise, constructs effects of technological adoption have been discovered, for example, the perceived enjoyment of electrically charged vehicles influences the acceptance of autonomous driving and automobile possession behaviour.

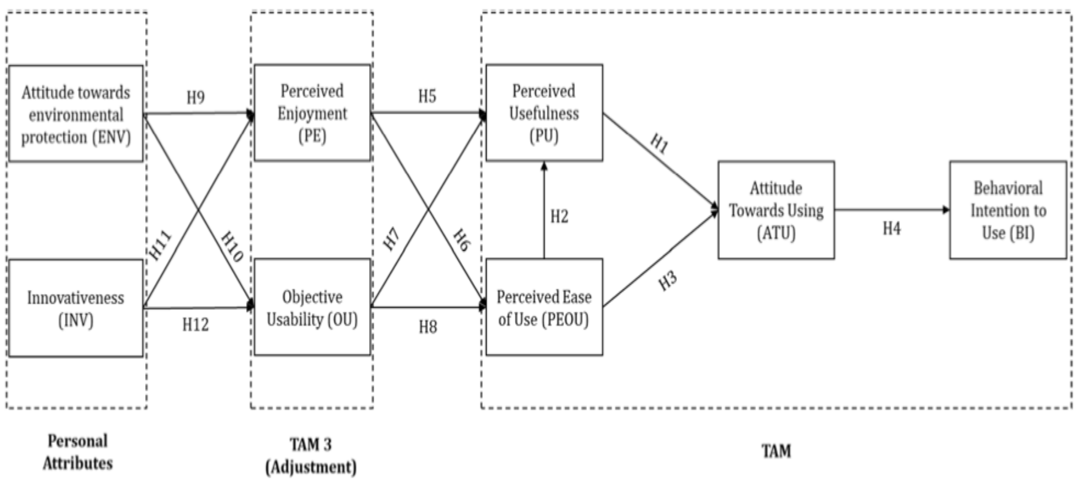


Figure 3-3: TAM Proposed in Müller (2019)

In summary, it has been developed by several writers through several time eras. Thus, as described above, it is a phenomenal, transformative and effective piece of technology in 2024. This research will conduct an in-depth analysis of the different scholars' perspectives and treat them as beneficial information. Therefore, this analysis will assist the study in determining how these technologies have evolved and whether any new ones have been developed expressly for autonomous vehicles.

In addition, these models are established in the theory that peoples' beliefs and perceptions of technology can influence its acceptance, with the behavioural intentions to use technology and actual usage of behavioural indicators of acceptance (Zhang et al., 2019). The investigation will therefore adapt to the fundamental assumptions of the original TAM given by (Davis et al., 1989). The research will adapt to the fundamental premises of the original TAM given by Davis (1989), which is presented from H1 to H6. In addition, the findings are consistent with earlier consumer acceptability studies in this area, such as the models presented by (Ghazizadeh et al., 2012; Choi and Ji, 2015 and Müller, 2019), expanding their findings in the field of AV technologies. Consequently, based on these recent studies, this research will keep up with the most recent autonomous vehicle technologies, such as V2V and V2I.

3.1.2. The Conceptual Framework

This study will conduct an in-depth analysis of respondents' views and treat them as user information, which will assist it in determining how these technologies may evolve and whether any new ones have been developed expressly for autonomous vehicles. The findings of this study will significantly contribute to the understanding of user acceptance of autonomous vehicles and connected technology. In addition, these models are established with the theory that peoples' beliefs and perceptions of technology can influence its acceptance, in terms of the behavioural intentions to use technology and the actual usage of behavioural indicators of acceptance (Zhang et al., 2019). In addition, it is a single theoretical model with different group factors: Personal Attributes, Professional Setting, and TAM. Each group factor represents a distinct set of influences on the behavioural intention to use autonomous vehicles and connected technology. These factors may operate independently or interdependently without implying a linear or sequential process, making the model adaptable to various user acceptance scenarios.

The framework builds upon the Technology Acceptance Model (TAM) and extends it by incorporating context-specific factors such as driver context and innovativeness, particularly relevant to autonomous vehicles. Several steps are taken to ensure the research covers the most significant factors in the framework. Firstly, the research conducted a thorough review of existing studies on autonomous vehicle acceptance, which revealed recurring factors such as perceived usefulness (Choi and Ji (2015); Muller (2019); Zhang et al., (2019) and Zhang et al., (2020), perceived ease of use (Venkatesh et al., 2003, Choi and Ji (2015) and Nastjuk et al., (2020), personal innovativeness (Rahmanet al., 2018:Muller (2019) and Nastjuk et al., (2020), Compatibility (Nastjuk et al., (2020) and Yuen et al., (2020).

These factors were consistently identified as significant predictors of user acceptance, which helps me ensure that they are well-established factors. In addition, a systematic literature review was employed on user’s preference for travelling and their intention of AV adoption and found that the factors of driver context (El Khatib et al., (2019) and Magyari et al., (2202). the critical factor having significant influence. Besides, individual behaviour is often influenced by the cultural consciousness rooted in the heart, which can’t be neglected. According to the UK culture, turst&safety (TR&SF) was selected for the framework as shown in figure 3.4.

Two external constructs extend the original TAM by incorporating additional factors relevant to adopting autonomous vehicles, such as PU and PEOU, allowing the model better to capture the complexity of user acceptance in this context. They are personal attributes and professional settings, including four more factors; First, Trust&Safety represents the user's confidence in the safety and reliability of autonomous vehicle technology. Second, Innovativeness plays a pivotal role in understanding how individual differences in openness to new technologies can influence the acceptance of autonomous vehicles. This underscores the need for a personalized approach to adopting autonomous vehicles. Third, Driver Context: related to environmental factors. Finally, compatibility is a crucial factor in understanding how well the technology of autonomous vehicles fits into the user's lifestyle or work environment. This highlights the need for a seamless integration of autonomous vehicles into users' lives. These factors are included because they cover multiple dimensions, including technology, environment, and individuals, to examine users' intention to adopt AVs. Moreover, these models are created based on the theoretical premise that individuals' thoughts and perceptions of a particular technology can significantly impact its level of acceptance. This acceptance is measured through BI to utilise the technology and the actual usage, which serve as indicators of acceptance (Zhang et al., 2019). The study will adapt to the fundamental premises of the original TAM given by Davis et al. (1989), which is tested by the hypotheses that the study will first need to consider regression analysis and then use SEM-AMOS 28.0 software.

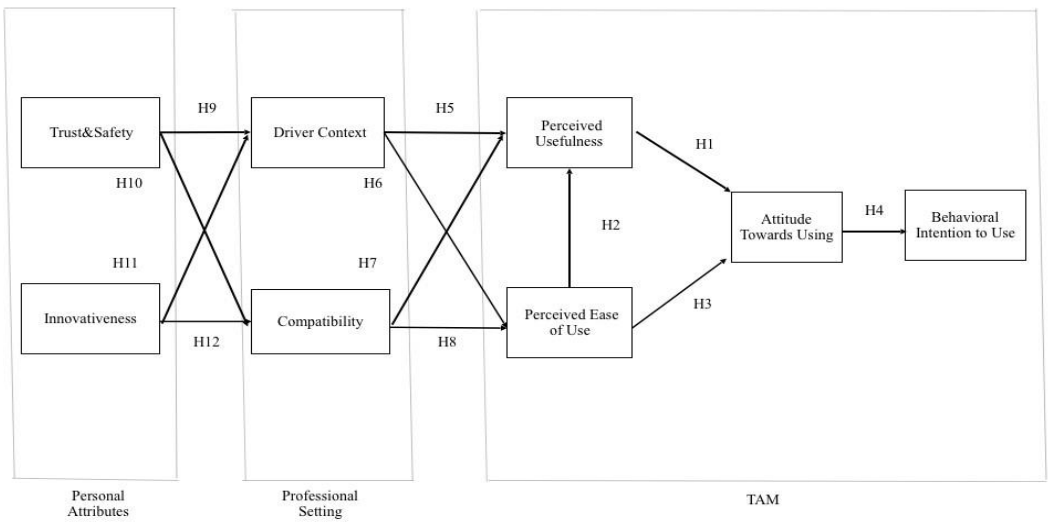


Figure 3-4: Research Framework

The framework model includes; initially, hypotheses (H1, H2, H3 and H4) demonstrate the TAM that impact three factors of BI, ATU, PU and PEOU. Hypotheses (H5, H6, H7 and H8) is concerned with the effects of DC and COP, which represents the professional setting. Hypotheses (H9, H10, H11 and H12) illustrates that applications based on TR&SF and INV affect the personal attribute.

3.2. The Framework Factors and Resources

Adopting new technology may take time; users usually delay acting on their intentions to adopt before reacting. As a result, this study tends to examine intentions over immediate actual behavioural responses. To gather initial information in this particular field, the research object selected for this study is application intention. Additionally, technology adoption research has embraced the tradition of using analytical intent as a mediating variable. For instance, theoretical frameworks, including TAM, highlight the vital purpose of explaining and forecasting behaviour. As indicated in Table 3.2, the many constructs recommended for developing a conceptual framework for this research that aims to affect TAM to enhance the road safety and productivity of autonomous vehicle technology discovered in the existing literature.

Table 3-2: Framework Constructs of the Research

Construct	Conceptualisation
Behavioural intention to Use (BI)	The individual's motivational readiness to use or not to use autonomous driving.
Attitude Towards Using (ATU)	The degree to which an individual has a favourable or unfavourable evaluation of using autonomous driving.
Perceived usefulness (PU)	The degree to which autonomous driving results in a positive use–performance relationship.
Perceived Ease of Use (PEOU)	The degree to which an individual believes that using autonomous driving is free of effort.
Driver Context (DC)	The degree to which autonomous driving results in better visibility and communication management.
Compatibility (COP)	The degree to which autonomous driving is perceived as consistent with existing mobility options.
Trust (TR) and Safety (SF)	The ability to forecast the predictability and functionality of autonomous driving.
Innovativeness (INV)	The willingness of an individual to try out autonomous driving.

3.3. Hypothesis Development

As shown in Figure 3.4, the research framework consists of three significant groups, with distinct constructs. The first group (referred to as TAM) contains four constructs: perceived usefulness, perceived ease of use, attitude towards use, and behavioural intention to use. The second group is a professional setting which consists of two constructs: driving context and compatibility. The last group, personal attributes, likewise have two constructs: trust and inventiveness.

3.3.1. TAM

3.3.1.1. Behavioural Intention to Use (BI)

Behavioural intention is defined by Seuwou et al., (2020) as a person's purpose to undertake a certain act, which can predict related behaviour when an individual act willingly. In addition, BI is the subjective probability of carrying out any behaviour and the reason for the usage of that behaviour. Hence, intentions reveal the motivating variables that drive behaviour and serve as an indicator of how hard individuals are willing to try and how much effort they invest in their behaviour. Moreover, it was discovered that behavioural intention is the primary determinant of an individual's use of mobile services and that usage intentions are reasonable predictors of future system utilisation.

However, regarding the TAM, the factors that significantly influence BI are PU and PEOU, this implies that not only TR &SF and ATU, but also the perception of PU can lead to intentions (Davis, 1989). In addition, Ribeiro et al., (2022), stated that willingness to use AVs indicates users' intention to employ AVs. While autonomous vehicles have various benefits, users may have concerns about their safety. Previous research suggests that an important barrier to the adoption of autonomous vehicles is uncertainty about the safety of AVs. Users may be interested in autonomous vehicles due to the convenience and cost savings. However, some individuals may also express opposition to autonomous vehicles due to concerns regarding potential risks and potential reduction in social interactions. Therefore, Ribeiro et al., (2022) recommended, users who have positive feelings toward autonomous vehicles are encouraged to use and accept them more.

3.3.1.2. Attitude Towards Using (ATU)

According to Osswald et al., (2012), the term attitude towards using refers to a person's overall emotional reaction when using a system: a criterion intended to represent the user's opinions regarding system usage and its impacts. It examines aspects of in-vehicle information systems that go beyond basic functioning and attempts to evaluate the attitude towards using the system based on emotive factors such as enjoyment and likability.

Davis (1989) presents a TAM that uses the belief-attitude-intention paradigm to anticipate user behaviour, namely how individuals first accept new technologies. According to Davis (1989), the TAM is the most utilised and verified model for investigating user behaviour; nevertheless, this study’s proposed model eliminates attitude since attitude is not necessarily a factor that influences all behaviours. Additionally, Venkatesh (2000) argues that attitude is not a direct predictor of intention, while other academics claim that attitude is a partial mediator between beliefs and intention. In addition to this, numerous researchers assert that PU and PEOU are more influential than attitude in determining AV usage intent. Davis (1989) suggests excluding attitude from TAM and concentrating on only three variables, such as PU, PEOU, and BI.

Despite this, the topic of attitude has garnered attention in studies regarding AV acceptance and significantly impacts users' acceptance of AVs (Liu et al., 2019). Respondents exhibited a favourable and positive attitude towards AVs in the literature, particularly in the research conducted by Payre et al., (2014), who discovered that attitude is the most significant predictor of a user's interest in driving AVs in their prediction model. Liu et al., (2019) go further into the favourable attitude of young respondents towards AVs, which is greater compared with the elderly. In contrast, Hartwich et al., (2019) argued that the elderly has a highly positive attitude towards AVs. The former noted that the elderly are less prepared to take chances than the young and do not believe that autonomous vehicles would provide them with advantages. In comparison, the latter argued that elderly individuals are more willing to employ assistance technology that adjusts to suit their needs depending on their age than younger individuals.

3.3.1.3. Perceived Usefulness and Ease of Use (PEOU)

Davis (1989) defined perceived ease of use as the extent to which individuals assume that utilising a specific system or technology would not require physical or mental effort. According to Eriksson et al., (2005), several pieces of research contend that PEOU precedes PU and that PEOU describes a condition, whereas PU describes a process. On the other hand, Davis (1989) believes that PEOU and PU have a direct clear correlation. Moreover, Lin (2007) revealed that PEOU has a direct influence on PU regarding internet usage and validated the important correlation between PEOU and PU in autonomous vehicle technology. Additionally, Jansson, (2011) and Petschnig et al., (2014) concluded that PEOU indirectly influences acceptance intent via PU and ATU. However, Xu et al., (2018) noticed that PEOU had a greater effect on AV acceptance than PU. Considering autonomous driving is a substantial technical renovation of autonomous vehicles with a completely new human-computer interaction mode than regular ones, it may provide certain issues for future users.

3.3.1.4. Perceived usefulness (PU)

In 1989, Davis defined perceived usefulness as the extent to which an individual feel that employing a particular system will improve their work performance. Likewise, Venkatesh (2000); Ha and Stoel, (2009) observe that PU is a major and direct perception that affects intention, and other research demonstrates the significance of the relationship between PU and BI. According to research by NoorA-Rahim et al., (2020), autonomous driving can be made beneficial by having AVs. Autonomous vehicles enable passengers to travel alone in a private vehicle when they are unable to drive. Further to this, V2V and V2I communication enables AVs to acquire real-time road data therefore enhancing their perceptual abilities and contributing to a comfortable, secure, and efficient travel experience. In the future, individuals may also engage in activities such as online shopping and AVs whilst in the vehicle.
Therefore, the adoption of AV is highly dictated by how it is perceived usefulness.

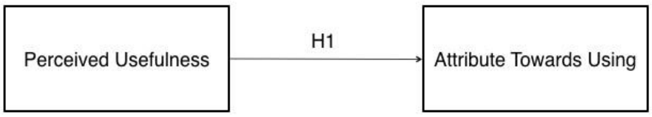
3.3.2. Theoretical Framework: TAM

Popular constructs (perceived utility from the TAM framework) were used by Chan and Lee (2021), to explain technological uptake. Beliefs that adopting a certain piece of technology would improve one's efficiency are measured by its perceived usefulness.

As Davis et al., (1989) described, the perceived usefulness of an autonomous vehicle, in terms of boosting users' performance by freeing up time, increasing mobility, and simplifying life, is an example of an extrinsic incentive that covers the positive functional consequence of an invention. According to the TAM, the PU of a product can favourably affect intention irrespective of attitude for the sake of achieving one's goals or reaping the benefits of using the product. According to Choi and Ji (2015), several pieces of research have shown PU and PEOU positively impact behavioural intention, however the significance level of these effects varies. Furthermore, PU mediates the relationship between PEOU and BI (King and He, 2006; Ma and Liu, 2004). If this is the case, it stands to reason that users are more likely to accept autonomous cars if they find them beneficial and simple to operate.

The impact of autonomous vehicles on perceived usefulness may also be influenced by attitude. Based on the concept of balanced cognitions, a favourable evaluation of an innovation's high utility should have a positive effect on one's attitude towards its usage. It has been established that PU influences ATU (Petschnig et al., 2014), which may also be hypothesised in the case of AVs since users' ideas about the functional results of adopting automobile innovations reportedly impact attitude. Thus, the following hypotheses were advanced:

H1: The Perceived Usefulness of the technology has a positive influence on the Attitude Towards Using.



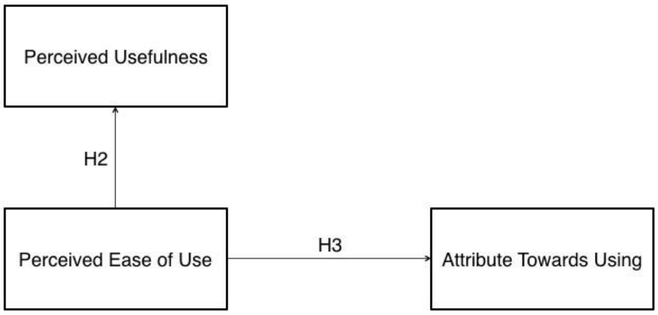
Hypothesis related to PU towards ATU

According to Chan and Lee (2021), PEOU refers to the degree to which a person feels that utilising a specific technology would be effortless. In addition, according to research cited by Chan and Lee (2021), the TAM components may be used to forecast user adoption of various new IT technologies. Therefore, it is anticipated that autonomous vehicles will provide additional advantages to users by improving road safety, creating decreased traffic, and having lower energy consumption, which will lead to greater adoption of the technology. Notably, the current AV technology does not have a standardised architecture design (Hewitt et al., 2019). Hence, PEOU will have a significant impact on behavioural intention since the user may have high expectations on how to operate or navigate an AV.

Additionally, TAM is the primary basis of the research model. As autonomous driving is not yet available to the public for everyday usage, Nastjuk et al., (2020) eliminated "actual system use" from the methodology section of the study model. The model's final output is the concept of "behavioural intention," which is a reliable predictor of actual system use. By the TAM and the theory of reasoned action, Nastjuk et al., (2020) propose that the attitude towards autonomous vehicle use predicts behavioural intention. This causal association supports other research. According to the original TAM theory, perceived usefulness and perceived ease of use are the primary factors of overall attitudes towards the usage of technology. In addition, it may be hypothesised that PU and PEOU have a positive link with usage intention. Similarly, it is hypothesised that PU has a positive correlation with PEOU. In addition to their applicability in the organisational setting, the proposed correlations are pertinent in the context of users of autonomous driving. These assumptions are summarised in the following hypotheses:

H2: The Perceived Ease of Use of the technology has a positive influence on its Perceived Usefulness.

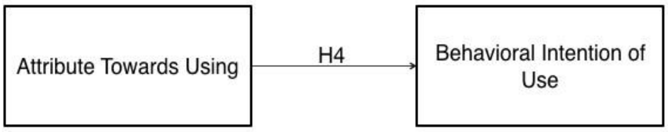
H3: The Perceived Ease of Use of the technology has a positive influence on the Attitude Towards Using.



Hypotheses related to PEOU towards PU and ATU

Davis et al., (1989) established TAM, proposing that ATU is an antecedent to technology acceptance. As aforementioned, ATU favourably or positively influences intention to use, which in turn influences actual technology usage. ATU is defined by Man et al., (2020) as the driver's positive or negative perceptions of utilising an AV. In addition, according to Wu et al., (2021), several pieces of research, such as Cho and Ji, (2015); and Marangunić and Granić, (2015), have demonstrated that the perceived usefulness of autonomous driving technology can increase persons' positive views about AVs and their desire to utilise AVs. As stated by Wu et al., (2021), behavioural intention will be positively affected by attitude. The more an individual aim to utilise autonomous vehicles, the more favourable their opinion towards them. Thus, the following hypotheses were advanced:

H4: The Attitude Towards Using the technology has a positive influence on the Behavioural Intention to Use.



Hypothesis related to ATU towards BI

3.3.3. Professional Setting

3.3.3.1. Driver Context (DC)

In the context of driving, Moosavi et al., (2017) and Magyari, (2021) found that DC was a mediator between the environmental factor especially, traffic congestion and driving behaviour. Understanding various driving contexts makes it possible to verify theories about how a driver would behave in those scenarios. Furthermore, this information can be used to provide helpful recommendations aimed at enhancing their driving safety. Consequently, the applications and elements of pervasive computing and TAM have been widely employed and extended in the context of driving scenarios to predict drivers' acceptance and utilisation of various AV technologies and additional features needed in a transportation system (Zhang et al., 2019).

Even though design rules outline visibility criteria for autonomous vehicles, there are several crossings where these criteria are not satisfied. For instance, Magyari et al., (2021) studies revealed that the majority of the 1,629 urban junctions evaluated had low visibility due to adverse weather, which significantly impacted autonomous vehicle sensors. It was discovered that the accident rate for autonomous vehicles was high when visibility was low. Similarly, another complication of autonomous driving is noted by El-Khatib et al., (2019), in that visual distractions caused by in-vehicle information systems, such as navigation systems and communication devices, produce increased rivalry for driver attention. One may predict that the more intricate the car information systems are, the higher the potential hazard it poses if used while driving.

However, El-Khatib et al., (2019) expected that vehicles will be autonomous and that individuals will alternate between driving as normal, and then switching to an autonomous mode, or they will handle certain driving operations although not all. By progressively transferring responsibility from the driver to the vehicle, there is a danger that the driver would misunderstand the remaining level of responsibility or will not comprehend how to select alternative modes of function for their vehicle. Yet, if autonomous technology becomes more popular, the chances of the driver not paying attention may increase. Hence, driver monitoring is essential until the most trustworthy autonomous vehicles reach a real-world driving scenario.

3.3.3.2. Compatibility (COP)

As indicated by Arts et al., (2011) compatibility is a measure of how well the use of an invention aligns with the current values, needs, prior experiences, and lifestyle of potential adopters. Hence, COP may be considered a multidimensional notion that encompasses both operational compatibility (i.e., what individuals do) and normative or cognitive compatibility (i.e., concerning what people feel or think). Moreover, compatibility is a significant construct during the adoption choice. In the context of autonomous driving, Nastjuk et al., (2020) define compatibility as the extent to which autonomous driving conforms to an individual's typical mobility behaviour in terms of daily driving or travelling.

Even if the relationships between compatibility and usefulness are different in a private adoption setting (a different product class such as autonomous vehicles), the content and operationalisation of compatibility must still be evaluated to determine a conceptual distinction. According to Arts et al., (2011), any reference to requirements in the compatibility construct should be eliminated since it might lead to confusion with usefulness. Concerning the other factors, namely compatibility with the current values, prior experiences, and lifestyle of potential users, it is interestingly similar to automated processes.

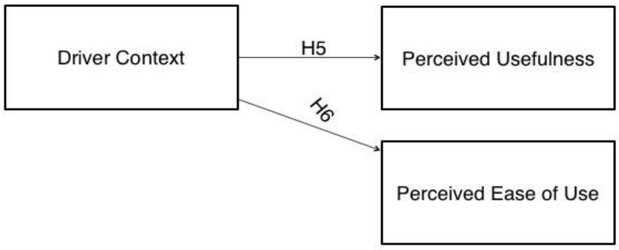
As Ouellette and Wood, (1998) said, automatic processes are how future behaviour is impacted by past behaviour via a variety of psychological elements that provide consistency in response. Hence, repeated execution of any behaviour in the past may result in the automatic recurrence of the activity in the future because of non-deliberative processes. Compatibility may be the most useful predictor of adoption intention and a substantial predictor of behaviour. In addition, compatibility is the second most essential component, following relative advantage. Considering the adoption of personal automobiles, the adopters of alternative fuel vehicles view autonomous vehicles as more suitable than non-adopters (Jansson, 2011). Hence, compatibility is incorporated into the current research model.

3.3.4. Theoretical Framework: Professional Setting

As society's concern for urban sustainability grows, autonomous vehicles are increasingly in line with emerging societal ideals (Yuen et al., 2020). Therefore, driving context allows autonomous vehicles to be a cleaner alternative to conventional vehicles by reducing traffic congestion and air pollution and enhancing driver visibility. In addition, for this study pervasive computing and TAM (Zhang et al., 2019) have been extensively utilised and expanded in driving situations to anticipate drivers' adoption and usage of technologies such as in-vehicle navigation, cruise control, and other needs of a hyphen system. Additionally, El-Khatib et al., (2019) emphasized, that the justification for incorporating autonomous functions in the driving context is mostly based on their safety benefits. One word is keen to enhance already sophisticated driver aid systems, such as lane departure warnings and intelligent speed adaption systems. Consequently, based on these advantages of DC regarding road safety, this research has suggested a positive effect of DC on PU, and PEOU.

H5: The Driver Context of the technology has a positive influence on its Perceived Usefulness.

H6: The Driver Context of the technology has a positive influence on its Perceived Ease of Use.

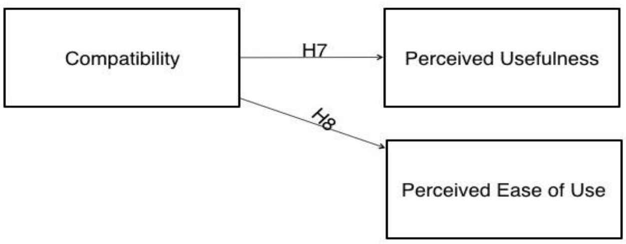


Hypotheses related to DC towards PU and PEOU

Regarding Compatibility, Nastjuk et al., (2020) indicated the positive influence of compatibility on attitude, whereas Karahanna et al., (2006) established a positive relationship between compatibility, attitude, perceived usefulness, and intention to use. According to a piece of research done by Wu and Wang (2005), compatibility greatly determines PU and BI. Jing et al., (2020) discovered that those who utilise driver assistance systems are more inclined to embrace AVs, implying that the user's previous behaviour will predict their future behaviour intention. Similarly, compatibility may impact AV adoption intention because of self-perception processes or cognitive consistency demands (Jansson, 2011). In addition, given the natural human aversion to change, compatibility may impact adoption intentions as a compatible invention demands minimal changes to one's lifestyle and habits. According to the research on innovation adoption, compatibility is one of the greatest indicators of both intention and behaviour. Consequently, it is hypothesised that compatibility has a beneficial effect on the concept of intention for AVs. In addition, compatibility has a considerable positive effect on the PU and AVs, as well as an indirect effect on attitude and intention (Arts et al., 2011 and Jansson, 2011). Nevertheless, the influence of the compatibility and driving context constructs on the TAM constructs is equivocal, according to Nastjuk et al., (2020), and further study is required (Jing et al., 2020). Thus, as a result of the above discussions, the following hypotheses are proposed:

H7: The Compatibility of the technology has a positive influence on its Perceived Usefulness.

H8: The Compatibility of the technology has a positive influence on its Perceived Ease of Use.



Hypotheses related to COP towards PU and PEOU

3.3.5. Personal Attributes

3.3.5.1. Trust (TR) and Safety (SF)

According to Kaur and Rampersad (2018), trust is defined as the willingness to place oneself in a vulnerable position regarding technology in anticipation of a beneficial outcome or positive future behaviour. Further thier studies, this can be broken down into three beliefs: ability, integrity, and benevolence. Ability means having the skill and knowledge to complete a task, while integrity means keeping a promise to complete a task. Benevolence means that the subject in question, an autonomous vehicle in this case, cares about its user's best interests. Moreover, It is a well-established fact that trust is a crucial driver of dependence on (and acceptance of) automation, standing between a user's ideas about automation and their intention to use it (Parasuraman et al., 2008). According to Ghazizadeh et al., (2012), the trust construct should be included to explain the individual acceptance of driving assistance technologies. Intelligent cars (whose steering, deceleration, and acceleration are managed by an integrated automated system) are autonomous vehicles. Consequently, Ghazizadeh's studies have explored numerous trust-affecting constructs based on the current literature on automation.

The work by Choi and Ji (2015) is significant to this research since it identifies the three dimensions of trust, each of which correlates with an interpersonal trusting belief. The assumption that the system is predictable and intelligible is one dimension. The second is the idea that the system executes tasks precisely and correctly. The third component is the perception that the system offers appropriate, efficient, and responsive help. Hence, Choi and Ji (2015) suggest there are three trust aspects for autonomous vehicles: system transparency, technological competency, and situation management. System transparency is the extent to which users can foresee and comprehend the operation of autonomous vehicles. Technological competency is the extent to which users perceive the performance of autonomous vehicles. Situation management refers to the user's conviction that users may regain control in any given circumstance or whenever desired.

Furthermore, Ribeiro et al., (2022) noted that trust in AVs is a significant predictor of the primary appraisal of AV use for travel and tourist objectives. If their primary appraisal demonstrates that the use of AVs for travel and tourism purposes is consistent with travellers' expectations and their network's norms, they will proceed to the secondary appraisal phase and conduct an intentional, systematic, and appropriate evaluation of the benefits and costs of AV use for travel and tourism purposes.

3.3.5.2. Innovativeness (INV)

A construct that has garnered significant focus is innovativeness (Rogers et al., 2014). INV is described by Rahman et al., (2018) and Ribeiro et al., (2022) as the propensity to accept technology innovations before others. Chan and Lee (2021) theorised that an individual is inventive if they embrace an invention significantly earlier than their peers. Those who are more inventive tend to acquire greater innovativeness for new ideas and technical systems. Moreover, according to Alshaafee and Iahad (2019), innovativeness is described as the user's willingness to adopt and experiment with new information technologies. This might boost the individual's confidence and trust in the new technology. Hence, INV affects adoption intention, perceived benefits, and perceived dangers positively for both present and prospective adopters of autonomous vehicle technology. Prospective adopters are more likely to accept risks compared to present users. Studies conducted by Raue et al., (2019) indicate that more than 80 per cent of responders are fewer than forty years old. Younger, more tech-savvy individuals are typically more interested in AV technology.

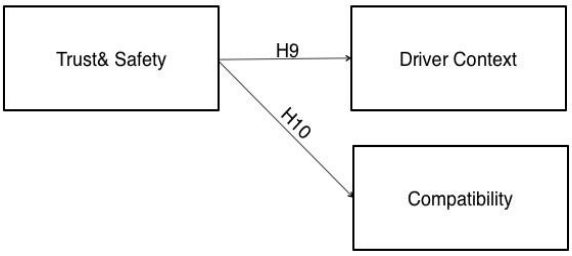
3.3.6. Theoretical Framework: Personal Attributes

Zhang et al., (2019) point out that relatively little attention has been devoted to the role of trust in determining whether users would accept AVs or not, although a lack of faith in AV technology is the most often cited reason for not adopting it (Zmud et al., 2016). The majority of the few studies that have examined trust as a predictor of driver acceptance of autonomous vehicles have concluded that trust is a positive and substantial indicator of drivers' positive attitudes towards AVs (Buckley et al., 2018; Choi and Ji, 2015; Kaur and Rampersad, 2018). It should be emphasised, however, that because the majority of users have not yet interacted with AVs, trust is more accurately referred to as initial trust (as opposed to dynamic trust, which is developed through engagement with a system) (Hoff and Bashir, 2015). At an early stage in the marketisation of developing technology, potential users must generate sufficient trust to overcome risk perceptions and establish a favourable attitude towards it (McKnight et al., 2002). For this reason, faith in AVs is crucial to the effectiveness of generating a positive attitude, which ultimately decides whether or not BI will adopt AVs. According to Seuwou (2020), the acceptance of the veracity of AV manufacturers' claims is without supporting proof or examination. A conviction that the user can rely on the automobile and algorithm to perform as stated while respecting user privacy.

Additionally, the level to which an individual believes that utilising a system will impact their wellbeing is the definition of safety. As Seuwou (2020) named the construct of safety, it takes into account the self-reflective nature of evaluating a situation as dangerous. Within the AV, this includes the evaluation of one's driving abilities and sense of safety concerning other drivers. The influence of safety is thought to be crucial in the process of forecasting BI, as the user will assess the possible effect of safety-related repercussions resulting from utilising the technology on public roads and in hazardous environments. This component includes vehicle safety and security as well as cyber security considerations. Thus, this study advocated including trust and safety in the original TAM and anticipated that:

H9: Trust and Safety have a positive influence on the Driver Context of the technology.

H10: Trust and Safety have a positive influence on the Compatibility of the technology.

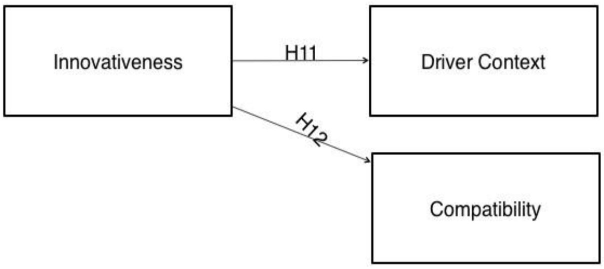


Hypotheses related to TR&SF towards DC and COP

As stated by Jansson (2011), comprehending user early adoption behaviour is crucial. According to Müller (2019), the original TAM and prior research have demonstrated that innovativeness also influences user's acceptability of automobile solutions (INV). Yet, this aspect of technological acceptability has rarely been considered in prior research. In addition, pieces of research existing research characterise early adopters of technology as more environmentally conscious and inventive than the ordinary user. The innovativeness concept addresses the technological concern, innovation ecosystem, public opinion, innovation resistance, and innovation trust. Perceived usefulness and perceived ease of use are positively affected by the elements in the case of autonomous vehicles, as demonstrated by innovative users' more favourable positive perceptions and greater adoption rates. Hence, the following possibilities are proposed:

H11: Innovativeness has a positive influence on the Driver Context of the technology.

H12: Innovativeness has a positive influence on the Compatibility of the technology.



Hypotheses related to INV towards DC and COP

All hypotheses proposed for this research study are presented below in Table 3.3.

Table 3-3: Research hypotheses

No.	Research hypotheses
H1	The Perceived Usefulness of the technology has a positive influence on the Attitude Towards Use.
H2	The Perceived Ease of Use of the technology has a positive influence on its Perceived Usefulness.
H3	The Perceived Ease of Use of the technology has a positive influence on the Attitude Towards Using.
H4	The Attitude Towards the use of technology has a positive influence on the Behavioural Intention to Use.
H5	The Driver Context of the technology has a positive influence on its Perceived Usefulness.
H6	The Driver Context of the technology has a positive influence on its Perceived Ease of Use.
H7	The Compatibility of the technology has a positive influence on its Perceived Usefulness.
H8	The Compatibility of the technology has a positive influence on its Perceived Ease of Use.
H9	Trust has a positive influence on the Driver Context of the technology.
H10	Trust has a positive influence on the Compatibility of the technology.
H11	Innovativeness has a positive influence on the Driver Context of the technology.
H12	Innovativeness has a positive influence on the Compatibility of the technology.

3.4. Chapter Summary

This chapter discusses, explains and justifies the significance of the theories used to support the research model in this investigation. In addition, the research model's theoretical underpinnings are explained. Based on the theoretical background, the conceptual framework of this study is established, with framework constructs derived from existing literature, including innovation adoption theories, pervasive computing and other factors concerning the technology acceptability of autonomous vehicle technology. The framework consists of three distinct groups: TAM, professional setting, and personal attributes that address the various theoretical aspects.

Additionally, twelve hypotheses were conceived to be tested to investigate the influence of various technology adoption factors on user acceptance of autonomous vehicles and connected technologies. The study hypotheses are derived from the relevant literature and address the nature of these emerging technologies. In the following chapter, the study will explore and explain the study design, establishing the most appropriate research methodology and data-gathering techniques.

Chapter 4: Research Methodology

4.1. Introduction

The previous section established and provided the conceptual approach and theoretical framework for the research, based on an in-depth review of the technology acceptance literature. The primary focus of this chapter is to address the methods employed in the current study. The method used for the study focuses on identifying the most effective approach to ensure the validity of the research. Therefore, it needs a clear and thorough justification of the study methodology and the reason behind the choice of specific approaches. This chapter provides a guide to the research philosophy, design, instrument, measurement scale, and questionnaire. In addition, outlining the particular method employed in the main study, including the procedures for data collecting, data cleaning, and data analysis. Following, the ethical aspect of this research will be addressed.

This research study uses literature to produce explanations of situations in which there are relevant behavioural intentions and attitudes for all users (Oliver et al., 2000). This study of emerging technology provides numbers-based results to show the preferences and opinions of the participants. The research will use surveys to ask participants to provide their opinions considering their observations of potential success in terms of potential trust AVs and connective technology. According to Polland (2005), "The process of giving surveys to people, getting them to complete it truthfully and returning it can be viewed as a special case of "social exchange." The theory of social exchange says that people behave in certain ways when they know how others will react to their behaviour". As stated by Poland (2005), the surveys are reliable and accurate to produce results about the volunteer's position and the opinions of the participants. Participants will comprise people who may utilise autonomous vehicles in the UK.

4.2. Research Philosophy

A key factor in questioning is being goal-oriented and having the ability to answer key queries of the study into autonomous vehicles. In particular, focusing on operational aspects and connective technology. In addition, the survey may be a collection of numbers; however, they are both professional and non-professional drivers to provide more detail and the latest information on the study (Sukamolson, 2007). It is important to note that this research reviews responses from the participants from the UK. Different people with some specific expertise in the industrial operation of AV, including manufacturers, will be participating during this survey, such as the automotive sector technology and other fields. The others consist of participants from the industrial sector and mechanical engineering. The main focus of the study is on gathering insights and opinions about AV techniques as well as obtaining the opinions of each participant.

4.3. Focus

This study examines autonomous vehicle technologies. In doing so, a detailed literature review was undertaken, to analyse the aspects of AV's success and the way it is often achieved. Whereas these studies were studied to search for common factors for AV technologies, especially V2V and V2I, there were some limitations in the review. Most studies have focused on factors related to the benefits of AV; however, there is a restricted range of research conducted on how technology acceptance towards AV technology in the market.

As a result, this study focuses on understanding the user technology perceptions of introducing AV as well as connective technology. This researcher notes that different AV studies also propose higher ways in which to deal with processes and systems involving AVs through the creation of the latest technologies such as V2V and V2I. However, there is still less information on these technologies in terms of their operations and implementation.

4.4. Research Paradigms

Collis and Hussey (2021) defines research paradigm as “a framework that guides how research should be conducted based on people’s philosophies and their assumptions about the world and nature of knowledge. In addition, a paradigm provides a framework that includes an accepted set of theories, methods and ways of defining data”.

As reported by Saunders et al., (2003), paradigms commonly used in research include positivist, exegetical and critical social theory. In quantitative research, a positivist model is used. The postural model is based on the logical positivism philosophy, which includes the use of strict rules and measurements. Another research paradigm is realism, which contains both positivist and constructivist elements. The difference between realism and positivism is that positivism is concerned only with individual reality, whereas realism is concerned with multiple perceptions of reality (Saunders et al., (2003).

4.4.1. Positivism Versus Interpretivism

Positivism and interpretivism are the two most distinct research paradigms in the social sciences (Blumberg et al., 2008; Collis and Hussey, 2021). Positivists believe in forms of social order and the individual use of quantitative methods, while interpretivists believe in the individual form of society and the use of qualitative methods. The method of positivism is associated with scientific methods, while the field of interpretivism is concerned with the knowledge of the socially constructed world. Using interpretive research methods makes it almost impossible to see beyond its own biases and experiences (Mora et al., 2020).

Positivism tends to be a theory that states a particular form of knowledge and retains that valid knowledge. All the established data that arises from the senses is known as empirical evidence, thus it can be said that positivism is predicated on empiricism. On the other hand, interpretivism proposes that it is impossible to study the social realm with the application of scientific methods and investigations that are used in practical life. In his case, the investigation of the social realm uses a different epistemology. From the other philosophic perspectives, interpretivism is aware of the fact that social science researchers should always consider the ideas, languages, concepts, and ideas of the researchers and their perception of the social world under investigation. In interpretivism research work, the researcher implements the elements of the study thus interpretivism integrates the human interest into the study (Tahir and Alexander, 2020).

According to this type of approach, the researcher needs to appreciate the differences between the ideas of different people. The positivist tradition gives more importance to the doing of quantitative research such as large-scale surveys. The concept of an interpretive approach is derived from the phenomenon that is subjective, contrary to which the actual invention is the approach that is understandable easily (Cohen et al., 2020). When there is an isolated phenomenon and a reasonable approach, then the approach is regarded as part of the positivist philosophy of research. Interpretivism is a philosophy that involves the development of trust in the general public and target customers in vehicles. Table 4.1 shows the differences between positivism and interpretivism.

To conclude, the positivist approach has many advantages in scientific, social, and market research. It emphasizes the use of objective data and facts in research, eliminating the subjective bias of researchers and thus improving the credibility of research results. It builds models through data analysis that can predict future trends and outcomes. This is significant in market research, economic forecasting, technological development, etc. The positivist approach excels at revealing causal relationships between variables; for example, a study of AV adoption intentions can identify how one factor (such as technological characteristics) affects another (such as consumer intention). The positivist approach emphasizes using quantitative data for analysis, making research results more accurate and actionable. It has rigorous standardization processes, from study design to data collection to data analysis and reporting, ensuring the research's rigour and reliability.

Table 4-1: Summarises the Differences between the Research Paradigms

Positivism	Interpretivism
Reality is objective and separate from the research	Reality is subjective and inseparable from the search
Knowledge is based on observable facts outside of the human mind	Knowledge is determined by people Bethan than by objectives external factors
Uses large samples	Uses small samples
Theory testing	Theory generation
Statistical analysis	Observation of individuals' interpretations of the phenomenon
Deductive approach	Inductive approach

Adapted from Bryman and Bell, (2007)

4.5. Research Design

As stated by. (Collis and Hussey, 2021), research design refers to the general plan adopted by the researcher to answer the research questions and is considered the general structure of any study. Collis and Hussey, (2021) claim that the study process can only be successful if the researcher makes the appropriate choices in the research design, which highlights its importance. In terms of this research, will employ a diverse range of constructs. The improvement of automotive safety features and enabling time-saving to be implemented more freely into technology is essential to the study's concerns since fully automated vehicles are dependent on applications that detect obstacles close to the vehicle. To fulfil the study's aims and objectives, a research design based on the hypothetic-deductive method is employed. The research design comprises several steps to test hypothesis that eventually leads to addressing the research questions. It involves reviewing the literature, developing the theoretical model or framework, formulating the hypotheses and, finally, making logical conclusions from the study's results. Figure 4.1 shows the process by which this study is conducted.

The research design began by examining a review of the literature on autonomous vehicle technology and pervasive computing. This phase helped to raise awareness of the field of research and to identify the reasons for conducting the current study. A conceptual framework model, with twelve hypotheses, was generated after finding the gaps in the literature and then defining the search strategy (survey). In addition, data are collected to test normality, reliability, descriptive statistics, Pearson's correlation test, multicollinearity and regression analyses. Moreover, the data was s analysed using SPSS to validate the theoretical model and test the research hypotheses. SEM using AMOS was performed to examine the hypotheses' relationships as well as to assess the overall fit of the proposed model. Finally, the findings are examined in light of the literature, as well as against the theoretical and management implications.

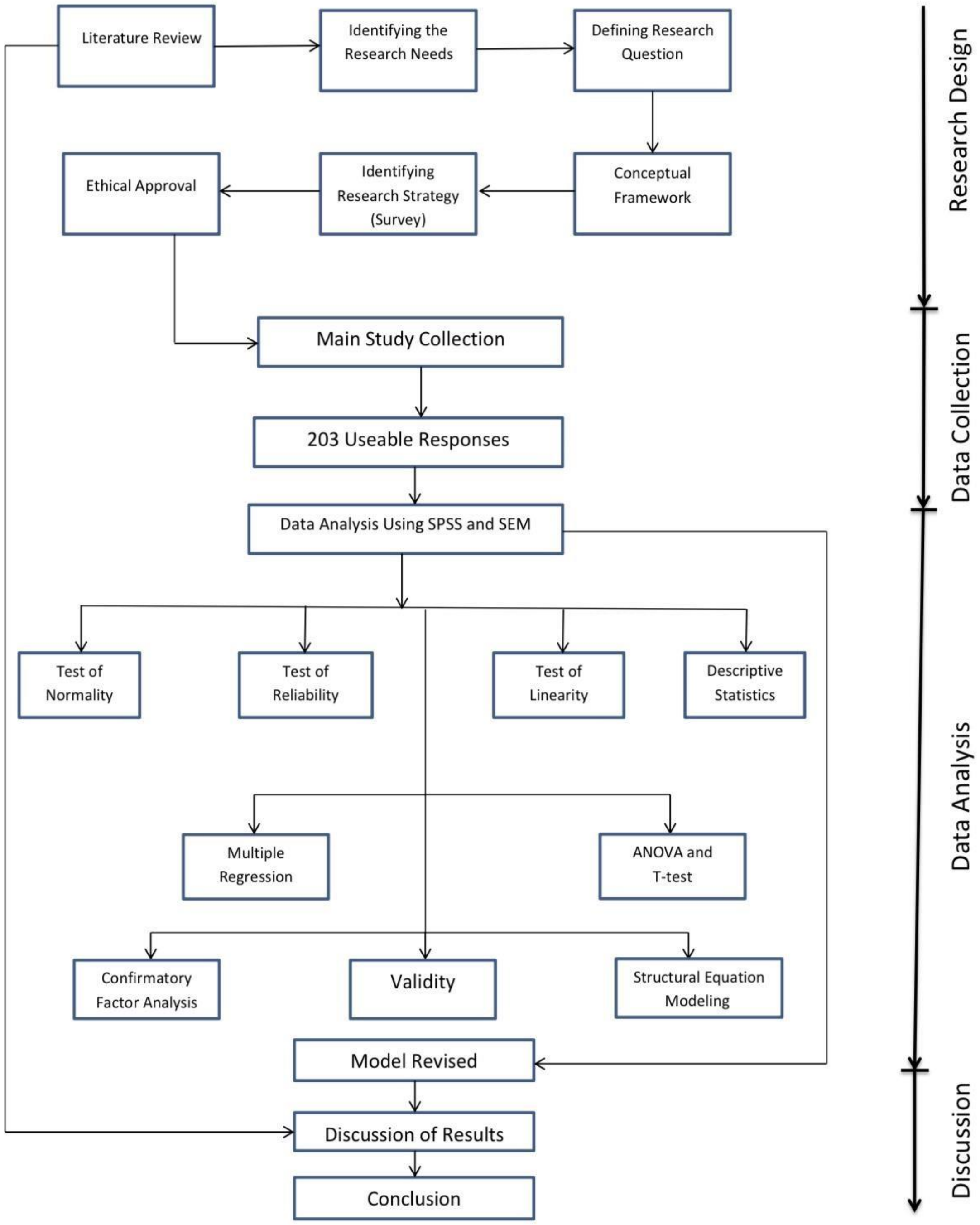


Figure 4-1: Research Design

4.6. Research Approaches

This represents a crucial element within the research since it relies on a process of analysing and evaluating key information. There are two methods of data analysis; deductive and inductive. The inductive research approach is useful in analysing qualitative information. The deductive approach, however, is important for analysing quantitative information such as data on new product development (Gioia et al., 2013). The main purpose of using the deductive approach is to facilitate the analysis of digital information over a minimum period. The inductive approach is not utilised to the present study as it requires data in a qualitative form and also requires a follow-up phase and more resources.

4.6.1. Deductive versus Inductive

The inductive and deductive approaches differ in many ways. For example, the primary way that makes them different is that inductive reasoning is all about the development of a theory and deductive reasoning focuses on testing a theory that already exists. The main distinction between the inductive and the deductive methods is that inductive reasoning focuses on the development of the theory, while deductive reasoning concentrates on the testing of the existing theory. In the case of deduction, the theories already predict the outcome which is already tested by the experiments conducted (Cohen et al., 2020). On the other hand, through the process of induction, the conclusion is partially and completely antonyms depending on what the evidence is supposed to be.

Deductive reasoning starts with a general idea that later reaches a specific conclusion. This means that the outcome is already predicted in this method. The conclusion is achieved with the help of logical thinking, and this thinking is valued by the employers. Deductive reasoning is known to be a form of valid reasoning in terms of deducing new information or conclusions from known sources and related facts (Gu et al., 2020). Alternatively, inductive reasoning concludes with the help of the generalising process and by using specific facts and data. Deductive reasoning follows the process of the top-down approach. On the other hand, inductive reasoning follows a bottom-up approach. Deductive reasoning tends to start from the building. In contrast, inductive reasoning tends to start from the conclusion part.

Table 4-2: Summarises the Differences between Deductive and Inductive Research

Deductive	Inductive
Scientific principles	Understanding of the meaning's humans attach to events
From theory to data	In-depth knowledge of the topic
Quantitative data collection	Qualitative data collection
Highly structured approach	More flexible structure

Adapted from Sanuders et al., (2012)

4.6.2. Quantitative Approach

Mohajan (2018) believed that qualitative research is difficult to clearly define. Since it has no theory or model of its own, nor does qualitative research contain entirely its own distinct set of methods or practices. Qualitative research needs some research questions which cover a range of topics, although most focus on the participants' understanding of meanings and social life in a given context. Moreover, Alharahsheh and Pius (2020), defined quantitative research as related to quantification with application to a specific phenomenon, and this is expressed in terms of quantity. In addition, quantitative research is often used to test existing theories as examined by Müller, (2019).

This is a method of research in which the numerical representation of data is involved. The data and information that are collected for the research and all the processes the research is going through are represented numerically so that accurate results are produced which can then be trusted and more trust can be gained (Mahi et al., 2020). These methods take all the evaluations from a qualitative and descriptive study and convert them into a numerical value. A survey is conducted, and the values derived from that are recorded and given a form with numerals. The survey involves the questionanswer round with the researcher with the target users and the data is collected from the users to conduct the research.

4.6.3. Qualitative Approach

Qualitative research relates to meaning and process as it may not be amenable to examination by quantity or quality. Qualitative research aims to provide a specific understanding of a phenomenon based on the people who struggle with it with less generalisation. Moreover, qualitative research aims to achieve a deep understanding of a specific situation through in-depth exploratory studies to enable the discovery of high-quality responses throughout the research process (Alharahsheh and Pius, 2020).

The qualitative and quantitative methods are connected to the primary data in this project. The questionnaires of the survey are needed for the collection of the primary data that is quantitative (Ayele and Juell-Skielse, 2020). Besides that, some researchers have shared the opinion that the secondary data is all about the accumulation of earlier theories and facts.

Table 4.3, outlines the main differences between quantitative and qualitative approaches in terms of the role of theory in research, ontology, epistemology, research strategy, data format, and the scientific used.

Table 4-3: Summarises the Differences between Qualitative and Quantitative Research

	Quantitative approach	Qualitative approach
Theory’s role	Deductive	Inductive
Ontology	Objective	Subjective
Epistemology	Positivism	Interpretivism
Research strategy	Survey Experimental studies	Participant observation focus group in-depth interviews
Data analysis	Statistically identifying Relationships among variables	Descriptive data Themes Patterns
Nature of data	Numerical	Textual
Scientific method	Confirmatory	Exploratory

Used by Elwalda et al., (2016).

4.6.4. Mixed Methods Research

The mixed-method approach is also used in various studies because this approach involves the use of both quantitative and qualitative methods. The use of mixed research methodology can provide insight into the study (Creswell and Clark, 2011). Using both methods increases the credibility of the research, because each method addresses the shortcomings of the other, allowing the study to benefit from both approaches.

The matter of reliability and validity in mixed research is very important and highly significant in understanding the proper reason for completing any research work (Bezai et al., 2021). The research that is conducted above definitely requires valuable data as it is of high importance in the research work. It is important to provide a valid basis for the research work. This reliable data is completely based on the data collected by the researchers with respect to the topic and the four managers that they provide as an interviewer (Kinra et al., 2020). Managers have undergone various processes, and impacts of cross-cultural training and development programs. The quantitative strategy is used in quantifying the attitudes, behaviours and opinions with alternative variables. The analysis of the phenomenon and the collection of the data is also dependent on the research philosophy. Contrastingly, the strategy of qualitative research provides a detailed understanding of the motivation opinions and reasons of the research. This method is the mixed method of all the above-mentioned methods (Dirsehan and Can, 2020). When there is an isolated phenomenon and a reasonable approach, then the approach is stated via the positivist philosophy of research. All methods like qualitative and quantitative and many other methods are combined to form the mixed method. The development of theory for the cars that are selfdriving is focused on the inductive approach. This method is very efficient and must be used in any research work to make it more accurate and reliable. This is all about innovation and the discussion and analysis of an existing theory are covered by deductive approach.

4.7. Research Strategy

As stated by Saunders et al., (2012), the term "research strategy" indicates the methodological approach that a researcher employs to address the research inquiries. Collis and Hussy (2021) claim that the choice of research strategy is significantly affected by the research paradigm that is embraced.

This research has chosen a deductive approach within the positivist paradigm. Consequently, the emphasis will be on employing quantitative methods to assess the hypothesis and develop a theoretical model. It is important to highlight that data analysis and modelling are essential procedures for the current study. In addition, this study presents surveys as the main strategic approach adopted in this research. Notably, there are different types of research strategies including experimental, surveying, action research, etc (Collis and Hussy, 2021). As Green et al., (2012) emphasise the survey as a vital part of the research process to gather essential data associated with autonomous vehicle technology that has a potential widespread adoption. Furthermore, research strategies can be tools and approaches that survey participants can use to collate data relevant to a specific topic (Kumar, 2018). This thesis will predominantly utilise a quantitative research approach to autonomous vehicle technology, and AV will be conducted based on an online survey. Hence, this could be supplemented by autonomous vehicle exploratory research into specific user aspects.

The survey is an appropriate method for collecting data on users' acceptance of autonomous vehicles, esp. for understanding attitudes, perceptions, and behavioural intentions on a larger scale. For the reason that the survey allows for the collection of standardized data across a large sample, making it easier to quantify and compare responses. Through a survey, we can identify trends and correlations between different factors (perceived usefulness, trust, safety, etc.) and users' attitudes on acceptance of autonomous vehicles. The questionnaires for a survey can include a mix of Likert scale items, multiple-choice questions, and open-ended responses to capture quantitative and qualitative data, which are easy to distribute both in-person and online, making it easy to collect data. In addition, a survey allows for comparing different demographic groups (e.g., age, gender, income level) to see how acceptance varies across these segments. Thus, a survey is an effective method for collecting data on users' acceptance of new technology, especially when the goal is to measure attitudes.

4.7.1. Surveys

According to Groves et al., (2011), a survey is "a systematic method for gathering information from (a sample of) entities to construct quantitative descriptors of the attributes of the larger population of which the entities are members". Surveys are mostly based on the use of a structured questionnaire with a sample that represents a specific population. Participants are asked a variety of questions that skillfully and concisely obtain specific, relevant and interesting information from an individual. Questions are accurately chosen, shaped, sequenced and asked of the participants. To adapt the specifics of the research plan to meet their needs as a user. There are two types of surveys: descriptive surveys and analytical surveys. The descriptive survey provides helpful insights into the characteristics of a particular person and demographic, which can then be considered in terms of how this affects them behaviourally, whereas the analytical survey determines whether or not a relationship exists between the target and if one is worth pursuing/creating.

Collis and Hussey, (2021) stated that the use of a survey questionnaire as a data collection method has many advantages. Firstly, questionnaires are relatively easy to administer Since the vast majority can now be conducted online, and free applications can be used to monitor, filter, and sort the responses submitted. Secondly, questionnaires are cost and time-effective, as a large amount of data can be collected in a highly economical way. Well-chosen questions can produce information that would take more time and effort to obtain if it was gathered by observations. If you were to observe a cross-section of society, they may be the wrong demographic, whereas the right target audience will naturally gravitate towards a survey online that is about something they are interested in. Online surveys can be taken by people passionate about the topic, whilst others need a financial incentive to take a survey which could rig the results. This study follows the positivism research model, a survey questionnaire is the most appropriate method. This approach allows a large number of individuals to be surveyed, as well as being cost and time-effective. Moreover, an online questionnaire survey is more suitable for respondents as they can spend the whole of the allocated time on it, or less.

The questionnaire profile will consist of three sections of technology acceptance, as shown in Index A. The first section was related to AV applications, the second part was related to V2V applications and the third section was related to V2I applications. The data for this study will be collected from different participants both professional and nonprofessional drivers using an online survey questionnaire, as shown in Appendix B. In addition, questionnaires are one of the most used methods for gathering data, as a small or large amount of data can be collected in a short period. Moreover, questionnaires are easily quantified and can be analysed more objectively than other methods.

4.7.2. Study Population and Sample

'Population' defines the aggregate of individuals possessing shared features relevant to the research (Saunders et al., 2012), while 'sample' signifies the selected segment of the population utilised for examination (Bryman and Bell, 2007). A sample is essentially a subset of the study's population, necessitated by the impracticality of examining the total population. A representative sample of the population is selected, allowing for inferences regarding the research population to be selected. Furthermore, utilising a sample permits greater time allocation to the study design and can enhance the study's accuracy, as a smaller number of cases is often used.

4.7.2.1. Study Population

The population of this study, which includes both professional and non-professional drivers, is not just a group of individuals but a vital part of the research process. The respondents, comprising technical companies and Brunel postgraduate students, were selected using various methods. The primary objective of this study is to gather the perspectives and attitudes of the participants on autonomous vehicles and connected technologies. Therefore, most users are familiar with AVs, and their reviews are crucial in providing a solid ground for this study. However, it is impractical for any survey to include the entire population due to considerations of expense, time, and accessibility.

Additionally, this study used non-probability sampling due to its nature and goals. Non-probability sampling is frequently employed when probability sampling is impracticable. Cooper and Schindler (2014) claim a non-probability sampling method is acceptable, provided the sampling goals are adequately fulfilled. Furthermore, non-probability sampling methods conserve resources and time, enabling the researcher to examine the phenomena of interest efficiently. Conversely, probability sampling methods necessitate a comprehensive list of all population members (Black, 1999; Cooper and Schindler, 2014), which is problematic given that the population size for this study is 203.

Likewise, this study employed a multisampling strategy for convenience and snowball sampling to ensure participant access at a limited cost and effort. Convenience sampling, with its high response rate compared to other methods, provides a more accessible way to reach participants. By using snowball sampling, the researcher was able to gather additional responses from these participants. Snowball sampling, suitable for use without a population list, is an appropriate technique for the present study. These two sampling techniques allowed the researcher to manage the available resources efficiently.

As shown in Table 4.4 this study employed non-probability sampling, utilising a multi-technique approach that incorporates convenience and snowball methods to obtain a sample representative of the primary population.

Table 4-4: Sampling Techniques

Technique	Descriptions	Advantages	Disadvantages
Snowball	Subjects with desired traits or characteristics give names of further appropriate subjects	Possible to include members of groups where no lists or identifiable clusters even exist (e.g., drug abusers, criminals)	No way of knowing whether the sample is representative of the population
Volunteer, accidental, convenience	Either asking for volunteers, or the consequence of not all those selected finally participating, or a set of subjects who just happen to be available	Inexpensive way of ensuring sufficient numbers for a study	Can be highly unrepresentative

Used by Elwalda et al., (2016).

4.7.2.2. Sample Size

The sample size is determined after the research population is defined and the sampling technique is implemented. Substantial sample size is frequently necessary to address the research concerns. Large samples can more accurately represent the characteristics and features of the study population (Collis and Hussey, 2021).

The sample size is determined by cost consideration and norms of thumb, as this study has implemented non-probability sampling (Blumberg et al., 2008). Additionally, most studies should employ a sample size of 30 to 500 cases, as this study employs structure equation modelling (SEM) and analyses the relationship between the variables. Tabachnick et al. (2013) classify sampling in SEM as "100 cases = poor, 200 cases = fair, 300 cases = good, 500 cases = very good, and 1000 or more cases = excellent." Consequently, the sample size of the current study is estimated to be between poor and fair, as 203 responses have been achieved.

Hair et al. (2010) assert that a sample size of at least 200 is crucial to ensure the accuracy of structural equation modelling. Thus, collecting responses exceeding this number for the sample was imperative. As reported by recent studies by Ahmed et al. (2020), 298 respondents answered the questionnaire, which consisted of 26 items and 05 variables. This study surveyed 203 individuals and obtained data from company contacts, university staff, and LinkedIn professional networking sites relevant to AVs.

4.8. Research Instrument and Measurement Scale

4.8.1. Construct Development

Participants are asked to respond to questions using a 7-point Likert scale in the questionnaire ranging from strongly disagree to strongly agree. There will be eleven questions about profit demographics (age, gender, areas of living, driving experience, weekly mileage, purpose of driving, previous accidents, education, driver profession, and driver assistance system). The questionnaire addresses eight constructs that make up the theoretical framework that the questionnaire is based on.

Behavioural intent to use, perceived usefulness, perceived ease of use, attitude towards utilising, compatibility, driving context, trust, and innovativeness were the eight constructs examined in this study as shown in Table 4.5. Several items were used to assess each construct, and all of the items had their content validity enhanced by being reworked from previously published materials.

To measure perceived usefulness, perceived usefulness, and behavioural intention, this research used the items scale from Choi and Ji (2015); Nastjuk et al., (2020); Koul and Eydgahi (2018) and Müller (2019); Zhang et al., (2019) and Zhang et al., (2020). Next, in terms of compatibility and driver context were adapted from Nastjuk et al., (2020); Rahman et al. (2015); El-Khatib et al., (2019), Magyari et al., (2021) Jing et al., (2020). Finally, the items used to measure trust and safety were adapted from Choi and Ji (2015); Kaur and Rampersad (2018); Zhang et al., (2019) and Zhang et al., (2020). About innovativeness, which was assessed using measures adapted from previous studies on Müller (2019) and Nastjuk et al., (2020).

Table 4-5: Technologies and Adapted Sources

Construct	Items	Adapted Source
Behavioural intention to Use (BI)	BI1, BI2, BI3 and BI4	Choi and Ji (2015); Nastjuk et al., (2010); Koul and Eydgahi (2018) and Muller (2019)
Attitude Towards Using (ATU)	ATU1, ATU2, ATU3 and ATU4	Muller (2019) and Nastjuk et al., (2020)
Perceived usefulness (PU)	PU1, PU2, PU3, PU4 and PU5	Choi and Ji (2015); Muller (2019); Zhang et al., (2019) and Zhang et al., (2020)
Perceived Ease of Use (PEOU)	PEOU1, PEOU2, PEOU3 and PEOU4	Choi and Ji (2015) and Nastjuk et al., (2020)
Driver Context (DC)	DC1 and DC2	Rahman et al., (2015) and Magyari et al., (2021).
Compatibility (COP)	COP1, COP2, COP3, COP4 and COP5	Nastjuk et al., (2020) and Yuen et al., (2020)
Trust (TR) and Safety (SF)	TR1, TR2 and TR3	Kaur and Rampersad (2018); Zhang et al., (2019) and Zhang et al., (2020)
Innovativeness (INV)	INV1, INV2, INV3 and INV4	Muller (2019) and Nastjuk et al., (2020)

4.8.2. Measurement Scale

Between November 2022 and January 2023, a collection of data was generated by surveying 203 individuals in the United Kingdom. The survey utilised online questionnaires that were distributed to both professional and non-professional drivers. The respondents were selected through different methods, including (company contacts, university staff and LinkedIn professional networking sites). For the most part, this thesis will use a quantitative research approach to the topic of autonomous vehicle technology; the study will be performed online in the form of a survey using a 7-point Likert scale with both professional and non-professional drivers. Individual emails will be sent out to each potential participant. Furthermore, the email will include an introductory line or a description of how their contact details were obtained. Additionally, the survey participants are both professional and non-professional drivers with a minimum age of eighteen years, and they were obtained via websites such as LinkedIn, technical companies, and Brunel postgraduate students.

In addition, data has been collected from two hundred and three respondents using survey-based questionnaires conducted in the United Kingdom. In addition, online autonomous vehicle technologies such as V2V and V2I will be conducted based on a questionnaire of both professional and nonprofessional drivers with seven-point Likert scales, indicating the extent of agreement where 1 = strongly disagree to 7 = strongly agree adapted from the literature. The main focus of the study is to gather the insights and attitudes of the participants towards AVs, V2V, and V2I, as shown in Table 4.6.

Table 4-6: Constructs and Indicators

Construct	Indicator
BI	Assuming I had access to an AVs/V2V/V2I, I intend to use it. I expect that I will use AVs/V2V/V2I in the future. I will use AVs/V2V/V2I on a regular basis when available. I intend to own an AVs/V2V/V2I when they become available in the market.
ATU	In my opinion, it is desirable to use AVs/V2V/V2I. In my opinion, using AVs/V2V/V2I would be beneficial for me. I like the idea of using AVs/V2V/V2I. Using AVs/V2V/V2I will have a positive impact on society.
PU	Using AVs/V2V/V2I would enhance my effectiveness while driving. AVs/V2V/V2I will contribute to a better traffic flow. Using AVs/V2V/V2I will increase my productivity. Using AVs/V2V/V2I will decrease traffic accident risk. Using AVs/V2V/V2I will improve my daily efficiency.
PEOU	I expect learning to use AVs/V2V/V2I will be easy for me. I believe my interaction with AVs/V2V/V2I would be clear and understandable. Learning to operate AV/V2V/V2I would be easy for me. It would be easy for me to become skilful at using AVs/V2V/V2I.

DC	Driving AVs/V2V/V2I in urban areas will improve visibility. I think driving AVs/V2V/V2I vehicles in urban areas will change traffic congestion.
COP	I think using AVs/V2V/V2I will not fit well into my journey patterns. Using AVs/V2V/V2I would be compatible with my driving habits. I think using AVs/V2V/V2I is compatible with my everyday life. I think using AVs/V2V/V2I is compatible with my personal communication devices. Using AVs/V2V/V2I would fit well with all aspects of my lifestyle.
TR&SF	AVs/V2V/V2I have enough safeguards to make me feel comfortable using it. My trust in an AV/V2V/V2I will be based on the reliability of the underlying technologies. Overall, using AV/V2V/V2I will have more privacy and security.
INV	I keep myself informed about recent AVs/V2V/V2I developments. If I hear about a new development in the area of AVs/V2V/V2I, I will be interested in trialling it for ways to trial it. I like to give AVs/V2V/V2I a trial, even if they are not widely used yet. I would like to experiment with AVs/V2V/V2I. Among my peers, I would be one of the first to try out autonomous vehicles.

4.9. Participants and Data Collection

The process of gathering information through data collection using both primary and secondary sources is important to consider. Furthermore, a questionnaire is the most effective method for the investigator to use when collecting primary information on technology acceptance. In the case of the secondary method, there are various sources such as journals, books, published research, articles, etc., and these are considered the essential sources for collecting secondary data which are used for a literature review. Therefore, both sources of data collection within the investigation are useful to the researcher (MacKenzie and Podsakoff, 2012). Furthermore, the data is collected from online surveys filled out by both professional and nonprofessional drivers. Moreover, participants provided their demographic information and responded to various items based on the eight constructs.

Firstly, this survey has participants of different responses ages and can be categorised into four groups maximum participants were aged 18-24 34% whereas the age group of 25-34 consist of 31%, the age limit and 28.1% of participants above, more than fifty-five. Secondly, as per gender divergence, where male participants were more interested in comparison to females, the percentage of males is 70.4% and females account for 29.6%**.** Thirdly, the survey categorised participants based on different areas, the participants who came from urban areas were more interested compared with other areas. The participants that belong to urban areas account for 50.7%, while those in suburban areas account for 31%, and the participants that relate to rural areas represent 18.2%. Fourthly, in terms of driving experience, the majority of the participants (39.5%) had between 4 to 9 years' experience and the minority was that 14.35% had 16+ years' experience. The rest of the participants (26.6%) had at least

1-3 years of experience and 19.7% had 10-15 years of experience. Fifthly, while weekly mileage shows that the participants who belong to the 0-49 miles (25.6%) category were interested only in driving, the 50-99 miles category (accounting for 31.5%), the 100-199 miles represents 31.5%, the 200-499 miles represents 7.9% and the 500+ group account for just 3.5%. Sixthly, the survey categorises interested participants based on driving activities and the participants who relate and that commute to work is more than compared to others. Therefore, the participants that commute to work represent the highest percentage at 41.4%, journeys/travel represent 35%, and leisure at 21.2%.

Other different minor categories stand at 2.4% such as attending university, commuting to a farm and dropping children off at their childminder. Seventhly, participants are categorised on an accidental basis as it showed that participants who were involved in car accidents involving minor damage accounted for 38.9% of those surveyed. Accidents that involved an injury accounted for 18.2%; accidents that involved major damages to the car accounted for 7.4%, and lastly, 35.5% of those surveyed represented drivers who had never been involved in an accident. Eighthly, the survey categorises participants based on Brunel University students. The participants from Brunel University represent 17.2% of those who took part in the research survey.

In addition, the other participants represent 82.8% of those who took part in the research survey. As a result of this, the majority of the participants of this survey are professional drivers, where 45.3% of them are non-professional drivers. However, the professional drivers are then further divided into six mains: 22.1% are local courier drivers, 20.8% were local haulage drivers, national courier drivers accounted for 16.9%, international haulage drivers at 10.4%, national haulage drivers at 9.7% whereas the remaining categories were of an aggregate 20.1%. Finally, the survey has demonstrated that most of them used an automatic parking driving assistance system 28.1%, the second largest group 27.6% used blind spot detection, and thirdly, 21.7% used automatic braking systems, collision avoidance systems had been used by 9.4% drivers, while the remaining categories account for just 13.2% which consists of people who use all the driving system above and the cruise control lane.

4.10. Data Analysis

To achieve the goal of this study, several statistical techniques will be used to analyse the data such as a preliminary examination of the data, reliability, multiple regression analyses, descriptive statistics, NOVA and a structural model using AMOS will be implemented to test the supposed relationships and to assess the general fit of the proposed model.

4.10.1. Preliminary Examination of the Data

According to Newman (2009), consider unanswered questions as missing data. Tabachnick et al., (2013) state that missing data may hinder statistical analysis and lead to less reliable results. To obtain reliable results, it is necessary to process the missing data before it is analysed. Missing data can occur randomly or for other reasons (Pallant, 2020). As Kleinbaum et al., (2007) mentioned, missing data should be no more than 10%; However, Bryman and Cramer (2012), argue that missing data levels of 10 per cent should be termed as missing for that participant. Further preliminary examination of the data using outliers, normality, and multicollinearity tests was carried out to prepare the data for further analysis.

4.10.1.1. Data Screening

Pallant (2020), says that data screening is a crucial step to identify and resolve errors in data collection before undertaking data analysis. Therefore, this study aims to enhance the clarity of the data. Initially, this study employed box plots to examine potential outliers, as outliers can influence the estimated value of regression and the illustration of relationships within a sample (Hair et al., 2010).

4.10.1.2. Normality

According to Pallant (2020), defines normality as the distribution of a data set. Screening data set for normality is essential for nearly every multivariate analysis (Tabachnick et al., 2013). Another study suggested that Skewness and Kurtosis and Kolmogorov-Smirnov and Shapiro-Wilk tests are different approaches to testing the normality (Nazarian, 2013), based on this suggestion this will be used to measure the normality of variables.

This study employed Kurtosis and Skewness tests to conduct the normality. Whereas, the Kolmogorov-Smirnov and Shapiro-Wilk tests are used to evaluate the normality of the data. Firstly, the kurtosis test is employed to verify the normal distribution, and secondly, the Skewness test is utilized to determine the stability of the distribution (Hair et al., 2010).

4.10.1.3. Linearity

Linearity refers to the direct link and correlation between variables. Many multivariate approaches, including multiple regression, logistic regression, factor analysis, and structural equation modelling, implicitly rely on linearity due to their reliance on correlational measures of connection (Lim, 2012). Thus, it is essential to investigate the linear relationship between variables, as nonlinear effects cannot be captured by the correlation value.

Pearson's correlation coefficient is utilized to assess the linearity of the data and investigate the linear relationship between variables, as well as any potential nonlinear impacts. Furthermore, the variance inflation factor (VIF) and tolerance (t) value are assessed to identify multicollinearity, which refers to a significant correlation between two or more independent variables. Therefore, both tests reveal the extent to which every independent variable is influenced by the group of other independent variables (Hair et al., 2010).

4.10.1.4. Multicollinearity

Multicollinearity is another premise of regression that relates to the correlations between independent variables (Field, 2024). When the independent variables are highly correlated (i.e., r = 0.90 or more), multicollinearity difficulties arise. Based on Pearson's correlations results tables in the next chapter for each technology such as AV, V2V and V2I showed that there were no variables value equal to or more than 0.9. However, this research also attempts to testify to multicollinearity to confirm these results of variable relationships relating to Linearity. Therefore, to identify multicollinearity tolerance and variance inflation factors (VIF) measurements were performed. Tolerance refers to the amount to which one independent variable cannot be explained by the other independent variables, whereas VIF is the inverse of the tolerance value (Field, 2024). Tolerance levels below 0.1 and VIF values above 10 are indicative of multicollinearity problems (Field, 2024).

4.10.2. Reliability

Data analysis is always dependent on two factors: measurement reliability and data validity (Nazarian, 2013). The level to which a variable is consistent with what it is intended to assess is the definition of reliability (Hair et al., 2010). A test with high reliability will produce scores that are comparable to those of another check. Cronbach alpha in 1951 presents an indicator of the internal consistency of a test; it is represented by a value between 0 and 1 (Streiner 2003; Tavakol and Dennick, 2011). In this study, the reliability test was determined by calculating Cronbach's alpha using SPSS version 20. A Cronbach's alpha value of 0.90 is regarded as great reliability, values between 0.70 and 0.90 as high reliability, values between 0.50 and 0.70 as moderate reliability, and values of 0.50 as poor reliability.

4.10.3. Multiple Regression Analysis

According to Pallant (2020), the differences between the two types of regression tests: "multiple regression examines the relationship between a single dependent variable and several independent variables based on a coherent theoretical or conceptual reason. While single regressions investigate the same relationship between a single dependent variable and a single independent variable". However, multiple regression techniques are used in this study to examine the hypotheses. Whereas, three different models were created to test the model hypotheses.

TAM effects on behavioural intention to use, attitude towards use, perceived usefulness, and perceived ease of use were tested in the first group of the model. The impact of the professional setting was tested in the model's second group, which focused on driver context and compatibility. Part three of the model tested the role of personal attributes including trust and innovativeness.

4.10.4. Segmentation based on ANOVA Analysis and T-test

In this section, the significant level of the differences presented is examined by comparing the means of different independent groups. Tabachnick et al., (2013); Field (2024); Bryman and Cramer (2012) stated that ANOVA and t-test are appropriate to explore the statistical difference since statistical evidence is required to accept or reject research findings. ANOVA test is used to make comparisons of means when a variable has more than two categories (Pallant, 2020). Using ANOVA, the effects of AV outcomes on different demographics were analysed. In addition, a T-test is used when comparing the mean scores of two different groups.

4.10.5. Confirmatory Factor Analysis

As mentioned by Hair et al., (2010) and Rouf and Babu, (2023), confirmatory factor analysis (CFA) is used to determine the underlying relationship between variables by testing their associations and reducing the size of the data set for simplified analysis. Moreover, CFA is used to verify measurement theory and establish correlations between a set of measurement items and their associated factors, according to theoretical hypotheses. Therefore, this study used CFA as the required analysis method. Before testing hypotheses, it is necessary to investigate the underlying factors using CFA according to the underlying theory.

4.10.6. Construct Reliability and Validity

According to Hair et al., (2010) and Kline, (2023) the primary goal of CFA is to evaluate construct validity using the proposed measurement theory. Construct validity refers to the degree to which a collection of measured items accurately represents the underlying theoretical construct and is created specifically for measurement purposes. Accordingly, this study validated the construct to ensure the accuracy of the measurement. Finally, Table 4.7 shows that convergent validity can be checked by factor loadings (Fls), average variance extracted (AVE) and composite reliability (CR).

Table 4.7: The Measurement of Convergent Validity

Indices	Sig.
Factor loadings (Fls)	> 0.5
Critical ratio (t-value)	> 0.455
Critical value (p-value)	< 0.6

Adapted from Zainudin et al., (2017)

4.10.7. Structural Equation Modelling

Hair et al., (2010) defined, SEM as "a family of statistical models that seek to explain the relationships among multiple variables". In addition, Hair et al., (2010) and Garba and Hafiz (2022) stated that SEM is a technique that investigates and analyses a collection of associations between independent and dependent variables. SEM is utilised to assess the overall model fit and evaluate the consistency between a theoretical model and the estimated model.

According to Hair et al., (2010) several methods can be used to evaluate the overall model fit. However, several academics argue that CFA and SEM should include at least four model fit tests, as no single model can guarantee a perfect fit. Tables 4.8 and 4.9 demonstrate the most significant model fit tests (Rouf and Babu, 2023), which are adopted in this study.

Table 4.8: Assessment of Model Fit

Model Fit Indices	Definition
CMIN/DF Chi-square	A statistical test to observe and estimate the difference between covariance matrices which is the key value in assessing the good fit of the SEM model.
GFI&AGFI	An early attempt to produce a fit statistic and only guidelines to fit. The role of GFI and AGFI are close and both are classified as absolute indexes of fit.
NFI	One of the original incremental model fit indices.
CFI	an incremental fit index that is an improved version of the NFI
TLI	It is conceptually similar to the NFI, but not normed. It is a comparison of the normed chi-square values for the null and specified model, which to some degree considers model complexity.
RMSEA	One of the most widely used measures that attempts to correct for the tendency of the GOF test statistic to reject models with a large sample or a large number of observed variables.

Adapted from Hair et al., (2010)

Table 4.9: GOF tests Criteria based on CFA and SEM

Indices	Value	Ref
CMIN/DF	<3	Hair et al., 2010
GFI	≥0.80	Doll et al., 1994
AGFI	≥0.80	Doll et al., 1994
NFI	≥0.90	Hair et al., 2010
TLI	≥0.90	Hair et al., 2010
CFI	≥0.90	Hair et al., 2010
RMSEA	≤0.08	Browen and Cudeck, 1993

Adapted from Rouf and Babu, (2023)

Kline, (2023) stated that when it comes to examining complex relationships of variables in the context of statistical theory, SEM is a highly rigorous approach in the social sciences. Hence, as shown in Table 4.10 in this study, the hypotheses were checked using the critical ratio (t-value) and critical value (p-value) according to SEM using AMOS.

Table 4.10: Hypothesis Testing

Indices	Sig.
Critical ratio (t-value)	> 1.96
Critical value (p-value)	< 0.05

Adapted from Mai et al., (2019)

4.11. Ethics Considerations

This study uses a quantitative research approach on the topic of autonomous vehicle technologies such as V2V and V2I. This was performed online in the form of a survey conducted in the United Kingdom. After receiving approval from the Brunel University Research Ethic Committee, an online survey was developed and data collecting took place between November 2022 and January 2023. To survey participants, both professional and nonprofessional drivers with a minimum age of eighteen years old, who were obtained via websites such as LinkedIn, technical companies and Brunel postgraduate students. In addition, the online survey includes a questionnaire, participant consent form, and cover letter for the study. The cover letter stated the purpose of the study, voluntariness and confidentiality of participants. In addition, this research further confirms at this point that no individual will be harmed or affected physically or mentally during the research or procedure. Moreover, the research will consider the benefits that come or constitute the better and the effect of the applications of connected vehicle technologies. Thus, this part reinforces the comprehensive research study and its effectiveness for growth.

4.12. Chapter Summary

This chapter mainly addressed the research methods that will be employed in the present study. These are essential to the research process and assist in selecting the best approaches to be used during the research. Furthermore, this study considers ethical concerns associated with the research. Additionally, this chapter also covered several statistical techniques that will be used to analyse the primary research data. First, a preliminary examination of the data should be performed using outliers, normality, Pearson's correlations, multicollinearity, reliability, and multiple regression analysis tests. Following that, the descriptive statistics of the sample will be presented. This includes displaying the results for the sample's mean and standard deviation. After that, ANOVA and T-test will be performed. Confirmatory factor analysis, the Validity of the measurement scale and a structural model using AMOS will be implemented to test the supposed relationships and assess the proposed model's general fit. The following chapter will provide the present study's findings and statistical analyses using SPSS, ANOVA test and T-test before SEM in the next chapter.

Chapter 5: Data Analysis and Results

5.1. Introduction

In this section, this study will test the hypothesis by checking the relationship between different independent variables and dependent variables. Hypothesis testing was performed using multiple regression and single regression in SPSS version 20, the statistical software used in this study. Before performing a regression analysis, it is important to describe the demographic profile of the participants and check for outliers, box plots, normality, and multicollinearity in the data. Furthermore, descriptive statistics are computed for the survey constructs. The reliability of the measurement scale will also be tested in this study. Multiple regression in this study to examine the hypotheses. Then, ANOVA and Ttests are conducted.

5.2. Preliminary Examination of the Data

All survey questions needed to be answered; therefore, it was not surprising that the research did not reveal any missing numbers when checked. As a result, a preliminary examination of tests for outliers was performed to prepare the data for further analysis. The results showed a few participants were identified via box plots, and their survey responses were removed.

5.2.1. Outliers Check

Significant deviation from the mean or median is what Field (2024) calls outliers. Parametric techniques used in data analysis are sensitive to outliers, claims Pallant (2020). In addition, outliers prevent conclusions from generalising reliably (Tabachnick et al., 2013). Respondents used a 7-point Likert scale to indicate how they felt about the different survey questions asked. Box plots were created in SPSS to identify and evaluate extreme values in the dataset used for this study. Box plots in SPSS are useful for detecting outliers when examining the distribution of scores on variables (Pallant, 2020).

Outlying values, as defined by Pallant (2020), are shown by small circles that lie outside of the box plot. As shown in Figure 5.1 this study discovered twelve points beyond the minimum and maximum values. Box plots display the potential range of scores for every factor and identify any exceptional values for AV, V2V and V2I.

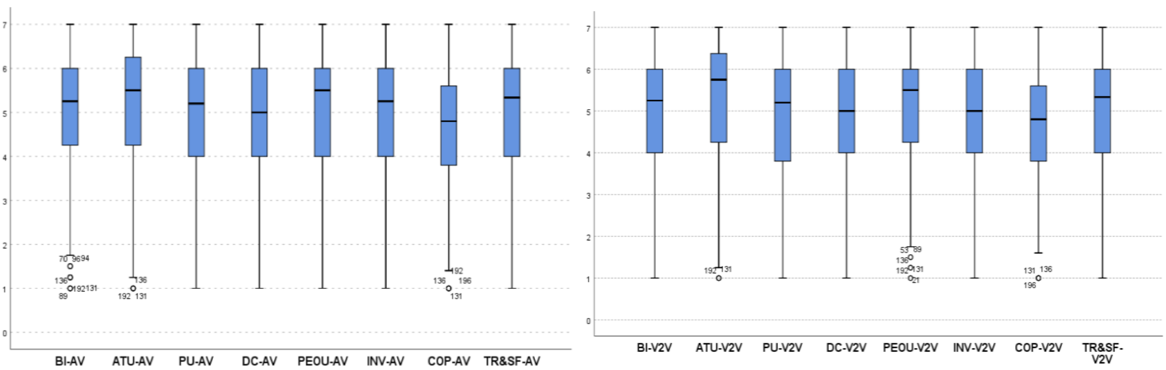


Figure 5-1. Constructs Box Plots AV and V2V

5.2.2. Normality

The Normality should be ≤ 2.58, as shown in Table 5.1, that all results of Skewness and Kurtosis are normal distribution because all results are in the range of normality. However, the results demonstrate different values that have two kinds of results positive and negative. The results of Skewness and Kurtosis of having different scores, positive or negative, do not demonstrate any difficulties as long as all scores are within acceptable range (Nazarian, 2013).

Table 5-1: Normality by Skewness and Kurtosis

Construct	Technologies	N	Skewness	Kurtosis
BI	AV V2V V2I	191	-0.76 -0.68 -0.86	-0.20 -0.44 0.05
ATU	AV V2V V2I	191	-0.91 -0.91 -1.013	0.20 -0.07 0.19
PU	AV V2V V2I	191	-0.68 -0.59 -0.79	-0.19 -0.58 -0.09
DC	AV V2V V2I	191	-0.50 -0.47 -0.59	-0.48 -0.48 -0.24
PEOU	AV V2V V2I	191	-0.89 -0.72 -0.80	-0.04 -0.23 -0.09
INV	AV V2V V2I	191	-0.67 -0.70 -0.75	-0.30 -0.28 -0.12
COP	AV V2V V2I	191	-0.57 -0.62 -0.73	-0.10 -0.14 0.27
TR & SF	AV V2V V2I	191	-0.92 -0.80 -0.89	0.26 -0.02 0.34

5.2.3. Linearity

The linearity of this study uses Pearson's correlations that indicate that all independent factors show a substantial and positive correlation (P-value 0.001) with the dependent variable. This is in accordance to the findings of Pearson's correlations test. In addition, as used by (Field, 2024). Pearson's correlation of the independent variables reveals that none of the independent variables show at 0.90 or higher. This indicates that there are no multicollinearity concerns with the data. Tables 5.2, 5.3 and 5.4 display the findings of Pearson's correlation test.

Table 5-2: Pearson's Correlation for AV

Correlations								
	BI-AV	ATU-AV	PU-AV	DC-AV	PEOU-AV	INV-AV	COP-AV	TR&SF-AV
BI-AV	1							
ATU-AV	.828**	1						
PU-AV	.715**	.779**	1					
DC-AV	.703**	.707**	.772**	1				
PEOU-AV	.672**	.724**	.643**	.641**	1			
INV-AV	.683**	.721**	.705**	.636**	.589**	1		
COP-AV	.582**	.596**	.603**	.578**	.559**	.643**	1	
TR&SF-AV	.714**	.715**	.621**	.661**	.614**	.683**	.745**	1

Table 5-3: Pearson's Correlation for V2V

Correlations								
	BI-V2V	ATU-V2V	PU-V2V	DC-V2V	PEOU-V2V	INV-V2V	COP-V2V	TR&SF-V2V
BI-V2V	1							
ATU-V2V	.810**	1						
PU-V2V	.722**	.776**	1					
DC-V2V	.663**	.672**	.805**	1				
PEOU-V2V	.618**	.734**	.623**	.648**	1			
INV-V2V	.686**	.719**	.729**	.655**	.562**	1		
COP-V2V	.628**	.647**	.623**	.606**	.564**	.650**	1	
TR&SF-V2V	.630**	.721**	.661**	.614**	.555**	.692**	.751**	1

Table 5-4: Pearson's Correlation for V2I

Correlations								
	BI-V2I	AUT-V2V	PU-V2I	DC-V2I	PEOU-V2I	INV-V2I	COP-V2I	TR&SF-V2I
BI-V2I	1							
AUT-V2V	.817**	1						
PU-V2I	.697**	.762**	1					
DC-V2I	.658**	.677**	.799**	1				
PEOU-V2I	.616**	.731**	.613**	.623**	1			
INV-V2I	.641**	.654**	.671**	.606**	.565**	1		
COP-V2I	.522**	.610**	.549**	.497**	.549**	.621**	1	
TR&SF-V2I	.591**	.673**	.611**	.563**	.567**	.660**	.748**	1

5.2.4. Multicollinearity

Table 5.5 demonstrates that this study's variables do not produce multicollinearity difficulties since all tolerance values are more than 0.1 and all VIF values are less than 10, with one exception of PEOU-V2V at 0.089 and VIF at 11.195. However**,** VIF can be used to diagnose multicollinearity. Values above 10 are indicators of strong multicollinearity (Field, 2024). Therefore, according to Statistik (2020), "if a regression coefficient is statistically significant even when there is a large amount of multicollinearity, it is statistically significant in the face of that collinearity".

Table 5-5: Multicollinearity for AV, V2V and V2I

Construct	Tech	Tolerance	VIF
PU	AV	0.239	4.183
	V2V	0.102	9.761
	V2I	0.130	7.664
PEOU	AV	0.206	4.861
	V2V	0.089	11.195
	V2I	0.103	9.718
ATU	AV	0.311	3.213
	V2V	0.134	7.442
	V2I	0.162	6.164
DC	AV	0.332	3.015
	V2V	0.194	5.157
	V2I	0.240	4.168
COP	AV	0.204	4.892
	V2V	0.101	9.877
	V2I	0.149	6.727
TR&SF	AV	0.301	3.326
	V2V	0.172	5.823
	V2I	0.191	5.247
INV	AV	0.150	6.657
	V2V	0.106	9.462
	V2I	0.160	6.236

5.3. Demographic Profile

The total number of respondents was 203 before the missing data was analysed. The survey questions were divided into three theologies answered by all respondents between November 2022 and January 2023 in the United Kingdom. In this study, the demographic characteristics of autonomous vehicle technologies, including V2V and V2I, will be examined. The survey utilised online questionnaires distributed to professional and non-professional drivers. The respondents, including technical companies and Brunel postgraduate students, were selected through different methods. Table 5.6 demonstrates demographic factors such as age, gender, driving areas, driving experience, weekly mileage, purpose of driving, previous accidents and driving assistance are used to collect data for this study.

Table 5-6: Demographics of Respondents

Characteristics	Items	Frequency (n=203)	Percentage (%)
Age group	18-24	69	34
	25-34	63	31
	35-54	57	28.1
	55+	14	6.9
Gender	Male	143	70.4
	Female	60	29.6
Do you currently live in an	Urban	103	50.7
	Suburban	63	31
	Rural Area	37	18.3
Driving experience (years)	1-3	54	26.6
	4-9	80	39.5
	10-15	40	19.7
	16-or more	29	14.3
Weekly mileage	0-49	52	25.6
	50-99	64	31.5
	100-199	64	31.5
	200-499	16	7.9
	500-or more	7	3.5
Purpose of driving	Commute to Work	84	41.4
	Journeys	71	35
	Travel/Leisure	43	21.2
	Other	5	2.4
Previous accidents	I have never been involved in an accident	72	35.5
	Accident with minor damage only	79	38.9
	Accident with injury	37	18.2
	Accidents with major damage	15	7.4
Postgraduate student at Brunel university	Yes	35	17.2
	No	168	82.8
Are you a professional driver	Yes	92	45.3
	No	111	54.7
	If yes, please provide answers		
	Local Courier driver	21	22.1
	National Courier driver	15	16.9
	Local Haulage driver	19	20.8
	National Haulage driver	9	9.7
	International Haulage driver	5	5.2
	Other	23	25.3
Driver assistance systems	Automatic braking	44	21.7
	Automatic parking	57	28.1
	Blind spot detection	56	27.6
	Collision avoidance systems	19	9.4
	Other	27	13.2

The survey was conducted on different age groups, mostly from the 18-34 age range, and the majority of them were male drivers commuting to work from urban and suburban areas. These drivers have an average of two hundred miles weekly. The participants are from Brunel University, and those outside of a university background will also be considered to take part in the survey. In addition, it has been that most of them either caused an accident or had a minor accident at some point in their life. Furthermore, the basis of this study can be summarised in that the driving assistance system usage of professional/non-professional drivers ’local haulage, as well as national haulage, is mostly limited to parking, braking and blind spot detection system usage.

5.4. Descriptive Statistics

The descriptive statistics reveal favourable reactions from the participants when compared with the model's constructs, Table 5.7 shows the means and standard deviations of the constructs, the descriptive statistics reveal that all items of the constructs had a mean score of larger than 2.5 and a small standard deviation, indicating that most participants agreed with items of the constructs.

Table 5-7: Means and Standard Deviation of all Constructs

Construct	Technologies	N	Mean	SD
BI	AV V2V V2I	191	5.13 5.02 5.30	1.39 1.46 1.38
ATU	AV V2V V2I	191	5.30 5.37 5.47	1.39 1.35 1.35
PU	AV V2V V2I	191	5.00 5.01 5.16	1.32 1.34 1.27
DC	AV V2V V2I	191	4.84 4.92 5.15	1.52 1.39 1.38
PEOU	AV V2V V2I	191	5.19 5.23 5.34	1.38 1.27 1.25
INV	AV V2V V2I	191	5.04 4.98 5.10	1.37 1.34 1.34
COP	AV V2V V2I	191	4.76 4.75 4.94	1.20 1.14 1.13
TR & SF	AV V2V V2I	191	5.05 4.99 5.10	1.38 1.37 1.31

5.5. Reliability Tests

As indicated in Table 5.8, Cronbach's alpha scores for all constructs in the various technologies indicate that all constructions received a score of more than 0.7, indicating that all constructs are highly reliable. However, ATU showed the highest reliabilities for AV, V2V and V2I at 0.842, 0.872 and 0.846, while COP showed the lowest reliabilities for AV and V2I between 0.731 and 0.721, whereas PEOU indicated the lowest reliabilities in terms of V2V at 0.762.

Table 5-8: Reliability Test

Construct	Technologies	N	Cronbach alpha(α)	Type
BI	AV V2V V2I	191	0.820 0.819 0.796	High
ATU	AV V2V V2I	191	0.842 0.872 0.846	High
PU	AV V2V V2I	191	0.810 0.840 0.836	High
DC	AV V2V V2I	191	0.804 0.802 0.791	High
PEOU	AV V2V V2I	191	0.763 0.762 0.742	High
INV	AV V2V V2I	191	0.804 0.822 0.799	High
COP	AV V2V V2I	191	0.731 0.786 0.721	High
TR & SF	AV V2V V2I	191	0.782 0.808 0.777	High

5.6. Hypotheses testing by Multiple Regression

The multiple regression analysis results show that the model is statistically significant (P-value < 0.05). Three different groups were created to test the model hypotheses: the TAM, the professional setting and personal attributes for three technologies, namely AV, V2V and V2I.

5.6.1. AV

According to the findings of the regression analysis, PEOU for AV exhibited that the highest significant Beta value was at (39.5%) towards PU, as shown in Figure 5.2.

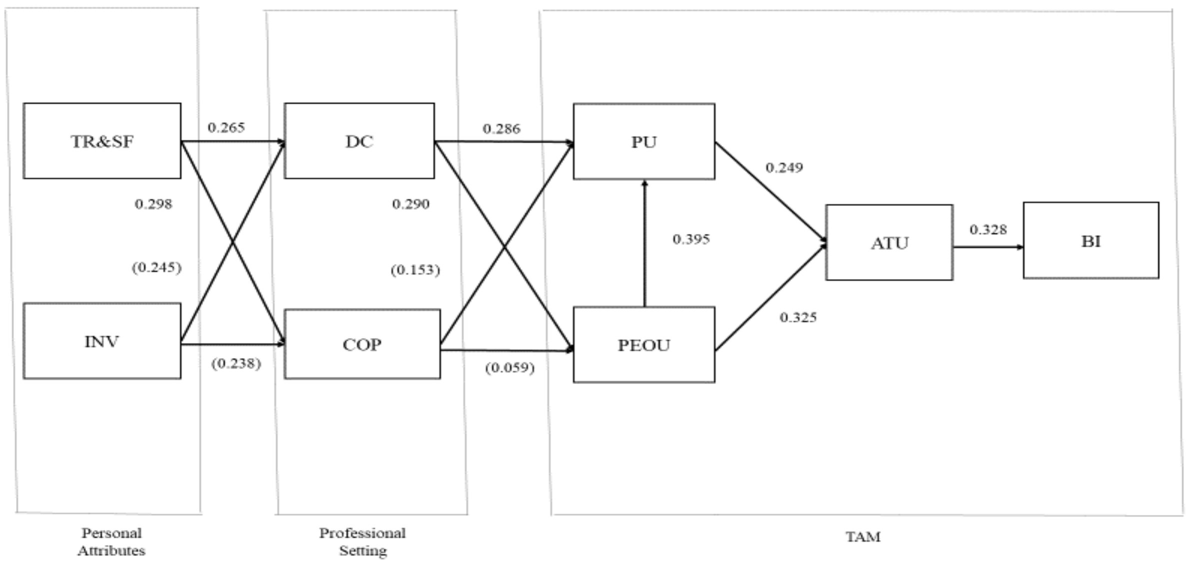


Figure 5-2: Beta Values for AV

5.6.2. V2V

In terms of the findings of V2V, it was revealed that the variable COP had the highest impact on the variable PU with a Beta value of (86.5%) as seen in Figure 5.3.

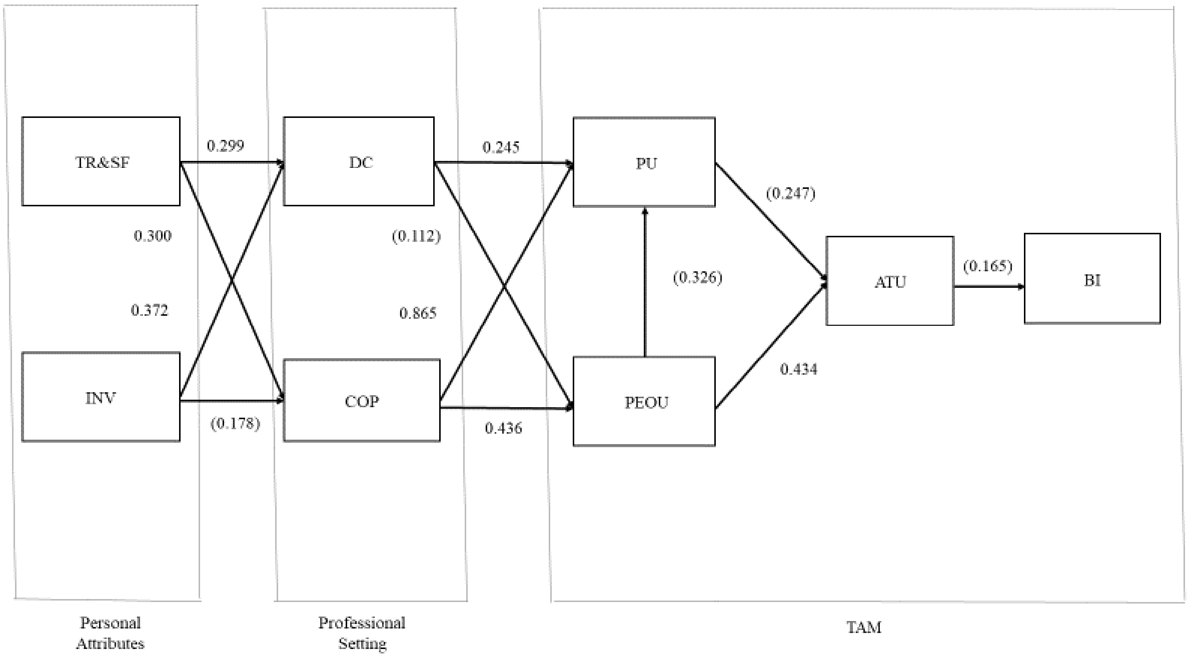


Figure 5-3: Beta Values for V2V

5.6.3. V2I

The results of the regression analyses of the three groups indicated that the most significant relationship was observed between ATU and BI for V2I with a Beta coefficient of (40.5%) as depicted in Figure 5.4.

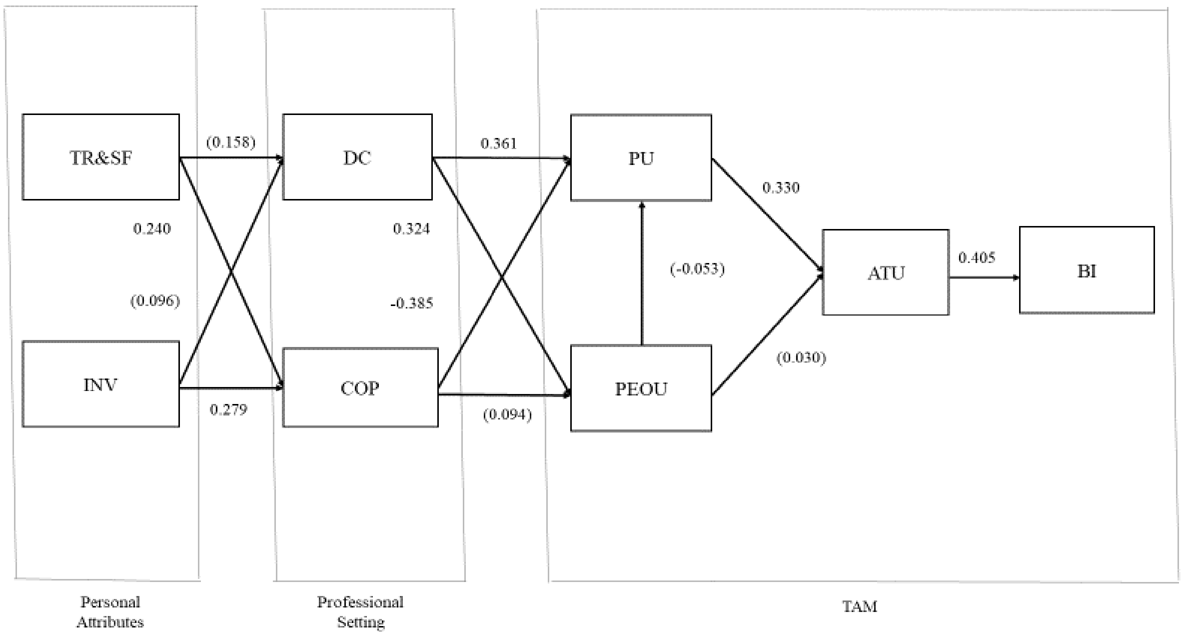


Figure 5-4: Beta Values for V2I

5.6.4. Summary of Accepted and Rejected Hypotheses

Based on the regression analysis results, all the research hypotheses examined are shown in Table 5.9, indicating the accepted or rejected hypotheses.

Table 5-9: Summary of Accepted and Rejected Hypotheses

variable	Tech	variable	Beta	Sig (P)	Hyps	Result
PU	AV	ATU	0.249	0.007	H1	Supported
	V2V		0.247	0.078		Rejected
	V2I		0.33	0.008		Supported
PEOU	AV	PU	0.395	0.001	H2	Supported
	V2V		0.326	0.080		Rejected
	V2I		-0.053	0.760		Rejected
PEOU	AV	ATU	0.325	0.002	H3	Supported
	V2V		0.434	0.006		Supported
	V2I		0.030	0.837		Rejected
ATU	AV	BI	0.328	0.001	H4	Supported
	V2V		0.165	0.120		Rejected
	V2I		0.405	0.001		Supported
DC	AV	PU	0.286	0.001	H5	Supported
	V2V		0.254	0.005		Supported
	V2I		0.361	0.001		Supported
DC	AV	PEOU	0.290	0.002	H6	Supported
	V2V		0.112	0.360		Rejected
	V2I		0.324	0.004		Supported
COP	AV	PU	0.153	0.208	H7	Rejected
	V2V		0.865	0.001		Supported
	V2I		-0.385	0.007		Supported
COP	AV	PEOU	0.059	0.655	H8	Rejected
	V2V		0.436	0.021		Supported
	V2I		0.094	0.546		Rejected
TR & SF	AV	DC	0.265	0.007	H9	Supported
	V2V		0.299	0.021		Supported
	V2I		0.158	0.197		Rejected
TR & SF	AV	COP	0.298	0.001	H10	Supported
	V2V		0.300	0.006		Supported
	V2I		0.240	0.021		Supported
INV	AV	DC	0.245	0.073	H11	Rejected
	V2V		0.372	0.023		Supported
	V2I		0.096	0.469		Rejected
INV	AV	COP	0.238	0.091	H12	Rejected
	V2V		0.178	0.289		Rejected
	V2I		0.279	0.041		Supported
Total hypotheses = 12 Total hypotheses with technologies= 36 Supported hypotheses with technologies = 22 Rejected hypotheses with technologies = 14						

5.7. Segmentation based on ANOVA Analysis and T-test

5.7.1. Analysis of Variance (ANOVA)

In this study, significant results were found in various variables for a variety of demographics, including age, driving areas, driving experience, and driving assistance. In contrast, there were no statistically significant results in the various variables regarding previous accidents, weekly mileage and driving purpose.

5.7.1.1. Ages

The effects of the results of the autonomous vehicle technologies on different age groups were analysed using ANOVA. In this study, a significant difference in PEOU and TR&SF outcomes was observed between AV, V2V, and V2I technologies, as shown in Figure 5.5.

Initially, as shown in Table 5.10, the AV descriptive statistics for PEOU, and TR&SF variables, where the means for the 18–24 age group are (5.3484 and 4.7377) with standard deviations of (1.42396 and 1.46706). While the mean for the age group 25-34 years are (4.6393 and 4.8962) with standard deviations (of 1.55491 and 1.48391), and the mean for the age group 35-54 years are (5.6273 and 5.5576), with standard deviations (0.87648, 1.07927). While the means for the 55+ age group for the PEOU-AV are (5.2321 and 5.1429) with standard deviations of (1.28775 and 1.08379). Moreover, the relationship between the age groups for the variable AV-(PEOU and TR) shows that F = (5.777 and 3.981) and P-value = (0.001 and 0.009), which are the values below the level of significance when (P-value < 0.05). Therefore, the results of ANOVA analyses show that there are significant results in these age groups in terms of PEOU and TR&SF variables.

Secondly, in terms of descriptive statistics of V2V for PEOU, and TR&SF variables, where the mean for the age group 18-24 years are (5.4221, 4.6667) with a standard deviation of (1.27601, 1.54919). Also, the mean for the age group 25-34 years is (4.7213, and 4.9727) with a standard deviation (of 1.42456, and 1.40409), and the mean for the age group 35-54 years is (5.5364, and 5.2970) with a standard deviation (0.90321, 1.10865). While the mean for the age group 55+ for descriptive statistics PEOU, and TR&SF is (5.4643, and 5.2857) with a standard deviation of (1.16379, and 1.01995). in addition, the relationship between the age groups for the variable V2V-PEOU was found at F = 5.314 and P-value = 0.002, which is the value below the level of significance at (P-value < 0.05). Therefore, the results of ANOVA analyses show that there is a significant result in these age groups. On the other hand, there are no significant results in the age groups in terms of the V2V-(TR&SF) variables, which shows that F = (2.332), and P-value = (0.076).

Finally, regarding the descriptive statistics of V2I for PEOU and the TR&SF variable, where the mean for the age group 18-24 years is (5.4549 and 4.8306) with a standard deviation of (1.31221 and 1.39791). in addition, the mean for the age group 25-34 years is (4.8770 and 5.0820) with a standard deviation (of 1.39390 and 1.36986), and the mean for the age group 35-54 years is (5.6455 and 5.4182) with a standard deviation (0.81606, and 1.00455). While the mean for the 55+ age group of V2I for the PEOU and TR&SF variable descriptive statistics is (5.6071 and 5.0714) with a standard deviation of (1.19982 and 1.55348). Whereas the relationship between the age groups for the PEOU-V2I variable shows that F = 4.542 and P-value = 0.004, which is the value below the significance level at (P-value < 0.05). Therefore, the results of ANOVA analyses show that there are significant differences between these age groups. In contrast, the V2I of TR&SF showed different results at F = (1.979) while P-value = (0.119) as there are no significant results between these age groups.

Table 5-10: ANOVA of Age for PEOU and TR&SF

Construct	Age group	Mean	Std. Deviation	F	Sig.
PEOU-AV	18-24 25-34 35-54 55	5.3484 4.6393 5.6273 5.2321	1.42396 1.55491 0.87648 1.28775	5.777	0.001
PEOU-V2V	18-24 25-34 35-54 55	5.4221 4.7213 5.5364 5.4643	1.27601 1.42456 0.90321 1.16379	5.314	0.002
PEOU-V2I	18-24 25-34 35-54 55	5.4549 4.8770 5.6455 5.6071	1.31221 1.39390 0.81606 1.19982	4.542	0.004
TR&SF-AV	18-24 25-34 35-54 55	4.7377 4.8962 5.5576 5.1429	1.46706 1.48391 1.07927 1.08379	3.981	0.009
TR&SF-V2V	18-24 25-34 35-54 55	4.6667 4.9727 5.2970 5.2857	1.54919 1.40409 1.10865 1.01995	2.332	0.076
TR&SF-V2I	18-24 25-34 35-54 55	4.8306 5.0820 5.4182 5.0714	1.39791 1.36986 1.00455 1.55348	1.979	0.119

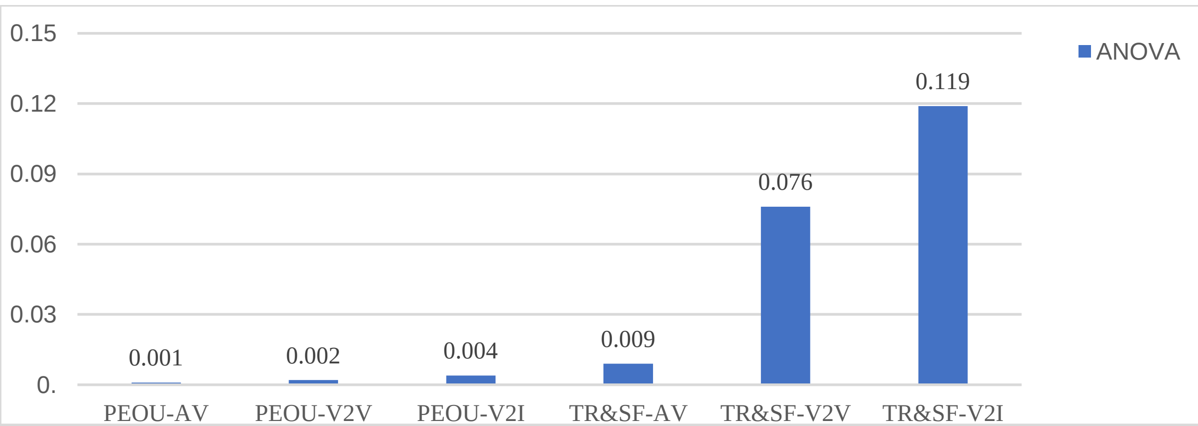


Figure 5.5: ANOVA of PEOU and TR&SF

As shown in Table 5.11, the results of the post-hoc test using Tukey HSD, in terms of variables in different age groups, the following table shows the results for PEOU-AV as the 18-24 age group was compared to the 25-34 age group. The average difference is (0.70902*), and the probability value is 0.019, and the difference between the two age groups can be considered "significant" as the p-value is <0.05, in addition to the comparisons of other age groups between (35-54 and). 25–34) are also significant because the p-value is 0.001. In addition, the relationship between the age groups (18-24 and 25-34, 35-54 and 25-34) regarding the PEOU-V2V variable shows that the mean differences are (0.70902* and 0.98793*) while the P-values are (0.010 and 0.002), which are the values less than the level of significance at ($p < 0.05$). Therefore, the results showed that there were statistically significant differences between these age groups. Moreover, the relationship between the age groups (18-24 and 25-34, 35-54, and 25-34) in terms of the PEOU-V2I variable, the results showed that the mean differences are (0.57787* and 0.76841*) while the P-values are (0.045 and 0.004), indicating that the results are significant between groups about PEOU-V2I.

To conclude, AV-TR&SF shows a significant result between the age groups (35-54 and 18-24, 3554 and 25-34) at the mean difference (0.81987* and 0.66140*) and the *p*-value are 0.007 and 0.044. Meanwhile, V2V and V2I regarding TR&SF show different results which are not significant at different age groups, as shown in Table 2, in which the p-values are 0.062, 0.571, 0.075 and 0.506, which the values are greater than the level of significance at ($p < 0.05$).

Table 5-11: Multiple Comparison for PEOU and TR&SF

	Age group 1	Age group 2	Mean Difference (I-J)	Sig.
PEOU-AV	18-24	25-34	0.70902*	0.019
PEOU-AV	35-54	25-34	0.98793*	0.001
PEOU-V2V	18-24	25-34	0.70082*	0.010
PEOU-V2V	35-54	25-34	0.81505*	0.002
PEOU-V2I	18-24	25-34	0.57787*	0.045
PEOU-V2I	35-54	25-34	0.76841*	0.004
TR&SF-AV	35-54	18-24	0.81987*	0.007
TR&SF-AV	35-54	25-34	0.66140*	0.044
TR&SF-V2V	35-54	18-24	0.63030	0.062
TR&SF-V2V	35-54	25-34	0.32429	0.571
TR&SF-V2I	35-54	18-24	0.58758	0.075
TR&SF-V2I	35-54	25-34	0.33621	0.506

5.7.1.2. Driving Areas

The effects on the results of driving area groups were analysed using ANOVA. In this study, a significant difference in PEOU outcomes was observed between AV technologies, as shown in Figure 5.6. As shown in Table 5.12, the descriptive statistics AV, V2V, and V2I for the PEOU variable where means are urban area (5.1480, 5.1760, and 5.2602) and standard deviations are (1.4947, 1.4055, and 1.38750). While the mean for the suburban area is (5.4750, 5.4875, and 5.6542), with standard deviations of (1.11205, 1.00678, 86246), and the mean for the rural area is (4.8182, 4.9470, 4.9848), with standard deviations of (1.38106, 1.20830, and 1.28989). In addition, the relationship between groups of driving regions of the PEOU variable of AV and V2V showed non-significant results at Pvalue = (0.079 and 0.116). In contrast, ANOVA analyses revealed significant results regarding V2IPEOU where the P-value of 0.031 is less than the significant P-value <0.05.

Table 5-12: ANOVA of Driving Areas for PEOU

	Driving Areas	Mean	Std. Deviation	F	Sig.
PEOU-AV	Urban Suburban Rural area	5.1480 5.4750 4.8182	1.49477 1.11205 1.38106	2.575	0.079
PEOU-V2V	Urban Suburban Rural area	5.1760 5.4875 4.9470	1.40563 1.00678 1.20830	2.176	0.116
PEOU-V2I	Urban Suburban Rural area	5.2602 5.6542 4.9848	1.38750 0.86246 1.28989	3.545	0.031

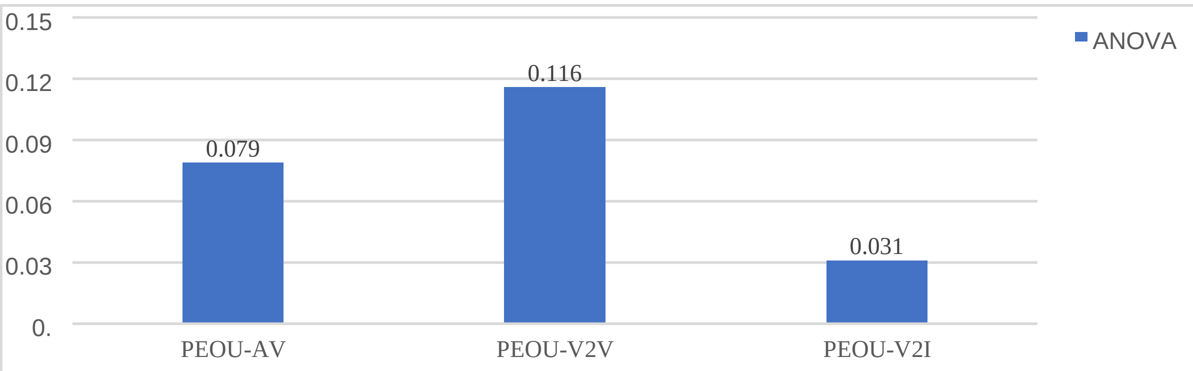


Figure 5-6: ANOVA of Driving Areas for PEOU

Shown in Table 5.13 are the results of the post-hoc test using Tukey HSD in terms of variables in different regions the following table shows the results of PEOU-AV where the suburban area was compared to the rural area. The average difference is (0.65682), and the probability value is 0.071 and the difference between the two areas can be considered "insignificant" as the p-value is more than 0.05, in addition to comparisons of PEOU-V2V driving areas between suburban and rural areas are also insignificant because the p-value is 0.120. In contrast, analyses of driving regions revealed significant results for V2I-PEOU, with a P value of 0.034 being less than a significant P value < 0.05.

Table 5-13: Multiple Comparison for PEOU

	Living Areas 1	Living Areas 2	Mean Difference (1-2)	Sig.
PEOU-AV	Suburban	Rural area	0.65682	0.071
PEOU-V2V	Suburban	Rural area	0.54053	0.120
PEOU-V2I	Suburban	Rural area	0.66932*	0.034

5.7.1.3. Driving Experience

The effects on the results of driving experience were analysed using ANOVA. In this study, a significant difference in PEOU outcomes was observed between AV technologies. as shown in Figure 5.7.

As shown in Table 5.14, the descriptive statistics AV, V2V, and V2I for the PEOU variable where means are between 1 to 3 years (5.2344, 5.2604, and 5.3125) and standard deviations are (1.50213, 1.35854, and 1.40903). While the mean between 4 to 9 years is (5.3214, 5.2987, and 5.4026), with standard deviations of (1.25122, 1.19003 and 1.13711), and the mean between 10 to 15 years is (4.6750, 4.7875 and 5.0063), with standard deviations of (1.32916, 1.15962, and 1.15121). Finally, the means for 16 years or more are (5.5385, 5.6827, and 5.6923) and the standard deviations are (1.43124, 1.33708, and 1.31588).

In addition, the relationship between groups of driving experience of the PEOU variable of AV and V2V showed significant results at P-value = (0.044 and 0.036). In contrast, ANOVA analyses revealed insignificant results regarding V2I-PEOU where the P-value of 0.159 is more than the significant Pvalue at 0.05.

Table 5-14: ANOVA of Driving Experience for PEOU

	Years	Mean	Std. Deviation	F	Sig.
PEOU-AV	1-3 4-9 10-15 16 or more	5.2344 5.3214 4.6750 5.5385	1.50213 1.25122 1.32916 1.43124	2.743	0.044
PEOU-V2V	1-3 4-9 10-15 16 or more	5.2604 5.2987 4.7875 5.6827	1.35854 1.19003 1.15962 1.33708	2.901	0.036
P0UE-V2I	1-3 4-9 10-15 16 or more	5.3125 5.4026 5.0063 5.6923	1.40903 1.13711 1.15121 1.31588	1.744	0.159

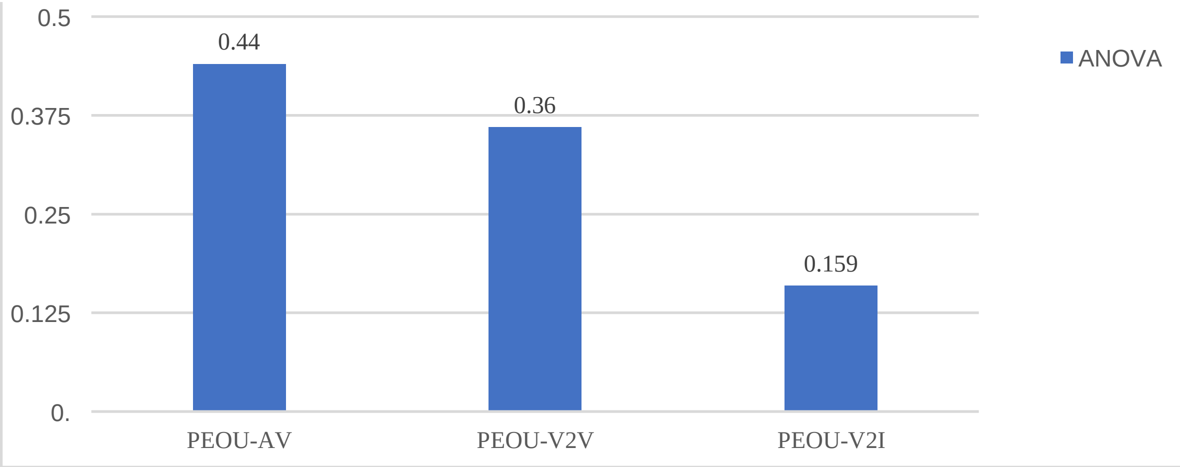


Figure 5-7: ANOVA of Driving Experience for PEOU

It is shown in Table 5.15 that the results of the post-hoc test using Tukey HSD, in terms of variables in the different driving experiences, the following table shows the results of PEOU-AV where the for +16 years as compared to 10 to 15 years. The average difference is (0.86346) and the probability value is 0.060, and the difference between two driving experiences can be considered "insignificant" as the p-value is more than 0.05. In addition, comparisons of PEOU-V2I driving experience between +16 years' and (10 to 15) years are also insignificant because the p-value is 0.127. In contrast, analyses of driving experience revealed significant results for V2V-PEOU, with a P value of 0.025 being less than a significant P-value < 0.05.

Table 5-15: Multiple Comparison for PEOU

	Years	Years	Mean Difference (1-2)	Sig.
PEOU-AV	16 or more	10-15	0.86346	0.060
PEOU-V2V	16 or more	10-15	0.89519*	0.025
PEOU-V2I	16 or more	10-15	0.68606	0.127

5.7.1.4. Driving Assistance

The effects on the results of driving assistants were analysed using ANOVA. In this study, a significant difference in PU outcomes was observed between AV, V2V and V2I. as shown in Figure 5.8.

As shown in Table 5.16, the AV, V2V and V2I descriptive statistics for the PU variable, where the means for the automatic braking are (4.8103, 4.8769 and 4.9538) with standard deviations of (1.46176, 1.44267 and 1.47788). While the mean for automatic parking is (5.2035, 5.1123 and 5.3088) with standard deviations (1.13923, 1.09611 and 1.01423), and the mean for the blind spot detection are (4.6481, 4.6704 and 4.8259), with standard deviations (1.42481, 1.44230 and 1.33744). In addition, the means for the collision avoidance systems for descriptive statistics are (5.4211, 5.3474 and 5.6211) with standard deviations of (1.14289, 1.58302 and 1.27174). Moreover, the relationship between the driving assistance concerning the variable AV and V2V-(PU) shows that F = (2.291 and 2.207) and P-value = (0.061 and 0.070), which are insignificant values. The results of ANOVA analyses show that there is significance in terms of V2I-PU variables at 0.035.

Table 5-16: ANOVA of Driving Assistants for PU

	Driving Assistance	Mean	Std. Deviation	F	Sig.
PU-AV	Automatic braking	4.8103	1.46176	2.291	0.061
	Automatic parking	5.2035	1.13923		
	Blind spot detection	4.6481	1.42481		
	Collision avoidance systems	5.4211	1.14289		
	Other	5.2818	1.21210		
PU-V2V	Automatic braking	4.8769	1.44267	2.207	0.070
	Automatic parking	5.1123	1.09611		
	Blind spot detection	4.6704	1.44230		
	Collision avoidance systems	5.3474	1.58302		
	Other	5.5273	1.11705		
PU-V2I	Automatic braking	4.9538	1.47788	2.638	0.035
	Automatic parking	5.3088	1.01423		
	Blind spot detection	4.8259	1.33744		
	Collision avoidance systems	5.6211	1.27174		
	Other	5.5636	1.14582		

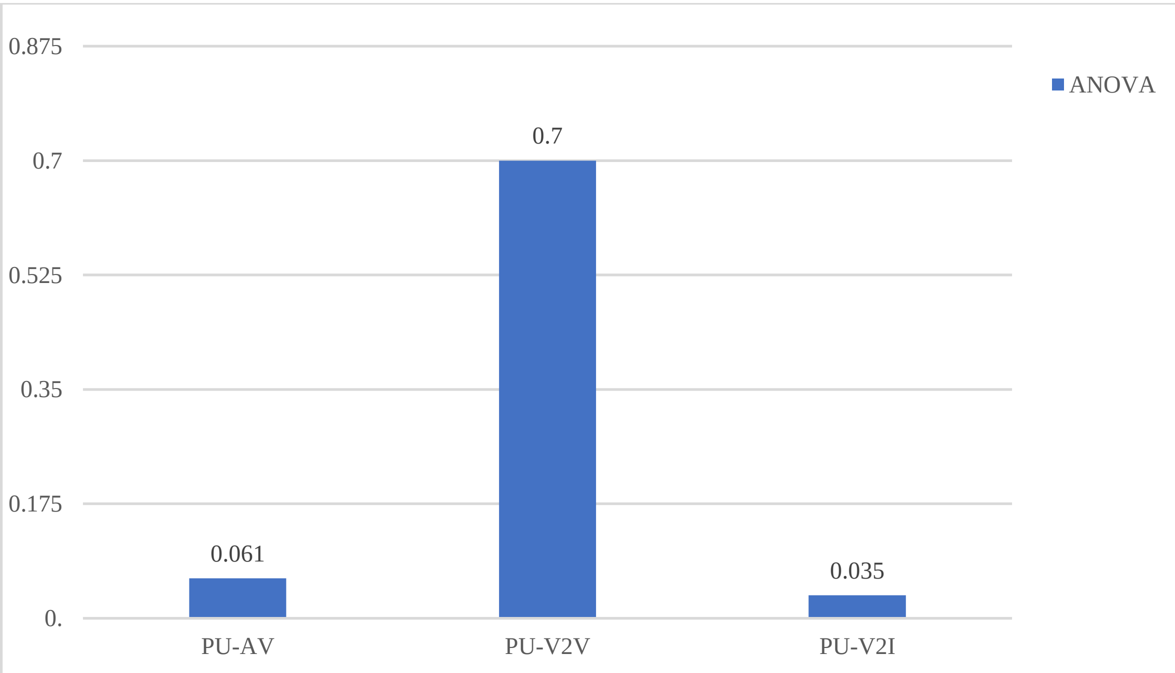


Figure 5-8: ANOVA of Driving Assistants for PU

The results of the post-hoc test using Tukey HSD, in terms of variables in different driving assistances, are shown in Table 5.17, in which the results of PU-AV, V2V and V2I had an exception of non-significant values because the p-values are (0.309, 0.084 and 0.141), although the previous ANOVA table showed a significant value at 0.035 regarding V2I.

Table 5-17: Multiple Comparison for PEOU

	Assistance 1	Assistance 2	Mean Difference (1-2)	Sig.
PU-AV	Other	Blind spot detection	0.63367	0.309
PU-V2V	Other	Blind spot detection	0.85690	0.084
PU-V2I	Other	Blind spot detection	0.73771	0.141

5.7.2. Independent T-tests

For this research, an independent t-test was carried out on the model factors based on demographics regarding gender, which consists of two different groups, namely BI and INV, as shown in Figure 5.9.

5.7.2.1. Gender

The effects of the results of the AV technologies on different gender groups were analysed using Ttest. Regarding this study, a significant difference in BI and INV outcomes were only observed between AV, V2V, and V2I technologies.

As shown in Table 5.18, T-test BI in terms of AV, V2V, and V2I, where means for males are (5.28, 5.13 and 5.43) and standard deviations are (1.313, 1.477 and 1.371). While the means for the female are (4.78, 4.75 and 5.00), with standard deviations of (1.494, 1.390 and 1.357). In addition, the relationship between gender groups regarding BI variables of AV and V2I showed significant results at P-values (0.021 and 0.046). In contrast, T-test analyses revealed insignificant results regarding V2VBI where the P-value at 0.100 which is more than the significant P-value at 0.05.

Furthermore, The T-test of INV regarding AV, V2V and V2I, where means for males are (5.209, 5.143 and 5.226) and standard deviations are (1.274, 1.277 and 1.240). While the means for the female are (4. 664, 4.591 and 4.802), with standard deviations of (1.506, 1.422and 1.519). In addition, the relationship between gender groups regarding BI variables of AV, V2V and V2I showed all significant results at P-values (0.011, 0.009 and 0.044), which are less than significant P-values at 0.05, as shown in Table 5.26.

Table 5-18: T-Test of Gender Groups

	Gender	Number	Mean	Std. Deviation	t	d.f	P-value
BI-AV	Male	133	5.28	1.313	2.336	189	0.021
	Female	58	4.78	1.494			
BI-V2V	Male	133	5.13	1.477	1.652	189	0.100
	Female	58	4.75	1.390			
BI-V2I	Male	133	5.43	1.371	2.01	189	0.046
	Female	58	5.00	1.357			
INV-AV	Male	133	5.209	1.274	2.569	189	0.011
	Female	58	4.664	1.506			
INV-V2V	Male	133	5.143	1.277	2.654	189	0.009
	Female	58	4.591	1.422			
INV-V2I	Male	133	5.226	1.240	2.025	189	0.044
	Female	58	4.802	1.519			

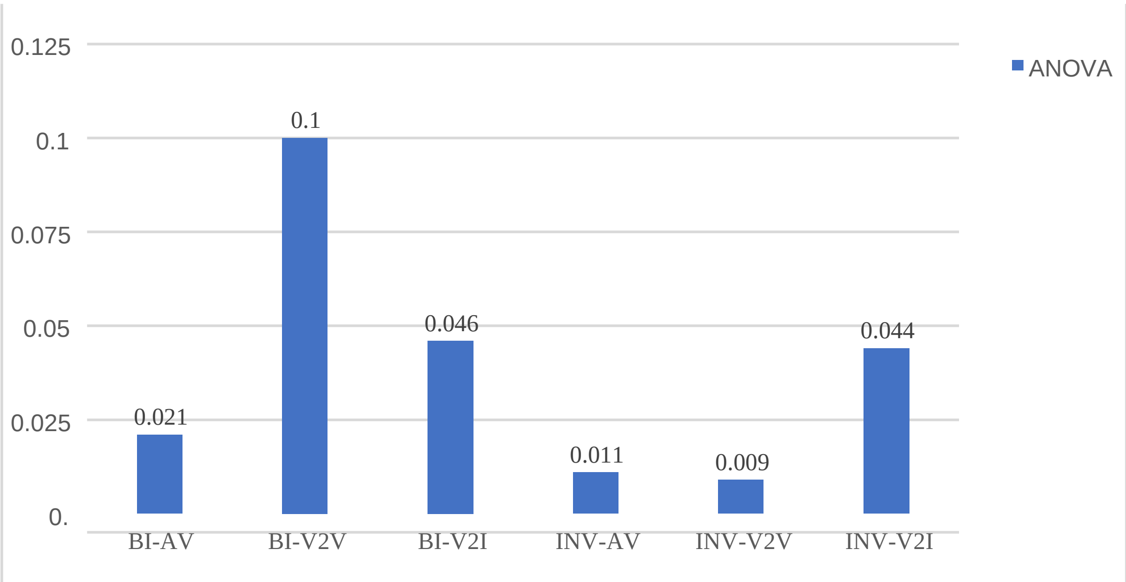


Figure 5-9: T-Test of Gender Groups for BI and INV

5.8. Structural Equation Modelling (SEM)

5.8.1. Measurement Model

In this chapter, AMOS will be used to conduct CFA and check the model's validity, and SEM will test the hypothesised relationships and evaluate the proposed model's overall fit. The present study investigates the impact of eight exogenous variables on the acceptance of autonomous vehicles and connected technologies in the United Kingdom. Prior to SEM, scholars should use CFA to assess reflective or formative measurement model indicators while setting up modelling; SEM can be used when CFA is complete (Garba and Hafiz, 2022; Zin et al., 2023). As Afthanorhan et al., (2014) reported from a prior empirical study, this research employed eight mediator variables to illustrate the fundamental path of these constructs on their related variables.

5.8.2. Confirmatory Factor Analysis (CFA)

As stated by Zin et al., (2023), before performing SEM, it is imperative to validate the measurement model for each latent construct within the model. This validation process confirms that the measurement model is valid and reliable. Therefore, CFA was initially conducted as a preliminary step to evaluate the measurement and structural model, as recommended by Garba and Hafiz (2022).

Moreover, Hair et al., (2010), reported that the regression estimates or factor loadings (FLs) of all observable variables or items are proven to be above the essential threshold of 0.50. Similarly, Ahmed et al., (2020), emphasised that factor loadings below 0.5 are excluded during this procedure. Nevertheless, the present analysis first revealed the AV loadings for all items, except one item at 0.28, as shown in Figure 5.10. Furthermore, the analysis of the CFA conducted in this study for AV did not match the criteria, as indicated in Table 5.19. Hence, it is recommended that the CFA be repeated to enhance its efficacy by employing suitable indicators (Awang, 2015).

Following the adjustment made to the CFA, the resulting correlation value was obtained as RMSEA= 0.065, CMIN/DF = 1.800. Figure 5.10 shows the remaining items for the independent variables of BI-AV contain four items such as (B1, B2, B3 and B4), and ATU-AV consists of four items (A1, A2, A3, and A4), there are four items associated with PU-AV (P2, P3, P4, and P5), and two items related to DCAV (D1 and D2). Furthermore, there are four remaining items (E1, E2, E3 and E4) concerning the dependent variable PEOU-AV. Regarding the dependent variable COP-AV and TR&SF-AV, each one has a different remaining item such as (C2, C3, C4 and C5) and (T1, T2 and T3).

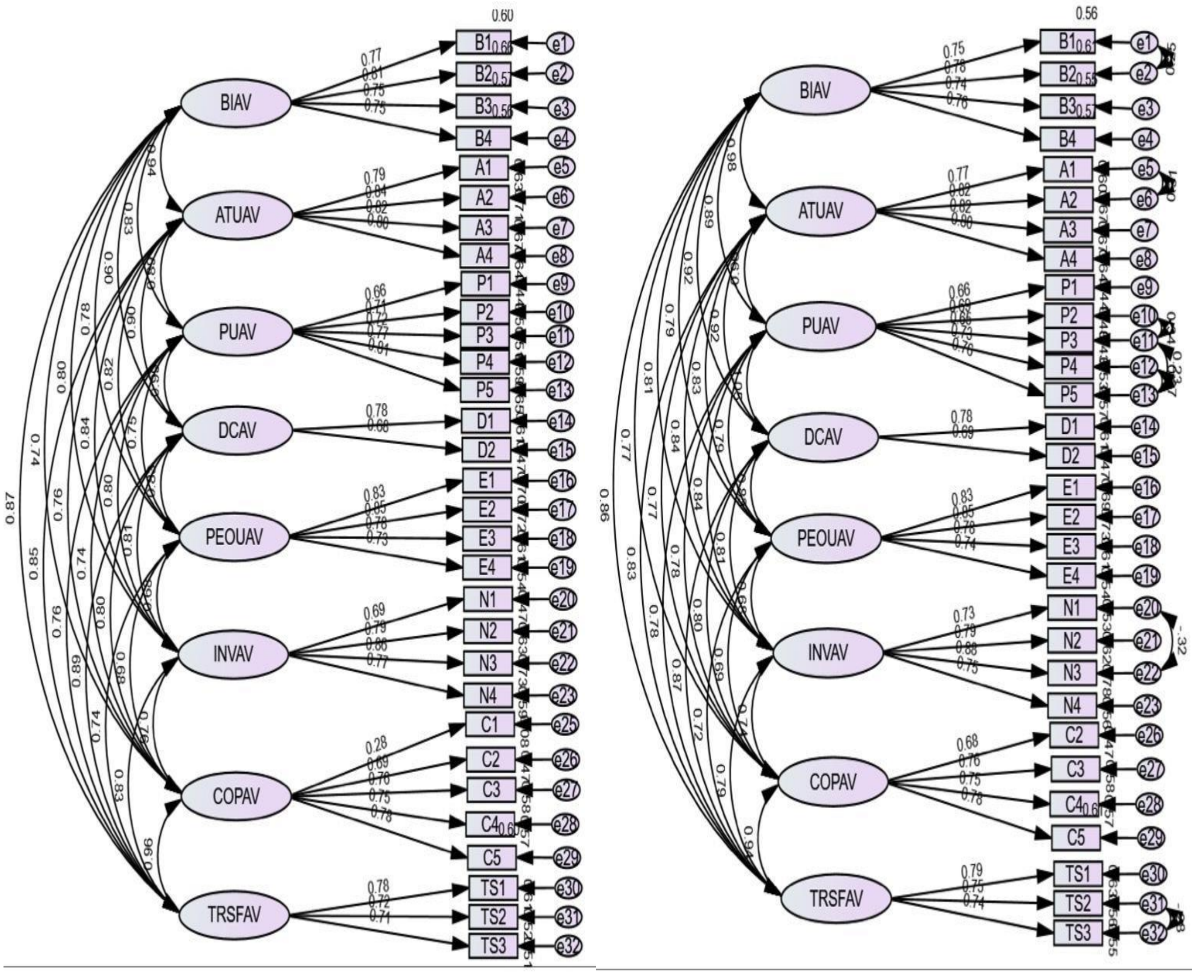


Figure 5-10: CFA for AV before and after the modifications

Furthermore, in relation to V2V, Figure 5.11 demonstrates the CFA loadings for all items exhibit values greater than 0.5, except for one item which was at 0.27. In addition, as Rouf and Babu, (2023) criteria presented in Table 6.1, the results of the V2V study indicated that the CFA performed did not match the criteria. Consequently, it is recommended to re-run the CFA in order to enhance the fit indices, as suggested by Awang, (2015).

After modifications to the CFA, the RMSEA was found to be 0.059, the CMIN/DF = 1.666, and the AGFI exceeded the threshold of 0.825. As shown in Figure 6.2, the remaining items for the independent variables of BI-V2V consist of four items (B1, B2, B3, and B4), ATU-V2V of four items (A1, A2, A3, and A4), PU-V2V of four items (P2, P3, P4, and P5), and DC-V2V of two items (D1 and D2). likewise, four items (E1, E2, E3, and E4) remain in regard to the dependent variable PEOU-V2V. In relation to the dependent variables COP-V2V and TR&SF-V2V, the remaining items are different for each: (C2, C3, C4, and C5) and (T1, T2, and T3), respectively.

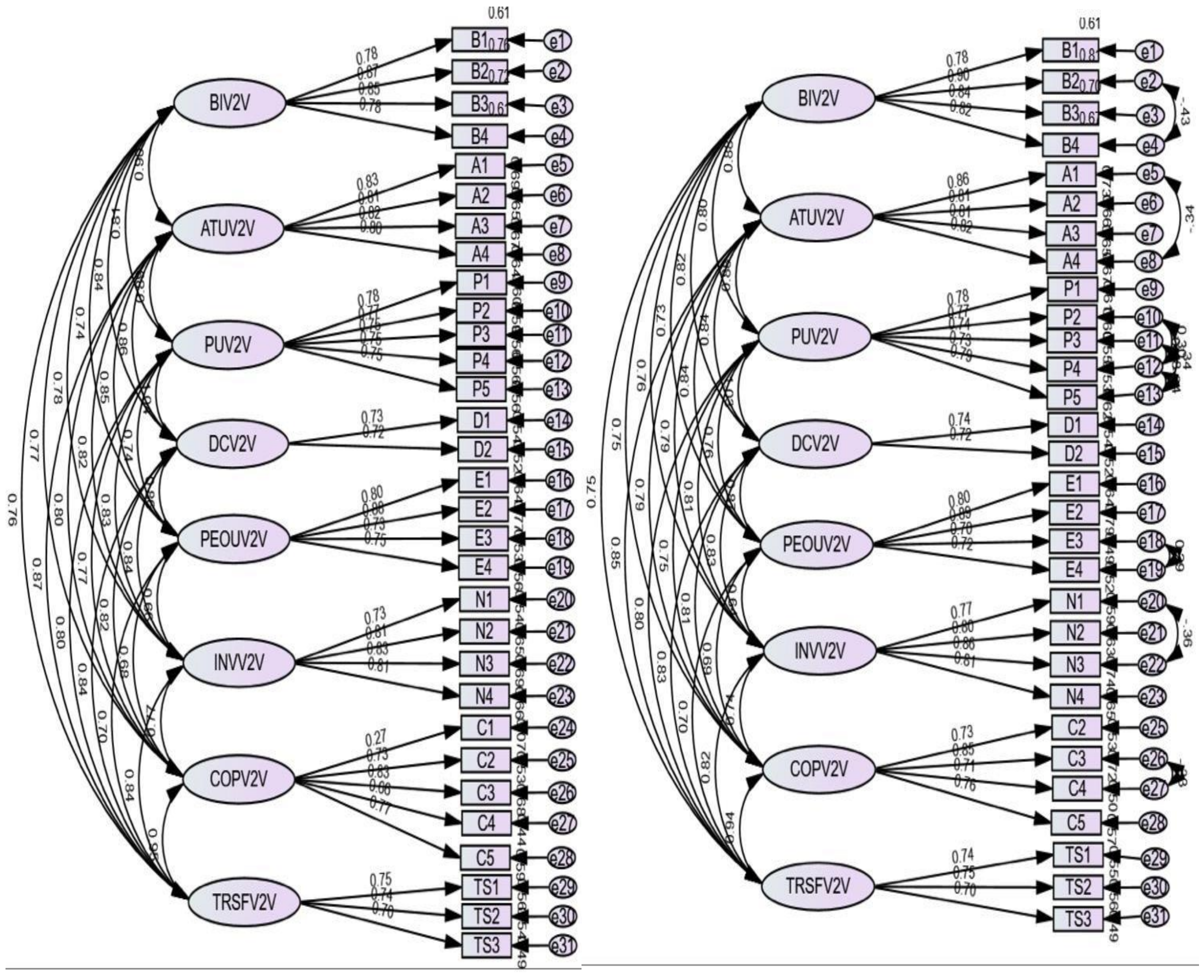


Figure 5-11: CFA for V2V before and after the modifications

Finally, regarding V2I, as shown in Figure 5.12 the CFA loadings of all items demonstrate values greater than 0.5, except for one item which was at 0.19. In addition, as shown in Rouf and Babu, (2023) criteria in Table 6.1, the results of the V2I study showed that the CFA performed did not match the criteria. Hence, it is recommended to re-run the CFA in order to enhance the fit indices, as suggested by Awang, (2015).

After adjustments to the CFA, the RMSEA was found to be 0.058, the CMIN/DF = 1.637, and the AGFI exceeded the threshold of 0.829. Similarly, Figure 6.3 shows the remaining items for the independent variables of BI-V2I contain four items such as (B1, B2, B3 and B4), and ATU-V2I consists of four items (A1, A2, A3, and A4), there are four items associated with PU-V2I (P2, P3, P4, and P5), and two items related to DC-V2I (D1 and D2). Furthermore, there are four remaining items (E1, E2, E3 and E4) for the dependent variable PEOU-V2I. Regarding the dependent variable COP-V2I and TR&SF-V2I, each one has a different remaining item such as (C2, C3, C4 and C5) and (T1, T2 and T3).

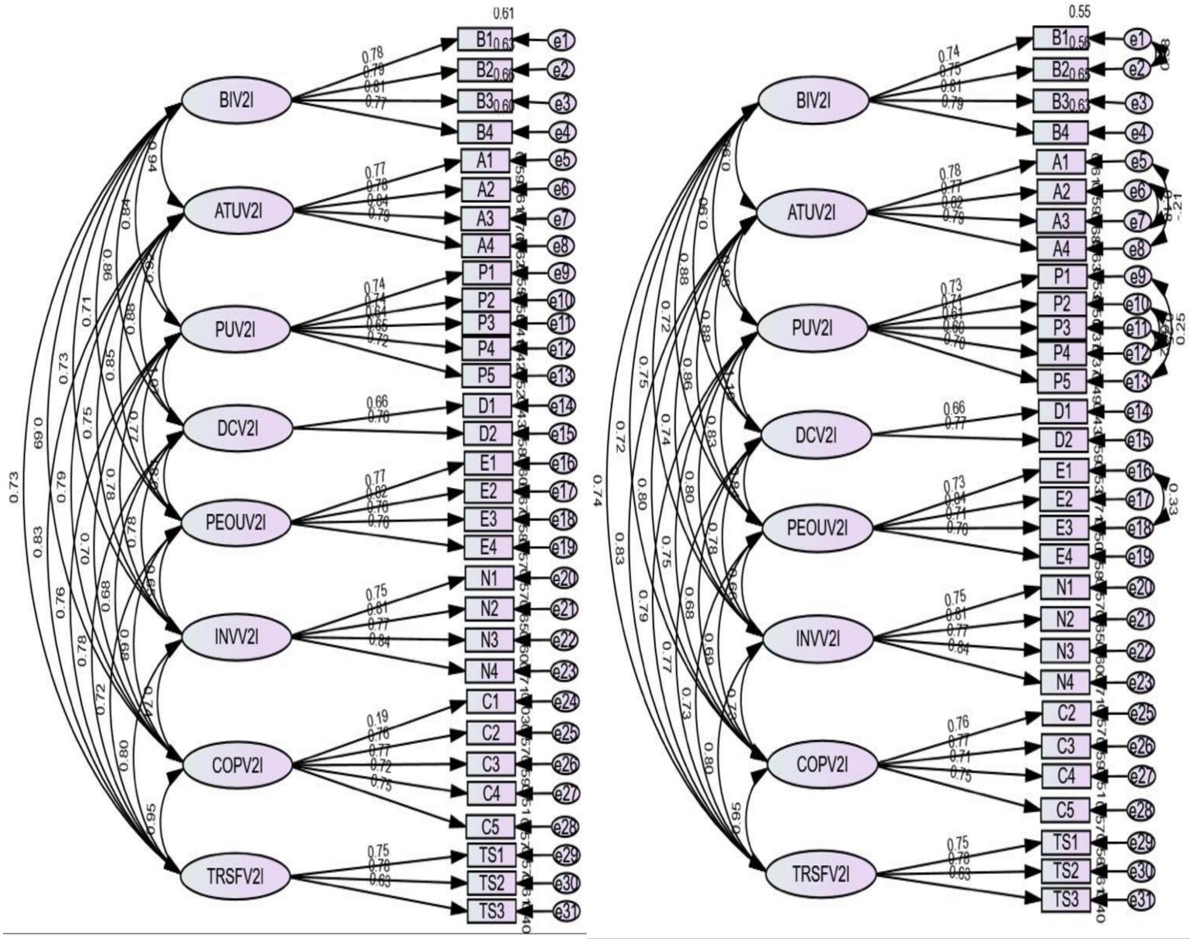


Figure 5-12: CFA for V2I before and after the modifications

Furthermore, several studies have successfully verified the level of construction requirements by achieving RMSEA, CFI, and Chisq/df criteria, as reported by Zin et al., (2023). Therefore, this study passed the GOF tests by fulfilling these requirements as mentioned in Table 5.19.

Table 5-19: GOF tests Criteria for CFA

Indices	Tech	Before	After	Value	Result	Ref
CMIN/DF	AV V2V V2I	2.016 1.900 1.820	1.800 1.666 1.637	<3	Fit Fit Fit	Hair et al., 2010
GFI	AV V2V V2I	0.792 0.787 0.792	0.820 0.825 0.829	≥0.80	Fit Fit Fit	Doll et al., 1994
AGFI	AV V2V V2I	0.745 0.740 0.746	0.774 0.779 0.786	≥0.80	Marginal Fit Marginal Fit Marginal Fit	Doll et al., 1994
NFI	AV V2V V2I	0.818 0.834 0.825	0.849 0.866 0.855	≥0.90	Marginal Fit Marginal Fit Marginal Fit	Hair et al., 2010
IF	AV V2V V2I	0.899 0.914 0.913	0.927 0.942 0.938	≥0.90	Fit Fit Fit	Hair et al., 2010
TLI	AV V2V V2I	0.883 0.900 0.898	0.913 0.930 0.926	≥0.90	Fit Fit Fit	Hair et al., 2010
CFI	AV V2V V2I	0.898 0.912 0.911	0.926 0.941 0.937	≥0.90	Fit Fit Fit	Hair et al., 2010
RMSEA	AV V2V V2I	.073 .069 .066	.065 .059 .058	≤0.08	Fit Fit Fit	Browen and Cudeck, 1993

Adapted from Rouf and Babu, (2023)

5.8.3. Validity Assessment

5.8.3.1. Convergent Validity

Following the acceptance of fitness indices, this study analyses the factor's validity and reliability. Table 5.20 reports the factor loadings, reliability, and validity of the eight constructs before evaluating the SEM model and its relevance to illustrate the associations between the measured variables and the underlying constructs (Garba and Hafiz, 2022). Moreover, Convergent validity is established when variables need to have an average variance extracted (AVE) value of at least 0.5, which Hair et al., (2010) and Fornell and Larcker, (1981) were able to achieve. In addition, the constructs demonstrated composite reliability (CR) of ≥ 0.7, indicating the validity of the scale by Hair et al., (2010). However, the results of this study agree with Zainudin et al., (2017), whose studies aimed to achieve the mandatory level of value for AVE and CR, which are greater than or equal to 0.455 and 0.6. Except for one AVE value which was at 0.451 regarding PU-V2I.

Table 5-20: Results of Factor Analysis, Reliability, and Convergent Validity.

Construct	Tech	Items	FLs-AV	FLs-V2V	FLs-V2I	AVE	CR
	AV	B1	0.748	0.778	0.742	0.574	0.843
BI	V2V	B2	0.783	0.898	0.747	0.695	0.901
	V2I	B3	0.743	0.835	0.808	0.597	0.855
		B4	0.756	0.818	0.791		
	AV	A1	0.773	0.857	0.778	0.644	0.878
ATU	V2V	A2	0.817	0.814	0.769	0.681	0.895
	V2I	A3	0.816	0.809	0.824	0.627	0.870
		A4	0.802	0.819	0.794		
		P1	0.662	0.781	0.725		
PU	AV	P2	0.691	0.771	0.715	0.490	0.827
	V2V	P3	0.655	0.740	0.605	0.580	0.874
	V2I	P4	0.729	0.729	0.605	0.451	0.803
		P5	0.756	0.786	0.698		
DC	AV	D1	0.686	0.721	0.766	0.539	0.700
	V2V	D2	0.780	0.736	0.656	0.531	0.693
	V2I					0.509	0.673
	AV	E1	0.833	0.801	0.729	0.642	0.877
PEOU	V2V	E2	0.852	0.891	0.843	0.610	0.861
	V2I	E3	0.780	0.699	0.710	0.581	0.847
		E4	0.735	0.718	0.761		
	AV	N1	0.727	0.769	0.753	0.623	0.868
INV	V2V	N2	0.790	0.796	0.807	0.654	0.883
	V2I	N3	0.882	0.861	0.772	0.630	0.872
		N4	0.748	0.807	0.841		
	AV	C2	0.683	0.727	0.756	0.556	0.833
COP	V2V	C3	0.760	0.846	0.771	0.579	0.846
	V2I	C4	0.754	0.705	0.714	0.560	0.836
		C5	0.781	0.758	0.752		
	AV	TS1	0.741	0.699	0.629	0.580	0.806
TR&SF	V2V	TS2	0.749	0.747	0.781	0.533	0.774
	V2I	TS3	0.794	0.743	0.751	0.523	0.766

5.8.3.2. Discriminant Validity

The discriminant validity is established when a construct is different from others as this study conducted. In addition, the correlation values should be less than 0.85 (Hair et al., 2021). Tables 5.21 5.22 and 5.23 present an example of the correlation analysis of the latent construct associated with AV, V2V and V2I with a particular focus on the relationship between the variables. Reliability values were verified and considered previously. As a result of that, this procedure ensures that there are no validity concerns. Based on the study analysis, the model constructs were shown to be reliable and valid.

Table 5-21: Results of Discriminant Validity based on AV

Latent Construct Correlation for AV								
	COPAV	COPAV	COPAV	COPAV	COPAV	COPAV	COPAV	COPAV
COPAV	0.745							
ATUAV	0.771	0.802						
DCAV	0.798	0.921	0.735					
PEOUAV	0.686	0.833	0.833	0.801				
TRSFAV	0.938	0.834	0.874	0.718	0.762			
PUAV	0.783	0.955	1.051	0.791	0.777	0.700		
INVAV	0.741	0.839	0.810	0.677	0.787	0.835	0.789	
BIAV	0.773	0.981	0.917	0.792	0.856	0.894	0.813	0.758

Table 5-22: Results of Discriminant Validity based on V2V

Latent Construct Correlation for V2V								
	COPV2V	COPV2V	COPV2V	COPV2V	COPV2V	COPV2V	COPV2V	COPV2V
COPV2V	0.761							
ATUV2V	0.791	0.825						
DCV2V	0.810	0.840	0.729					
PEOUV2V	0.686	0.837	0.873	0.781				
TRSFV2V	0.936	0.852	0.834	0.702	0.730			
PUV2V	0.750	0.883	1.025	0.759	0.801	0.762		
INVV2V	0.740	0.791	0.828	0.643	0.817	0.813	0.809	
BIV2V	0.751	0.878	0.819	0.730	0.746	0.796	0.756	0.833

Table 5-23: Results of Discriminant Validity based on V2I

Latent Construct Correlation for V2I								
	COPV2I	COPV2I	COPV2I	COPV2I	COPV2I	COPV2I	COPV2I	COPV2I
COPV2I	0.749							
ATUV2I	0.797	0.792						
DCV2I	0.681	0.882	0.713					
PEOUV2I	0.686	0.861	0.836	0.762				
TRSFV2I	0.950	0.835	0.775	0.733	0.723			
PUV2I	0.746	0.977	1.103	0.828	0.794	0.672		
INVV2I	0.734	0.745	0.777	0.665	0.795	0.804	0.794	
BIV2I	0.722	0.949	0.877	0.716	0.742	0.900	0.748	0.773

5.8.4. Structural Model Hypotheses Testing

According to Garba and Hafiz (2022), SEM was employed to assess the association between variables using measurement and a structural model. SEM is a widely recognised approach utilised to discover the direct and indirect impacts of variable coefficients, as well as to quantify the causal association between endogenous and exogenous variables. The present study includes eight exogenous variables, including perceived usefulness, perceived ease of use, compatibility, driving context, trust and safety, and innovativeness. The endogenous variable in this study was the attitude toward the use of autonomous vehicle technologies.

5.8.4.1. Hypothesis Testing for AV

The study data obtained from the administered questionnaires were analysed using the SEM. The subsequent section presents the outcomes of the conducted analysis. Firstly, in terms of the SEM analysis performed in this study, the AV did not match the standards, as shown in Figures 5.13 and also indicated in Tables 5.24 with all criteria.

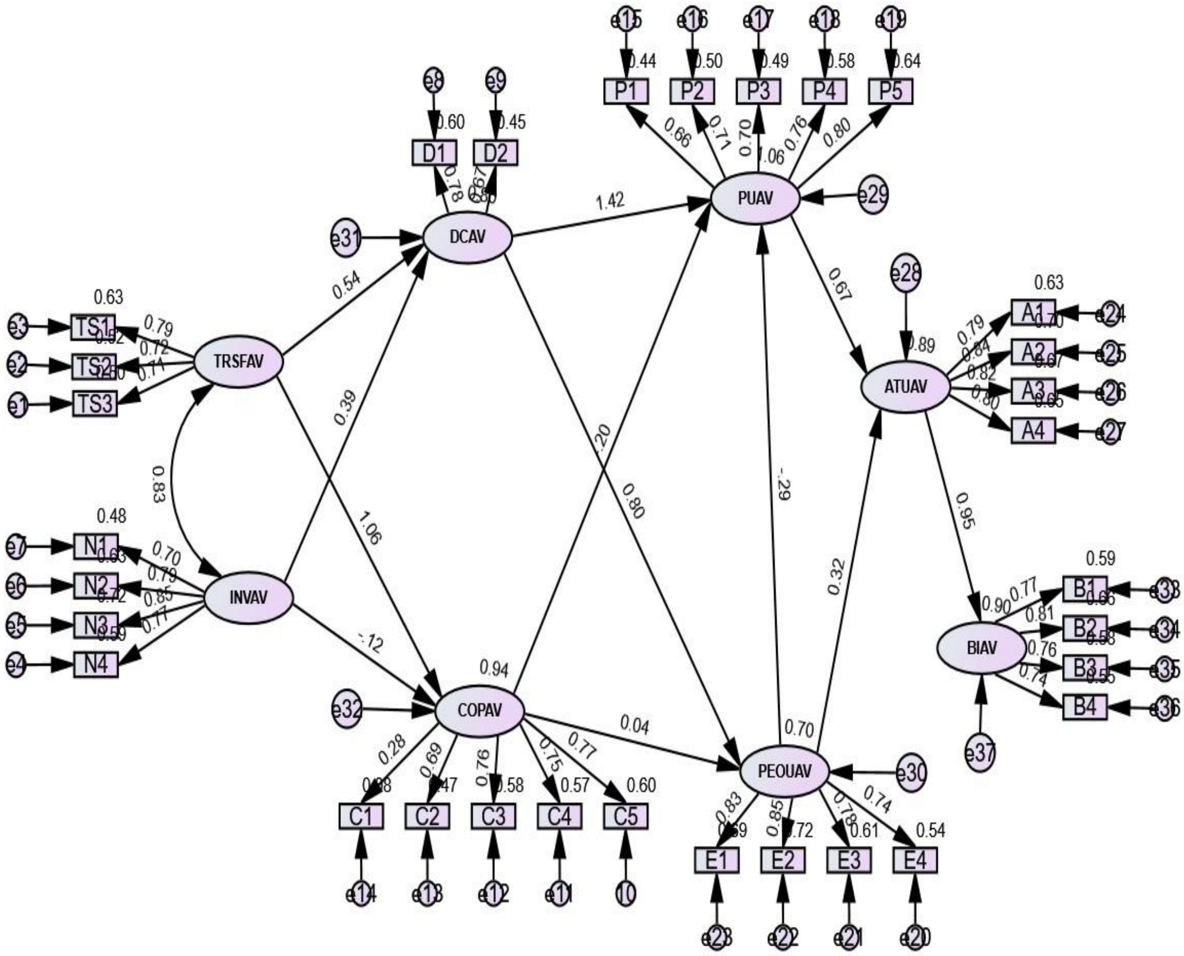


Figure 5-13: SEM for AV before the modifications

Model Fit Summary for AV:

Table 5-24: AV Model Fit Indices before Modifications

CMIN/DF	GFI	AGFI	NFI	IFI	TLI	CFI	RMSEA
2.026	0.785	0.747	0.810	0.894	0.882	0.893	0.073

Hence, Awang, (2015), proposed to re-run the SEM to meet the requirements of the GOF tests, Figure 5.14 shows the SEM of AV after adjustments. Also, Table 5-25 shows the modifications that were made to SEM, which indicated RMSEA = 0.065, CMIN/DF = 1.801.

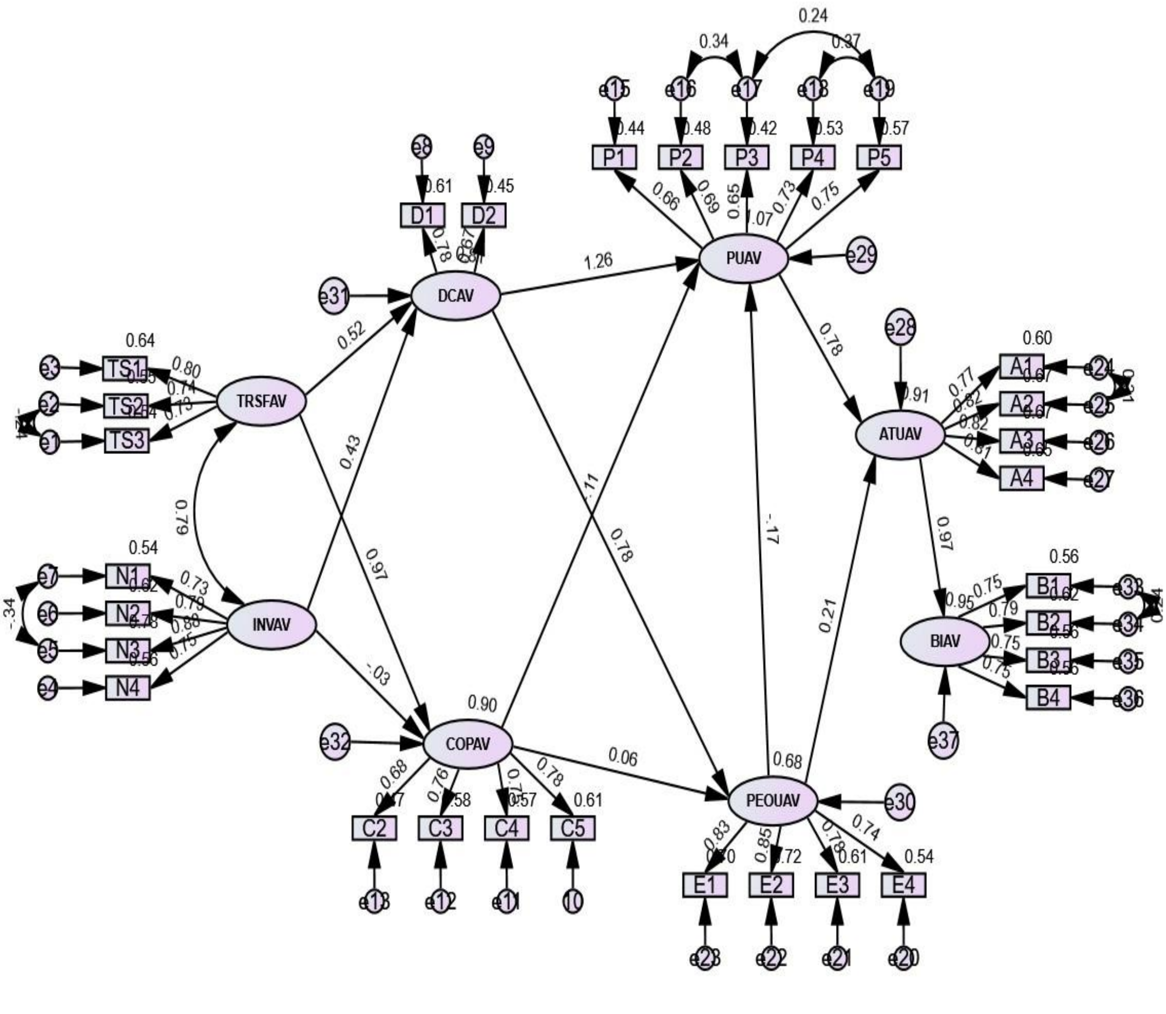


Figure 5-14: SEM for AV after the modifications

Model Fit Summary for AV:

Table 5-25: AV Model Fit Indices after Modifications

CMIN/DF	GFI	AGFI	NFI	IFI	TLI	CFI	RMSEA
1.801	0.815	0.777	0.843	0.923	0.912	0.922	0.065

5.8.4.2. Testing for V2V

Secondly, regarding the SEM analysis presented in this study, the V2V did not match the standards, as shown in Figures 5.15 and also indicated in Table 5.26 with all criteria.

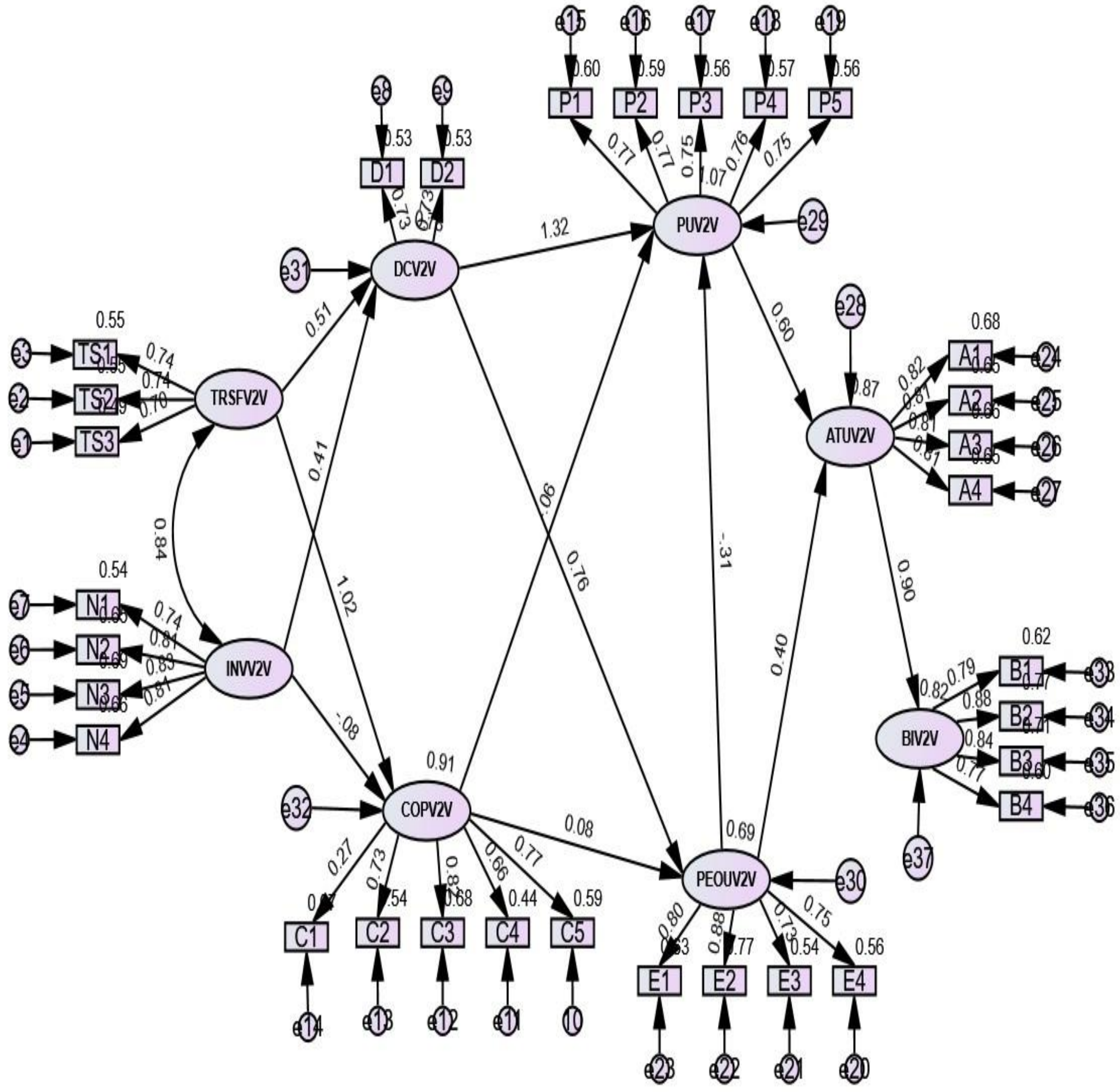


Figure 5-15: SEM for V2V before the modifications

<u>Model Fit Summary for V2V:</u>

Table 5-26: V2V Model Fit Indices before Modifications

CMIN/DF	GFI	AGFI	NFI	IFI	TLI	CFI	RMSEA
1.934	0.779	0.740	0.824	0.907	0.896	0.906	0.070

Consequently, it is recommended to re-run the SEM to meet the requirements of the GOF tests (Awang, 2015). Figure 5.16 shows the SEM of V2V after adjustments. Also, Table 5.27 shows the modifications that were made to SEM, which indicated RMSEA = 0.061, CMIN/DF = 1.715.

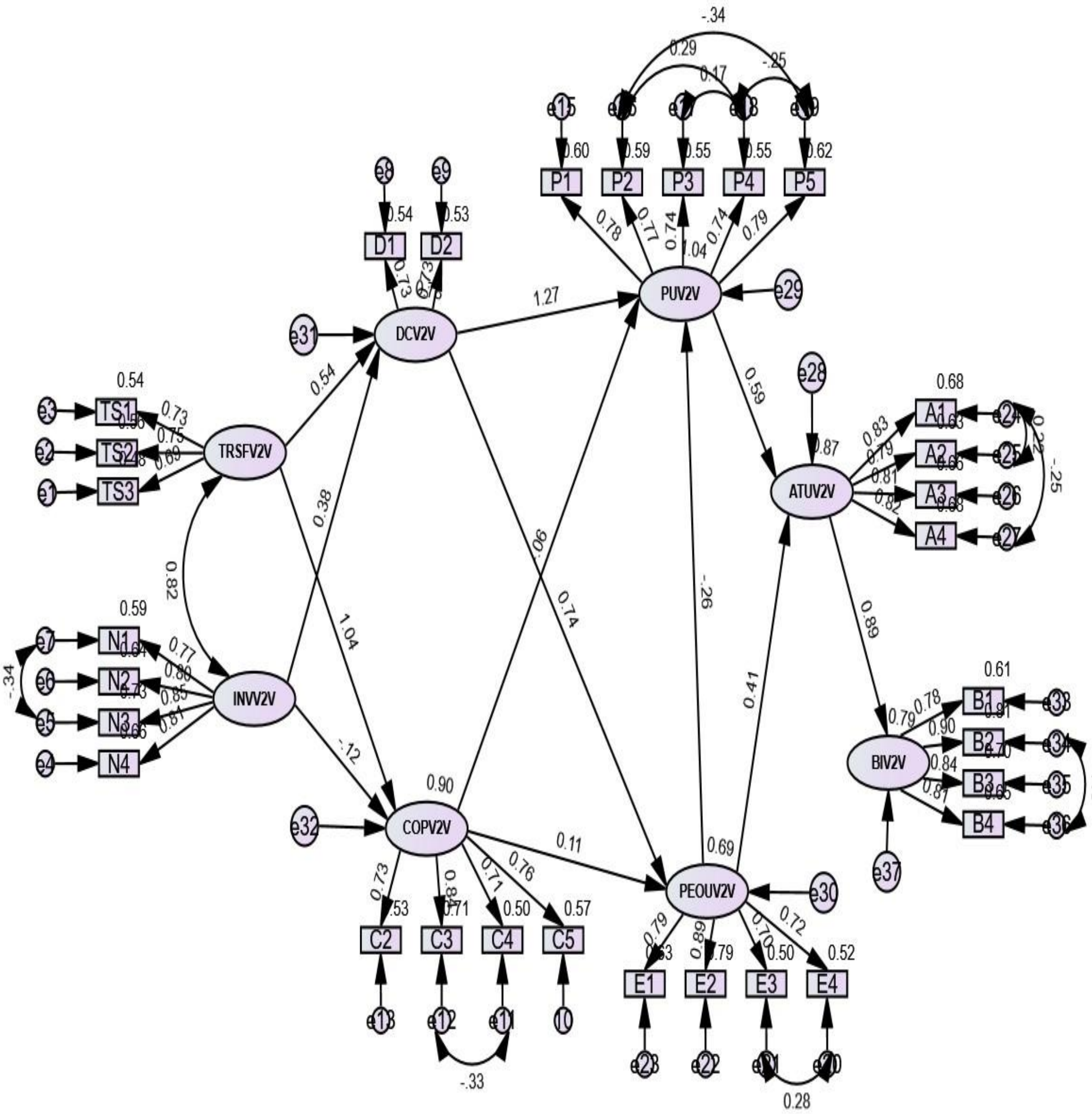


Figure 5-16: SEM for V2V after the modifications

<u>Model Fit Summary for V2V:</u>

Table 5-27: V2V Model Fit Indices after Modifications

CMIN/DF	GFI	AGFI	NFI	IFI	TLI	CFI	RMSEA
1.715	0.816	0.776	0.857	0.935	0.925	0.934	0.061

5.8.4.3. Hypothesis Testing for V2I

Finally, SEM analysis was performed in this study, likewise, V2I did not match the standards, as shown in Figures 5.17 and also indicated in Tables 5.28 with all criteria.

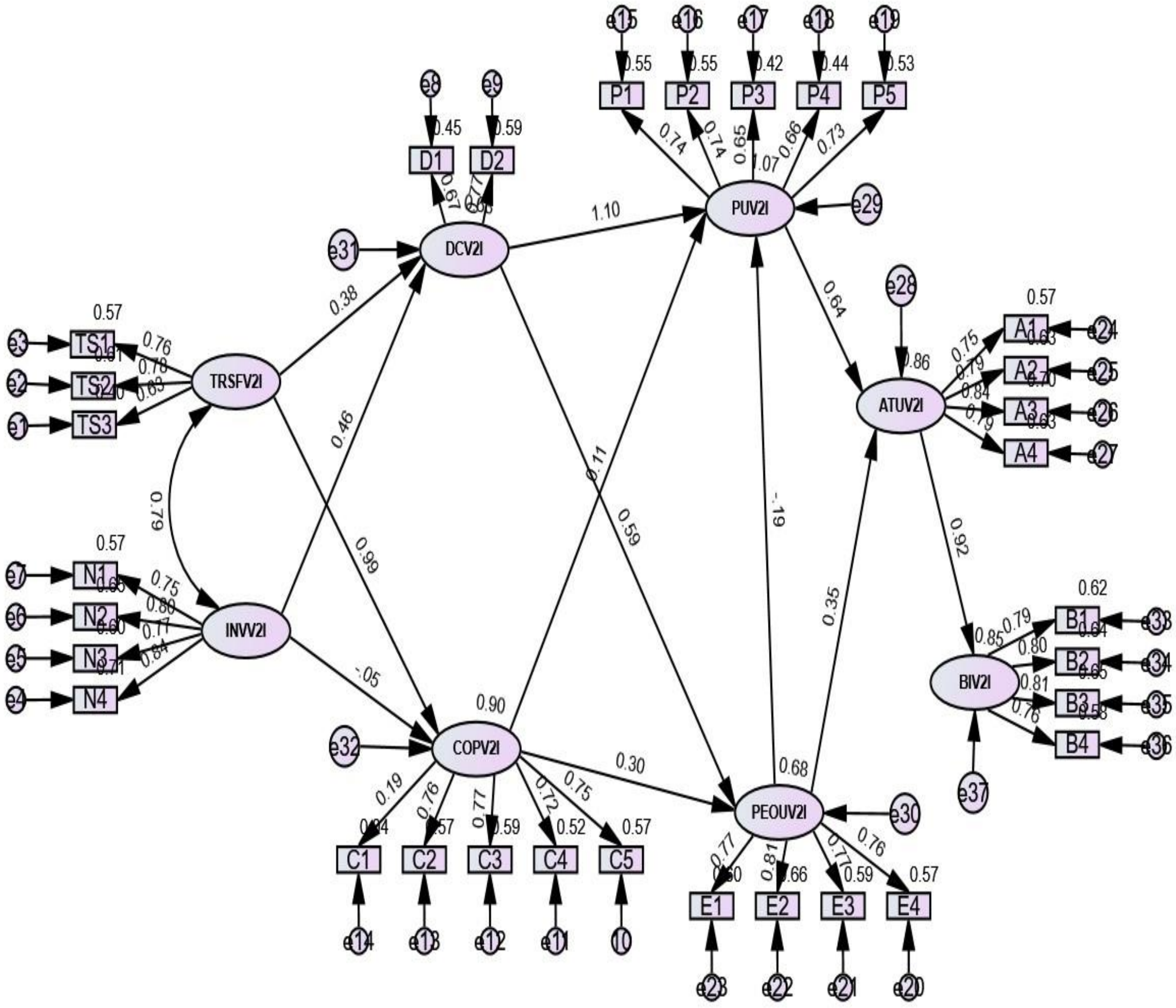


Figure 5-17: SEM for V2I before the modifications

Model Fit Summary for V2I:

Table 5-28: V2I Model Fit Indices before Modifications

CMIN/DF	GFI	AGFI	NFI	IFI	TLI	CFI	RMSEA
1.825	0.786	0.748	0.818	0.908	0.898	0.907	0.066

In addition, it is requested to re-run the SEM to meet the requirements of the GOF tests (Awang, 2015). Figure 5.18 shows the SEM of V2I after adjustments. Moreover, Table 5.29 shows the modifications that were made to SEM, which indicated RMSEA = 0.060, CMIN/DF = 1.684.

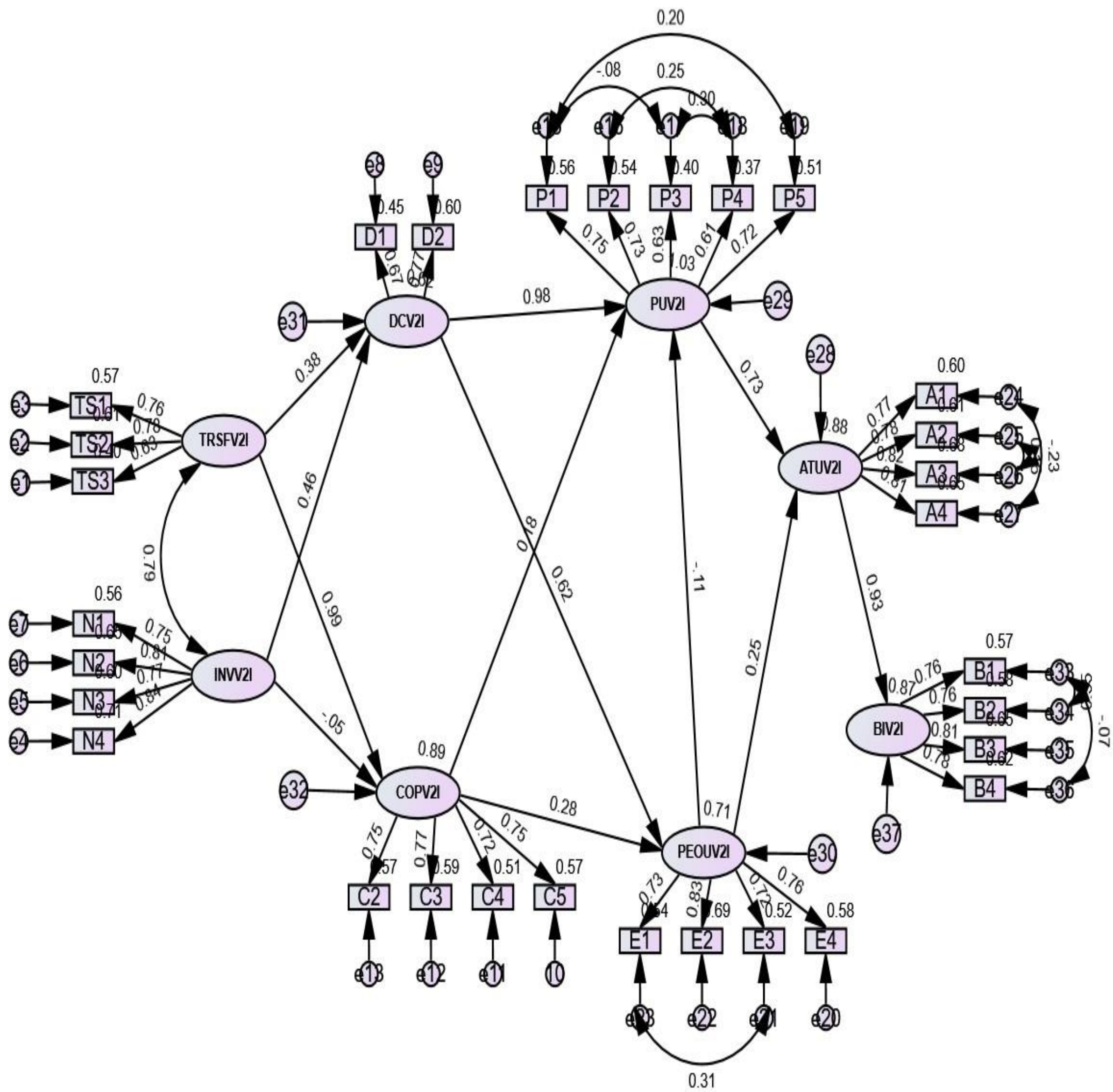


Figure 5-18: SEM for V2I after the modifications

<u>Model Fit Summary for V2I:</u>

Table 5-29: V2I Model Fit Indices before Modifications

CMIN/DF	GFI	AGFI	NFI	IFI	TLI	CFI	RMSEA
1.684	0.818	0.779	0.845	0.931	0.920	0.930	0.060

5.8.4.4. Summary of Accepted and Rejected Hypotheses

In addition, Table 5.30 shows the results of the current study demonstrated that β estimates were investigated and found to be within an acceptable range for eight of the latent constructs. A significant correlation was observed between the majority of the constructs, as evidenced by the critical ratios (C.R), which exceed 1.96. The statistical significance of this result was determined using AMOS (***). According to the results of Mia et al., (2019), when CR is greater than or equal to 1.96 and the P-value is less than 0.05, which means the result is significant.

Table 5-30: Summary of Accepted and Rejected Hypotheses as a Result of Regression Weights

Hyp.	Construct			Tech	Est (β)	S.E.	C.R.	Sig P	Result
H1	PU	--->	ATU	AV	.947	.142	6.691	***	Supported
				V2V	.697	.099	7.064	***	Supported
				V2I	.824	.132	6.256	***	Supported
H2	PEOU	--->	PU	AV	-.149	.146	-1.022	.307	Rejected
				V2V	-.291	.192	-1.521	.128	Rejected
				V2I	-.105	.159	-.661	.508	Rejected
H3	PEOU	--->	ATU	AV	.220	.097	2.276	.023	Supported
				V2V	.543	.108	5.025	***	Supported
				V2I	.267	.112	2.398	.017	Supported
H4	ATU	--->	BI	AV	.986	.093	10.583	***	Supported
				V2V	.799	.072	11.092	***	Supported
				V2I	.882	.086	10.238	***	Supported
H5	DC	--->	PU	AV	.949	.221	4.291	***	Supported
				V2V	1.314	.288	4.559	***	Supported
				V2I	1.106	.246	4.496	***	Supported
H6	DC	--->	PEOU	AV	.682	.151	4.512	***	Supported
				V2V	.679	.149	4.556	***	Supported
				V2I	.739	.159	4.647	***	Supported
H7	COP	--->	PU	AV	-.100	.146	-.686	.493	Rejected
				V2V	-.065	.177	-.368	.713	Rejected
				V2I	.201	.118	1.710	.087	Rejected
H8	COP	--->	PEOU	AV	.057	.160	.355	.723	Rejected
				V2V	.115	.146	.789	.430	Rejected
				V2I	.335	.136	2.466	.014	Supported
H9	TRSF	--->	DC	AV	.583	.134	4.355	***	Supported
				V2V	.520	.131	3.962	***	Supported
				V2I	.364	.133	2.738	.006	Supported
H10	TRSF	--->	COP	AV	.922	.141	6.523	***	Supported
				V2V	.879	.157	5.613	***	Supported
				V2I	.944	.175	5.408	***	Supported
H11	INV	--->	DC	AV	.464	.122	3.797	***	Supported
				V2V	.322	.108	2.983	.003	Supported
				V2I	.339	.098	3.459	***	Supported
H12	INV	--->	COP	AV	-.026	.106	-.247	.805	Rejected
				V2V	-.087	.109	-.795	.427	Rejected
				V2I	-.038	.102	-.372	.710	Rejected
Total hypotheses = 12 Total hypotheses with technologies= 36 Supported hypotheses with technologies = 25 Rejected hypotheses with technologies = 11									

*Note: *** means the p-value at a significant level is < 0.001 in AMOS output*

5.9. Chapter Summary

This chapter statistically examined the primary research data of the study, firstly by checking normality, multicollinearity and reliability. The theoretical framework of the relationship between different independent variables was examined using multiple regression in SPSS version 20. The study findings of the multiple regression analyses concerning AVs and connected technologies indicate that twenty-two hypotheses were approved; however, fourteen hypotheses were rejected. It also examined the demographic profile of the respondents in terms of age, driving areas, driving experience, previous accidents, weekly mileage and driving purpose. The results revealed significant differences in age, driving areas, driving experience, and driving assistance. Conversely, there were no statistically significant findings regarding previous accidents, weekly mileage and driving purpose. The T-test revealed a statistically significant difference among the BI and INV results.

Conformity Factor Analysis (CFA) was utilised in order to assess the measurement model further. After the modifications, all items significantly loaded on their particular variable and scored standardised loadings of greater than 0.6 after modifications, demonstrating high convergent validity of the data (Hair et al., 2010). Average Variance Expected (AVE) analysis results indicated that all constructs achieved a score of ≥ 0.5, except for one AVE value which was at 0.451 regarding PU-V2I. The internal consistency reliability of the survey was measured by Composite Reliability (CR) analysis. All constructs showed composite reliability of ≥ 0.7.

A structural model was performed to test the research model, firstly by achieving the GOF tests requirements of RMSEA, CFI, and Chisq/df criteria (Zin et al., (2023). Secondly, the research model showed an acceptable fit. The factors that most influence users' perceptions of AVs were shown to be PU; DC and TR&SF which indicates that TAM is still relevant to understand users' attitudes towards AVs. Further, it signifies the relevance of Pervasive Computing as a body of study that contributes to user perceptions depending on their Driver Context. Regarding V2V the modelling shows that PEOU is not supported whereas PU; DC and TR&SF were the predominant factors. This results again shows the relevance TAM theory as well as pervasive computing to provide insights into user adoption. Interestingly, although V2I is an emerging application that users are less familiar with the modelling results are similar apart from COP that has a positive influence towards PEOU. Finally, the hypotheses testing results revealed that all hypotheses were supported, except for H2, H7 and H12, which were rejected. The next chapter discusses the results obtained in this chapter based on a reflection against previous literature.

Chapter 6: Discussion

6.1. Introduction

User adoption plays a major role in accepting mobile connective technologies and significantly impacts users' perceptions and attitudes towards autonomous vehicles and associated applications. Assessing the behaviour of individuals who accept new technologies allows corporations to ascertain effective vehicle design strategies. This study contributes to a better understanding of the influence of technologies such as V2V and V2I on user attitude and intention. In order to gain an in-depth understanding of the causes that support the broad adoption, the automotive industry should be wellversed regarding these factors.

The study introduced and tested a research model by incorporating professional and non-professional drivers. The empirical findings brought light on the attributes of users from these drivers, revealing that attitudes towards autonomous driving differ depending on the driver's context and trust. This highlights the importance of pervasive computing as an essential theoretical framework. The research model examines the influence of V2V and V2I technologies on user attitude by employing theories of driving context and compatibility. Additionally, it investigates how users' characteristics, such as trust&safety and innovativeness, influence their perception of technology acceptance with the TAM. The initial focus of this chapter will be on the validity and reliability of the scale, as well as, a discussion of the study's findings. It will follow with an emphasis on the relevance of the findings to previous research literature.

6.2. Measurement Scale Purification

Box plots in SPSS are valuable for identifying outliers when analysing the distribution of scores on variables. Pallant (2020) defines outlying values as small circles outside the box plots of AV, V2V, and V2I. This study noticed twelve scores that were outside the range of minimum and maximum values. In addition, this study employed reliability and normalcy tests, as well as descriptive statistics. Furthermore, data analysis is always dependent on two factors: measurement reliability and data validity (Nazarian, 2013). The level to which a variable is consistent with what it is intended to assess is the definition of reliability (Hair et al., 2010). A test with high reliability will produce scores that are comparable to those of another check. Cronbach alpha in 1951 presents an indicator of the internal consistency of a test; it is represented by a value between 0 and 1 (Streiner, 2003; Tavakol and Dennick, 2011). A Cronbach's alpha scores for all constructs in the various technologies indicate that all constructions received a score of more than 0.7, indicating that all constructs are highly reliable. The questionnaire has a high degree of dependability that may be depended upon. While the highest AV, V2V and V2I reliabilities were ATU, the lowest reliabilities were COP for AV and V2V, while PEOU showed the lowest reliabilities for V2V.

Additionally, the normality assumption was examined before proceeding with CFA and SEM. The data shows a normal distribution in all AV V2V and V2I constructs, which is ≤ 2.58, and Skewness values range from - 1.013 to - 0.47. In contrast, the Kurtosis values show that the value is between - 0.58 and 0.34. Lastly, the descriptive statistics reveal that all constructs have a minimum standard deviation score, indicating that the data are grouped around the mean and are thus reliable. In addition, the descriptive statistics reveal that all items of the constructs had a mean score of larger than 2.5 and a small standard deviation.

6.3. Hypotheses Testing

6.3.1. Multiple Regression Analyses (SPSS)

Although previous studies by Ghazizadeh et al. (2012), Choi and Ji (2015), and Müller (2019) have made some progress in clarifying the variables influencing user acceptability and have identified certain contributing aspects, it is widely acknowledged that not all significant variables have been identified and further research is required. The findings indicate that unidentifiable variables will mostly contribute to the variability in the adoption of autonomous vehicles as these variables include similar personality characteristics that were not incorporated into their model, suggesting their potential use as additional constructs (Choi and Ji 2015). Conversely, Ness (2016) argues that it is important to carefully consider the influence of age and driving experience. Additionally, it is unclear which elements will influence people's acceptance of autonomous vehicles (Nordhoff et al. 2016). However, previous authors assert the importance of users' attitudes in predicting wide adoption of the technology. On the other hand, Litman (2017) claimed that it is early to presume the existence of widespread public acceptance for autonomous vehicles considering the numerous issues associated with autonomous driving. “The widespread adoption of autonomous vehicles will bring about changes in the value chain of the automotive industry and related sectors” (Lukovics et al., 2020).

However, according to the comprehensive findings of this research, both professional and nonprofessional respondents exhibit positive effects for the most autonomous vehicle variables, hence encouraging users to embrace autonomous vehicles. Based on the regression analysis results, all the research hypotheses examined are shown in Table 6.1 indicating the accepted or rejected hypotheses.

Table 6-1: Summary of Accepted and Rejected Hypotheses for Regression Analysis

Hypotheses	Research hypothesis	Tech	Result
H1	The Perceived Usefulness of the technology has a positive influence on the Attitude Towards Use.	AV	Supported
		V2V	Rejected
		V2I	Supported
H2	The Perceived Ease of Use of the technology has a positive influence on its Perceived Usefulness.	AV	Supported
		V2V	Rejected
		V2I	Rejected
H3	The Perceived Ease of Use of the technology has a positive influence on the Attitude Towards Using.	AV	Supported
		V2V	Supported
		V2I	Rejected
H4	The Attitude Towards Using the technology has a positive influence on the Behavioural Intention to Use.	AV	Supported
		V2V	Rejected
		V2I	Supported
H5	The Driver Context of the technology has a positive influence on its Perceived Usefulness.	AV	Supported
		V2V	Supported
		V2I	Supported
H6	The Driver Context of the technology has a positive influence on its Perceived Ease of Use.	AV	Supported
		V2V	Rejected
		V2I	Supported
H7	The Compatibility of the technology has a positive influence on its Perceived Usefulness.	AV	Rejected
		V2V	Supported
		V2I	Supported
H8	The Compatibility of the technology has a positive influence on its Perceived Ease of Use.	AV	Rejected
		V2V	Supported
		V2I	Rejected
H9	Trust and Safety have a positive influence on the Driver Context of the technology.	AV	Supported
		V2V	Supported
		V2I	Rejected
H10	Trust and Safety have a positive influence on the Compatibility of the technology.	AV	Supported
		V2V	Supported
		V2I	Supported
H11	Innovativeness has a positive influence on the Driver Context of the technology.	AV	Rejected
		V2V	Supported
		V2I	Rejected
H12	Innovativeness has a positive influence on the Compatibility of the technology.	AV	Rejected
		V2V	Rejected
		V2I	Supported
Total hypotheses = 12 Total hypotheses with technologies= 36 Supported hypotheses with technologies = 22 Rejected hypotheses with technologies = 14			

6.3.1.1. TAM

The topic of ATU has garnered attention in studies regarding AV acceptance and significantly impacts users' acceptance of AVs (Liu et al., 2019). Venkatesh (2000) argues that ATU is not a direct predictor of intention, in addition to this, numerous researchers assert that PU and PEOU are more influential than attitude in determining AV usage intent. Davis (1989) suggests excluding attitudes from TAM and concentrating on only three variables, namely PU, PEOU, and BI. However, this study disagrees with previous studies and shows a positive influence in particular H1 to H4 which entirely agrees with the studies (Müller, 2019) related to PU, PEOU and ATU for independent AVs. While differences between V2V and V2I technologies can be seen in the influences of H1 to H4, for example, V2V shows no positive effect was obtained among the variables except for PEOU. On the other hand, there was a positive effect in terms of PU and ATU, unlike PEOU concerning V2I. Therefore, further research is needed as Müller (2019) reveals a gap between respondents' willingness to use technology and their actual ability to do so due to a lack of resources.

6.3.1.2. Professional Setting

To the best of our knowledge, this study is the first to investigate the relationship between DC and (PU and PEOU). The literature related to pervasive computing is supported by the results of this study where both professional and non-professional driver respondents believe that DC supports well across the three technologies of AV, V2V and V2I by showing a positive effect on the majority of variables (especially PU and PEOU), which can also improve visibility. As stated by Magyari et al., (2021) under adverse driving conditions, the accident rate of AVs was high when visibility was low; in addition, AVs require that sighting distances are 10 to 40 meters shorter than for conventional vehicles to avoid any possibility of accidents. Furthermore, El-Khatib et al., (2019) noted that driver inattention and vehicle automation interact in a complex way, and that must be considered when designing future vehicles. Further, this study shows that the results of compatibility differed in the effects on TAM, indicating positive support with V2V, but not for AV and V2I (Karahanna et al., 2006), which established a positive relationship between compatibility, attitude, perceived usefulness, and intention to use. According to a piece of research done by Wu and Wang, (2005), compatibility greatly determines PU and BI. Jing et al., (2020), discovered that those who utilise driver assistance systems are more inclined to embrace AVs, implying that the user's previous behaviour will predict their future behaviour intentions. Nevertheless, in a previous study the influence of the compatibility and driving context on the TAM constructs was ambiguous, (Nastjuk et al., 2020), and further study is required (Jing et al., 2020).

6.3.1.3. Personal Attributes

Another major theoretical result of this study demonstrates that trust&safety has a positive influence on DC and ATU, and also indicates that the participants believe that AV and V2V can provide more convenience in their use, more reliability, privacy, and security instead of V2I. However, this contributes to the research gap identified by Piao et al., (2016) who believed that the subject is not sufficiently developed and the public lacks understanding. On the other hand, the influence of personal innovativeness is supported for AV and V2I while it was unsupported for V2V across all the respondents. However, Müller (2019) believed that the findings may be used by manufacturers and mobility service providers to improve their marketing strategies and services for all three technologies (AV, V2V and V2I). Integration of these three technologies into a standard search model allows for this kind of comparison to be made. These results concern the Personal Attributes. Jing et al., (2020) state that autonomous driving is less secure than human driving. Similarly, Piao et al., (2016) were concerned about safety when there is no human driver in the cabin. Moreover, a comprehensive prospect of the significance of V2 and V2I technologies can be achieved by considering the findings of this study in order to adopt autonomous vehicles in the UK.

6.3.2. Model Validation

According to Newman (2009), this research considers unanswered questions and missing data. Tabachnick et al. (2013) and Pallant (2020) state that it is necessary to process the missing data before it is analyzed to obtain reliable results. Therefore, this study is dedicated to enhancing the clarity of our data. To this end, this research initially employed box plots to detect any potential outliers, as these outliers can significantly impact the estimated value of regression and the depiction of relationships within a sample (Hair et al., 2010).

R-squared, a potent indicator of explanatory power, is always worth considering, even when it's not a perfect fit. It generates substantial data, even with a low R-square, as social or behavioural sciences models are designed to include only the most relevant factors. Even a minimal R-square, if significantly different from 0, suggests that the regression model has statistically significant explanatory power. Consistently present the R-square as the effect size, allowing individuals to measure the substantial importance of the value. R-square values tend to increase in specific fields, mainly due to the relative ease of formulating comprehensive, well-defined models. However, in the social sciences, where the models are relatively easy to define, the significance of R-squared values cannot be overstated.

Regarding recent studies of autonomous vehicle, behavioural intention, R-square values show a dynamic range for autonomous vehicle technology. In most of the recent studies, such as Choi and Ji, (2015); Müller (2019); Yuen et al., (2020) and Ribeiro, (2021), the R-square values vary significantly, ranging from 55.2% to 87%, reflecting the ever-changing and dynamic nature of our field. Additionally, the attitude towards using, as stated by Müller (2019), that the R-square value is moderate to high by

50.7%, similar to Yuen et al. (2020), which is 59%. Whereas this study indicates that the R-square in terms of ATU was observed at a high value at 84.8 % of the variance in BI (Appendix C)

Additionally, Al Kurdi et al. (2020) indicate that R-square values for PU and PEOU show high values of 69.4% and 70.3%; similarly, to this study, PU was presented to be responsible for 79.2% of the variance in ATU. The results of the PEOU show that the R-square was observed to be responsible for 76.6% of the variance in ATU (Appendix C). While Choi and Ji, 2015 show that the R-square value is at a medium level of 0.340. In contrast, a study by Müller (2019) shows the lowest values for PU and PEOU for autonomous vehicles at 0.281 and 0.259.

Accordingly, as Yuen et al. (2020) reported, compatibility (COP) explains a moderate variance in attitude at 32%; concerning DC and COP of this study, the results of R-square were observed to be responsible for (75.2% and 65.7%) of the variance in ATU (Appendix C). In addition, the third part of the model delves into the impact of personal attributes, such as trust&safety and innovativeness, on attitudes towards using. The results were found to be responsible for a significant portion, demonstrating 74% and 74.5% of the variance in ATU (Appendix C), respectively, underscoring the relevance and impact of our research on real-world attitudes. At the same time, Choi and Ji (2015) reported that trust shows a moderate variance of 47.4%. The R-square value relating to innovativeness is low for autonomous vehicles at 19.9% (Müller, 2019).

Additionally, this research meticulously evaluated the quality of the measurement model by examining the content, convergent, and discriminant validities (Hair et al., 2011). To establish content validity, the current study utilized items validated in previous research, thereby strengthening our claim of content validity. The factor loadings, reliability, and validity of the eight constructs were thoroughly evaluated before assessing the SM model and its relevance to illustrate the associations between the measured variables and the underlying constructs (Garba, and Hafiz, 2022). Moreover, variables need to have an average variance extracted (AVE) value of at least 0.5, which (Fornell and Larcker, 1981; Hair et al., 2017) were able to achieve. In addition, the constructs demonstrated composite reliability (CR) of ≥ 0.7, indicating the validity of the scale by Fornell and Larcker, (1981); Zin et al., (2023). However, the results of this study agree with (Zainudin et al., 2017), whose studies aimed to achieve the mandatory level of value for AVE and CR, which are greater than or equal to 0.455 and 0.6. As a result, this procedure ensures that these research technologies have no validity concerns. Based on the study analysis, the model constructs were reliable and valid.

6.4. Structural Equation Modelling (SEM)

Despite its exploratory nature, this research has the potential to substantially influence future studies in the UK, considering the current state of the AV industry. It is dedicated to identifying the factors that influence users' intention to implement this new technology, thereby facilitating more comprehensive research into users' actual adoption behaviour towards AVs. According to Wan et al., (2013), this consequence was predicted due to the limited size of the data and the demographic focus of the respondent population. Similarly, the present study collected from 203 professional and nonprofessional drivers in the UK failed the initial goodness-of-fit (COF) tests for CFA and SEM. However, Ahmed et al., (2020) considered, RMSEA, CFI, TLI, and Chisq/df to reach the GOF tests with near-perfect results. Moreover, Hair et al., (2010) argue that CFA and SEM should include at least four model fit tests, as no single model can guarantee a perfect fit. Therefore, the model of the present study of CAF and SEM have successfully undergone GOF tests after modifications, demonstrating nearly perfect results for AV, V2V and V2I.

The use of AMOS software to modify this structural equation modelling (SEM) approach is highly suitable, as it has been argued that the study conducted using this software would yield more precise outcomes (Mustafa et al., (2020). SEM was employed to assess the magnitude of the association between factors and user attitudes. The SEM was performed using AMOS 28.0 software, which incorporates two primary models for analysis: the measurement model and the structural model. The measurement model examines the association between research instruments and the research variable through reliability and validity analysis, followed by factor analysis to assess the fit indices of the variable. The structural model involves executing path analysis and hypothesis testing (Ahmed et al., 2020). In addition, factor analysis was used to illustrate the factor loading and determine the convergent validity. Consequently, the validity and reliability of the study instrument were assessed using Cronbach's alpha (α), average variance extracted (AVE), and composite reliability (CR), as indicated by Awang (2015).

However, in the study by Garba and Hafez (2022), the findings indicated that every item in the measurement model achieved the required values for AVE and CR. This demonstrates that every construct of the model is accessible for further study. Correspondingly, this study showed that the model constructs were both reliable and valid, except for one value for AVE that is less than 0.455 as suggested by Zainuddin et al. (2017). Consequently, the findings indicate that further studies are necessary, and additional items should be considered regarding V2I for PU, as recommended by Garba and Hafez (2022).

Regarding the hypothesis results as shown in Table 6.2, this research has considered Gefen et al., (2000) studies which have helpfully demonstrated that the SEM is used for high-quality statistical analysis and to explore the dimensions of the problem, compared to multiple regression. In addition, Gefen et al., (2000) said, SEM techniques also provide more information about the extent to which the research model is supported by the variables than in regression techniques. Moreover, Hair et al. (2014) stated, that SEM enables the finding and validation of correlations among various variables. One of the key advantages of SEM is its ability to analyse the connections between several underlying constructs in an approach that minimizes model error. This feature allows for the evaluation and final removal of variables that are characterized by inaccurate measurement. Finally, SEM techniques are highly suitable for accomplishing these objectives (Hair et al. 2014).

Table 6-2: Results of SEM for AV, V2V and V2I

Hypotheses	Research hypothesis	Tech	Result
H1	The Perceived Usefulness of the technology has a positive influence on the Attitude Towards Use.	AV V2V V2I	Supported Supported Supported
H2	The Perceived Ease of Use of the technology has a positive influence on its Perceived Usefulness.	AV V2V V2I	Rejected Rejected Rejected
H3	The Perceived Ease of Use of the technology has a positive influence on the Attitude Towards Using.	AV V2V V2I	Supported Supported Supported
H4	The Attitude Towards Using the technology has a positive influence on the Behavioural Intention to Use.	AV V2V V2I	Supported Supported Supported
H5	The Driver Context of the technology has a positive influence on its Perceived Usefulness.	AV V2V V2I	Supported Supported Supported
H6	The Driver Context of the technology has a positive influence on its Perceived Ease of Use.	AV V2V V2I	Supported Supported Supported
H7	The Compatibility of the technology has a positive influence on its Perceived Usefulness.	AV V2V V2I	Rejected Rejected Rejected
H8	The Compatibility of the technology has a positive influence on its Perceived Ease of Use.	AV V2V V2I	Rejected Rejected Supported
H9	Trust and Safety have a positive influence on the Driver Context of the technology.	AV V2V V2I	Supported Supported Supported
H10	Trust and Safety have a positive influence on the Compatibility of the technology.	AV V2V V2I	Supported Supported Supported
H11	Innovativeness has a positive influence on the Driver Context of the technology.	AV V2V V2I	Supported Supported Supported
H12	Innovativeness has a positive influence on the Compatibility of the technology.	AV V2V V2I	Rejected Rejected Rejected
Total hypotheses = 12 Total hypotheses with technologies= 36 Supported hypotheses with technologies = 25 Rejected hypotheses with technologies = 11			

Significant, P < 0.05

6.4.1. TAM

Regarding the research hypotheses, it is worth noticing that out of the twelve hypotheses analysed for AV, V2V and V2I technology acceptance, only eight constructs displayed a positive effect. Initially, the TAM showed a positive influence among the hypotheses such as H1, H3 and H4 as previously demonstrated by Müller, (2019) in terms of PU, PEOU and ATU for autonomous vehicles. Additionally, Ha and Stoel, (2009); Lee and Kozar, (2006) stated PU is a main effect of BI which has been confirmed in this study. In addition, users might utilise the autonomous vehicle to do different internet activities inside their vehicle. Consequently, this increases the PU of AVs which will significantly impact their adoption (Noor-A-Rahim et al., 2020).

Furthermore, respondents exhibited a positive attitude towards AVs as suggested in this study. This is supported by the research conducted by Payre et al., (2014); who discovered that ATU is the most significant predictor of a user's interest in driving AVs in their prediction model. Liu et al., (2019) performed a questionnaire survey directly on the respondents; in line with this study’s approach. In contrast, Hartwich et al., (2019) encouraged respondents to play a driving simulator game before completing the survey. The driving simulator provides respondents with a more intuitive sense of the autonomous system than the survey, which may be another reason why senior participant in the Hartwich et al., (2019) study had a more favourable view regarding AVs.

The present study suggests that PEOU has a positive influence on PU, and indicated that PEOU and PU had negative support. Although, Tsai (2008) revealed that PEOU has an important relationship with PU in AV technology, Choi and Ji (2015), revealed in their study that individuals may be more concerned with the PU of AVs than PEOU. Furthermore, Xu et al., (2018) discovered that PEOU had a much greater impact on PU and acceptance intention after respondents had experienced an AV on a testing ground. In contrast, Jansson, (2011) and Petschnig et al., (2014) concluded that PEOU indirectly influences acceptance intent via perceived usefulness and attitude. However, Zhang et al., (2019) emphasised that PEOU is not a major predictor of trust. This may be caused by the fact that individuals lack experience in riding AVs, making it difficult for them to determine if they are capable of controlling one. To conclude, users' acceptance of AVs is likely to be influenced by the difficulty of self-assessing their usage of AVs.

6.4.2. Professional Setting

Notably, the present study exposed that the driver context variable was employed for the first time as a construct to assess user adoption of AV, V2V and V2I. A strong positive relationship was discovered through H5 and H6. This was due to understanding various driving contexts such as environmental factors and driving behaviours (Magyari, 2021). As a result, the information presented in the study evaluates how these factors enhance driver safety. In turn, this enables users to confidently accept V2V and V2I technology. Consequently, the applications and elements of pervasive computing and TAM have been widely employed. This extends in the context of driving scenarios to predict drivers' acceptance and utilisation of various AV technologies and additional features needed in a transportation system (Zhang et al., 2019). However, Moosavi et al., (2017) reported the challenge in determining the driving contexts results from a lack of environment and/or driver monitoring; therefore, the authors recommended monitoring environments with the use of cameras installed inside vehicles.

Unexpectedly, the compatibility hypotheses such as H7 and H8 showed a negative relationship between constructs for both technologies AV and V2V at P-value >0.05. Nevertheless, El-Khatib et al., (2019) evaluate the interaction between the driver's inattention and vehicle automation. This can be complicated and should be considered during the development of an upcoming vehicle. Moreover, Nastjuk et al., (2020) stated, COP and DC constructs have an ambiguous effect on TAM, which requires further research (Jing et al., 2020). Furthermore, based on analyses of the statistics, it appears that the constructs related to AV and V2V exhibit insignificant results. To obtain statistical significance in hypothesis testing (Fornell, and Larcker, 1981), it is recommended to include extra items in the questionnaire, due to a lack of sufficient understanding of these new technologies by the general public (Battistini et al., 2020). Similarly, Yuen et al., (2020) note that AVs are arguably more compatible with the existing lifestyle, past experiences and transport needs of the public. As a result, this provides greater convenience for individuals with active lifestyles who may need multiple pick-ups and drop-offs.

6.4.3. Personal Attributes

Furthermore, trust is one of the most common phrases in the collected literature, it was observed that DC and COP are positively affected by TR&SF towards H9 and H10 as suggested in this study. In addition, this study confirmed the work of Ribeiro et al., (2022) who noted that trust in AVs has a significant impact on AV for users' safety. Therefore, this present study disagreed with Jing et al., (2020), in which many respondents are more receptive to AVs with manual driving alternatives than to wholly autonomous vehicles without steering wheels for safety issues. Additionally, Battistini et al., (2020) observed various trust and safety applications. For instance, cruise assistance blind spot warning and lane change and electronic emergency brake light systems. However, they are currently not fully developed and are deployed in mainstream industry. Despite INV affecting DC positively through H11, COP was negatively affected by INV with respect to the personal attributes. This finding is consistent with Rouf and Babu, (2023), who referred to individuals using autonomous vehicles accepting and interacting with new technologies such as V2V and V2I, which aims to disseminate and enhance acceptance of these technologies. However, more research needs to be done into the disparity between individuals' intention to use technology and ability in doing so (Müller, 2019).

6.5. Chapter Summary

This chapter has provided a discussion on the results of the primary research data obtained during this study into emerging technologies. In addition, both professionals and non-professionals examined the survey questionnaires. Furthermore, the chapter was developed to examine the factor structure using confirmatory factor analysis, and structural equation modelling techniques. The use of AMOS software in this study is a modification of the SEM approach, which is highly suitable and would lead to more accurate results.

The discussion chapter has highlighted significant contributions particularly that Trust is a major influence towards both autonomous vehicles and connected technologies which means that manufacturers must consider enhancing convenience and confidence in vehicles with sophisticated performance and safety-related applications, it leads to developing user confidence and the evolution of automotive technology. Moreover, the Driver Context significantly influences users' attitudes towards autonomous vehicles as well as the emerging applications of V2V and V2I. The results also indicate that Personal Innovativeness varies in that it was not supported with regards to Compatibility however it was supported with regards to Driver Context.

In the next chapter, this study will conclude by highlighting the academic and practical implications, their limitations, and suggestions for future studies.

Chapter 7: Conclusion

7.1. Introduction

This study, conducted in the United Kingdom, demonstrated that the three groups of the theoretical framework identified differences in the adoption factors for AVs towards V2V and V2I technologies. The theoretical framework of the three groups is a key output from this research where the TAM focuses on well-established adoption factors, the Professional Setting comprises key contextual factors concerning autonomous driving, and the Personality Attributes considers user characteristics and technology attitudes. In addition, the importance of the factors for the different technologies will help automotive manufacturers focus on the key areas that concern users and need to be addressed during car design. This chapter summarises the study's findings, contribution, and managerial implications. It also reviews the study's objectives and discusses how they were achieved. To conclude, it presents the study's limitations and any future recommendations.

7.2. Summary of the Study Findings

7.2.1. Multiple Regression Analyses Using (SPSS)

This study develops the research model for users of autonomous vehicles from a pervasive computing perspective to provide insights on the way they engage with and utilise modern technologies such as V2V and V2I. The theoretical framework, which includes 12 hypotheses, was developed by thoroughly examining and theoretically reviewing existing theories. The factors such as PU, PEOU show positive influence users' perceptions of AVs which indicates that TAM is still relevant to understand users' attitudes towards AVs. In addition, the literature that relates to pervasive computing is supported with the results of this study where both professional and non-professional drivers 'respondent's data indicate that driver context supports well across the three technologies of AV and V2I by showing a positive effect on most variables especially TAM. Furthermore, this study also shows that the results of compatibility differed in the effects on TAM, indicating positive support with V2V. Additionally, trust and safety have a positive influence on DC and COP, and also indicates that the participants believe that AV and V2V can provide more convenience in its use and more reliability. Across all the respondents the influence of personal innovativeness is supported for V2V in terms of DC, whereas the factor was unsupported for AV and V2I. Regarding the statistical testing, the outcomes of the multiple regression analyses indicate that 22 hypotheses were significant across the factors affecting user perceptions with the other hypotheses not being statistically significant, hence, 14 of the hypotheses were rejected, as shown in Figure 7.1. To conclude, the study developed and analysed 12 hypotheses based on the relationship between both independent and dependent variables with the total hypotheses of technologies 36.

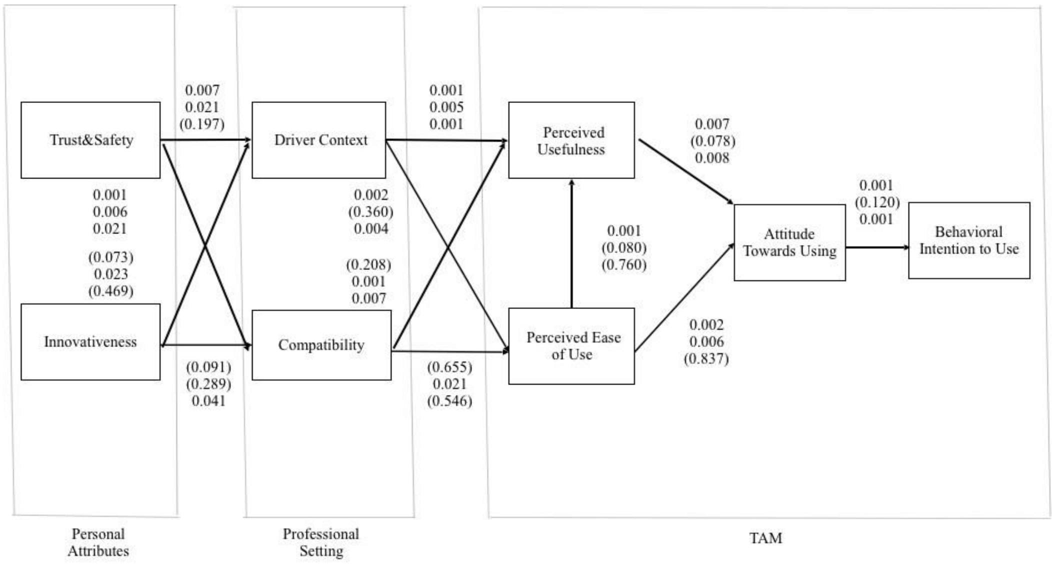


Figure 7-1: Results of Multiple Regression Analysis for AV, V2V and V2I

7.2.2. Structural Equation Modelling Using (AMOS)

The existing literature on pervasive computing and technology acceptance for autonomous vehicles and connected technologies has been utilised during this research and the developed framework modelled using AMOS. To verify the relationships between the twelve study hypotheses with users' acceptance of autonomous vehicle technologies, data analysis techniques employing confirmatory factor analysis (CFA) and structural equation modelling (SEM) AMOS version 28.0 software are utilised. The revised SEM of the relationship between various variables passed Goodness-of-Fit (GOF) tests with near-perfect outcomes for autonomous vehicle technology after the modifications. However, this study demonstrated that the average variance extracted (AVE) and composite reliability (CR) values displayed satisfactory levels of construct reliability and validity in assessing model fit indices.

The SEM results revealed that the TAM in terms of AV and V2V indicated that perceived usefulness and perceived ease of use had a significant influence on attitudes towards using autonomous vehicles. Moreover, AV and V2V had a strongly significant impact on driver context toward perceived usefulness and perceived ease of use. In contrast, compatibility for AV and V2V showed that there was no significant effect on the professional setting towards perceived usefulness and perceived ease of use. Furthermore, the study revealed that the personal attributes demonstrated a statistically significant effect between trust and safety towards driver context and compatibility. Although, it was observed that AV V2V, and V2I had no significant impact on innovativeness relative to compatibility, there was a positive relationship between innovativeness and driver context with respect to autonomous vehicles and connected technologies. The study developed and analysed 12 hypotheses based on the relationship between both independent and dependent variables with the total hypotheses of technologies 36. In terms of the findings of the SEM indicate that 25 hypotheses were significant across the factors affecting user perceptions with the other hypotheses not being statistically significant, hence, 11 of the hypotheses were rejected, as shown in Figure 7.2.

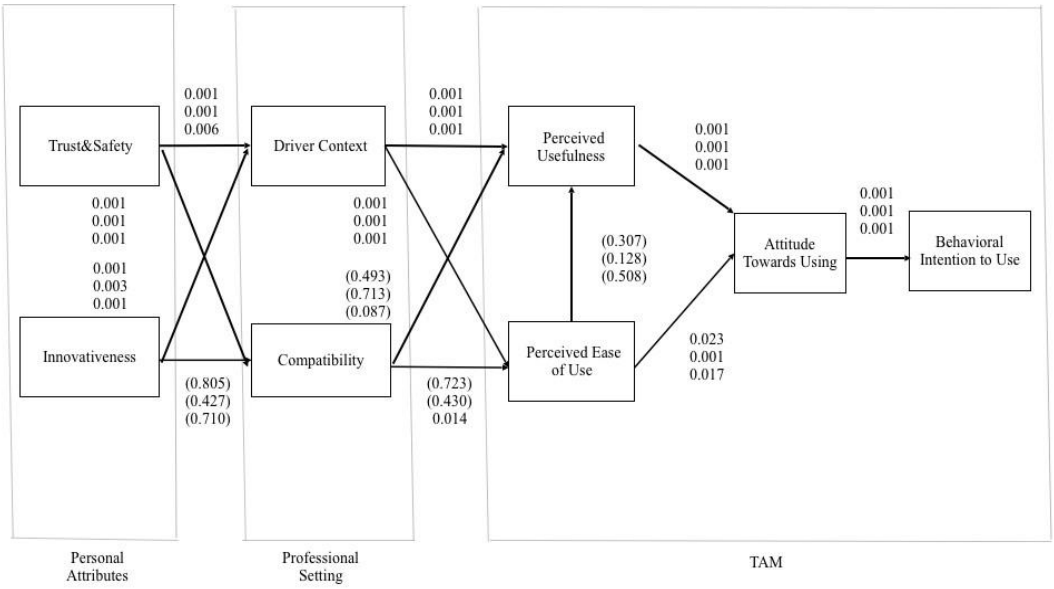


Figure 7-2: Results of SEM for AV, V2V and V2I

7.3. Research Contribution to Knowledge

This groundbreaking study delves into the uncharted territory of how connected technologies shape users' perceptions of autonomous vehicles. It offers unique insights into how the real-time exchange of information significantly influences users' attitudes, a perspective that has not been explored in the literature before. The study's focus on V2V and V2I adds a fresh dimension to the understanding of emerging technologies.

First, the present study contributes to understanding autonomous vehicles and connected technology in several ways. Firstly, this study uses TAM to focus on well-established adoption factors; TAM indicates that the PU construct of autonomous vehicles is significant in building trust and influencing users' attitudes to accept V2V and V2I. Both professional and non-professional drivers have been shown to believe that V2V and V2I enhance efficiency and contribute to improved traffic flow. This study's result could be useful for automotive manufacturers to consider when designing a vehicle. Moreover, it has been empirically proven that PEOU impacts users' attitudes towards adopting V2V and V2I technologies. Hence, professional and non-professional drivers believe that PEOU for V2V and V2I is easy to learn and easy to be skilled in operating. As a result, this study also suggests that this may be helpful information for developing and promoting an autonomous vehicle.

Second, the professional setting comprises key contextual factors concerning autonomous driving. This first study examined the effects of driver context, which rises in the literature of pervasive computing, to examine user attitudes towards V2V and V2I. This theoretical contribution shows how driver context (DC) influences users' intentions to accept autonomous vehicles. Regarding professional and non-professional drivers, they believe that V2V and V2I can improve visibility and reduce traffic. Furthermore, the empirical results in this study provide a new understanding of the users' attributes from professional and non-professional drivers, indicating that attitudes to autonomous driving vary according to DC, which signifies the relevance of pervasive computing as an underlying theoretical basis. This can potentially aid companies in improving user perceptions of achieving enhanced journey performances for autonomous vehicles.

Third, the research has highlighted essential contributions, mainly that Trust and Safety (TR&SF) significantly influence autonomous vehicles and connected technologies. This means manufacturers must consider enhancing convenience and confidence in vehicles with sophisticated performance and safety-related applications. This leads to developing user confidence and the evolution of automotive technology. Finally, user innovativeness in using AV technology devices has been found to affect their attitudes and intentions. The importance of the factors for the different technologies will help automotive manufacturers focus on the key areas that concern users and need to be addressed during car design.

7.4. Implications of the Study Results

This study provides decision-makers at automotive manufacturers with essential perspectives on how to facilitate V2V and V2I adoption. The study has developed a guiding framework for autonomous vehicle decision-makers in the UK that can be used to accelerate the adoption of V2V and V2I through the vehicle development process. The findings assist automakers in understanding which factors of autonomous vehicles make the most significant contribution to automotive companies' performance. This research also found that trust and driver context are some of the most influential factors in the acceptance of autonomous vehicle technologies V2V and V2I.

In addition, this research can also provide automotive manufacturers with significant factors that increase the ability to accept emerging technologies such as V2V and V2I. Regarding users, the results of this current study revealed that V2I is more innovative than AV and V2V. This could result from V2I-related, well-developed applications, items, and sufficient resources that automobile manufacturers consider throughout the vehicle design process.

However, this study suggests that based on automotive manufacturers' resources and capabilities, some still need partnerships that can be established with other technology companies to improve their reputation and performance. In addition, they should develop more advanced features, applications, and items in the coming years to be more reliable. Moreover, each application has drawbacks in obtaining accurate information, which plays a vital role in implementing autonomous vehicles. Therefore, this study suggests that automobile manufacturers should allow users to post comments on their websites.

7.5. Achieving Research Aim and Objectives

To examine driver perception factors and adoption attitudes which influence the acceptance of connected technologies (V2V and V2I) in facilitating AV adoption in the UK. To achieve the aim of the present study, the following objectives were proposed as shown in Table 7.1.

First objective: To achieve the first objective, an extensive study of the extant literature that defines the field of this research, which includes autonomous vehicle technology and pervasive computing. This is presented in chapter 2.

Second objective: The second objective was achieved by formulating a theoretical framework and extracting relevant factors from connecting technologies and autonomous vehicles, especially V2V and V2I. This is presented in chapter 3.

Third objective: The third objective was achieved by defining the research strategy used to validate the proposed model. Normality and the performance of linearity tests were checked. As well as multiple regression and reliability analyses are conducted. Further, ANOVA and T-test to evaluate the influence of model factors. Finally, CFA, validity, and SEM. This will be carried out using AMOS to assess the overall fit of the proposed model and validate the hypothesised relationships. This is presented in chapters 4,5 and 6.

Fourth objective: To achieve the fourth objective by extensively examining the hypotheses. Following, it examines the analysis of the results of the research model within the relevant literature. In addition, it provides a comprehensive summary of the research and includes a description of the main limitations, as well as potential areas and approaches for future research. This is presented in chapters 7 and 8.

Table 7-1: Meeting the Study's Aims and Objectives

Objective		Chapter
Objective 1	To conduct a comprehensive literature review on connecting technology for AVs.	Chapter 2
Objective 2	To develop a theoretical model that outlines the needs of the study highlights the characteristics of autonomous vehicle technology, and investigates their implications for the technological acceptance model.	Chapter 3
Objective 3	To demonstrate that the framework built during this study can support the performance of connecting technologies such as V2V and V2I.	Chapters 4, 5 and 6
Objective 4	To place the findings in the relevant literature, present the theoretical and management implications of the main findings, and provide recommendations for future research.	Chapters 7 and 8

7.6. Answering the Research Question

The following research questions were formulated to investigate factors that may have an impact on autonomous vehicle adoption in the UK.

Q1: To what extent does Pervasive computing theory influence users' perceptions of AVs?

A comprehensive background study was conducted to identify potential applications influencing pervasive computing, highlighted in Chapter 2. Furthermore, the results from the survey of professional and non-professional drivers indicate that attitudes to autonomous driving vary according to age and driver context, which signifies the relevance of pervasive computing as an underlying theoretical basis, as explained and analysed in chapters 3 and 4.

Q2: Which group factors have the most influence on user perceptions regarding AVs?

A field study was carried out in the UK to examine the different groups of AVs which affect user perceptions. The raw data was quantitatively and statistically analysed using SPSS and SEM (AMOS). The results are presented in chapters 5, 6 and 7.

Q3: What factors most influence users' attitudes towards V2V applications?

A field study was conducted in the UK to examine the factors influencing user adoption of V2V applications. The raw data was quantitatively and statistically analysed using SPSS and SEM (AMOS). The results are presented in chapters 5, 6 and 7.

Q4: What are the key determinants of user adoption of V2I as an emerging application?

A field study was conducted in the UK to examine the key factors influencing user attitudes for V2I applications. The raw data was quantitatively and statistically analysed using SPSS and SEM (AMOS). The results are presented in chapters 5, 6 and 7.

7.7. Research and Directions for Future Research

This study searched for factors that affect users' perceptions of autonomous vehicles and connected technologies, especially V2V and V2I; the review had some limitations:

This study initially used a predominantly quantitative research approach. However, a qualitative follow-up study would be beneficial in gaining insights into the patterns observed from this primary research.

In addition, it is essential to emphasise that the study was conducted in the UK. The generalisability of this study is consequently limited by the sample- and the UK-specific attributes. Therefore, it is crucial for future research to replicate this study in various geographical regions to assess the generalisability of the results. In addition, the research study was focused on UK users whose demographics are well observed; however, in developing countries, other demographics may be significant and should be included (for example, education, income, etc.)

Further studies are strongly recommended to explore these connected technologies, particularly V2I. Given that users have yet to become familiar with this technology in its infancy, it would greatly benefit from additional research to understand and enhance this emerging field.

Furthermore, this research has identified a limit regarding the generalisability of the results. Although the TAM has been effectively demonstrated to predict future innovations, it is essential to note that the model's outcomes may still need to be well-established due to insufficient direct experience. While the supplied video and description of autonomous driving might assist individuals in adopting the perspective of a driver, they cannot replace real driving experience with autonomous vehicles, and expressed preferences and behaviours in a hypothetical scenario do not consistently align with actual preferences and behaviours. This research also observes that the acceptance of autonomous systems rises with further experience. Consequently, this study's findings should be interpreted with great caution, as they significantly depend on the individual's perception of autonomous driving. This research recommends replicating this study after implementing autonomous driving and incorporating experienced individuals to ensure a more comprehensive understanding of the topic.

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Appendices

Appendix A

College of Engineering, Design and Physical Sciences Research Ethics Committee
Brunel University London
Kingston Lane
Uxbridge
UB8 3PH
United Kingdom

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20 December 2022

LETTER OF APPROVAL (CONDITIONAL)

APPROVAL HAS BEEN GRANTED FOR THIS STUDY TO BE CARRIED OUT BETWEEN 20/12/2022 AND 27/01/2023

Applicant (s): Mr Mazen Mossa

Project Title: A Study of Users' Attitudes to Self-Driving Vehicles in the UK....

Reference: 41416-LR-Dec/2022- 42962-3

Dear Mr Mazen Mossa

The Research Ethics Committee has considered the above application recently submitted by you.

The Chair, acting under delegated authority has agreed that there is no objection on ethical grounds to the proposed study. Approval is given on the understanding that the conditions of approval set out below are followed:

- **The agreed protocol must be followed. Any changes to the protocol will require prior approval from the Committee by way of an application for an amendment.**
- **Please ensure that you monitor and adhere to all up-to-date local and national Government health advice for the duration of your project.**
- **Please do not use google forms, use Microsoft forms or JISC surveys instead.**

Please note that:

- Research Participant Information Sheets and (where relevant) flyers, posters, and consent forms should include a clear statement that research ethics approval has been obtained from the relevant Research Ethics Committee.
- The Research Participant Information Sheets should include a clear statement that queries should be directed, in the first instance, to the Supervisor (where relevant), or the researcher. Complaints, on the other hand, should be directed, in the first instance, to the Chair of the relevant Research Ethics Committee.
- Approval to proceed with the study is granted subject to receipt by the Committee of satisfactory responses to any conditions that may appear above, in addition to any subsequent changes to the protocol.
- The Research Ethics Committee reserves the right to sample and review documentation, including raw data, relevant to the study.
- If your project has been approved to run for a duration longer than 12 months, you will be required to submit an annual progress report to the Research Ethics Committee. You will be contacted about submission of this report before it becomes due.
- You may not undertake any research activity if you are not a registered student of Brunel University or if you cease to become registered, including abeyance or temporary withdrawal. As a deregistered student you would not be insured to undertake research activity. Research activity includes the recruitment of participants, undertaking consent procedures and collection of data. Breach of this requirement constitutes research misconduct and is a disciplinary offence.

Simon Taylor

Professor Simon Taylor

Chair of the College of Engineering, Design and Physical Sciences Research Ethics Committee

Brunel University London

Appendix B

Self-Driving Vehicles (SDV) from the Pervasive Computing Perspective: A Study of Users' Technology Acceptance

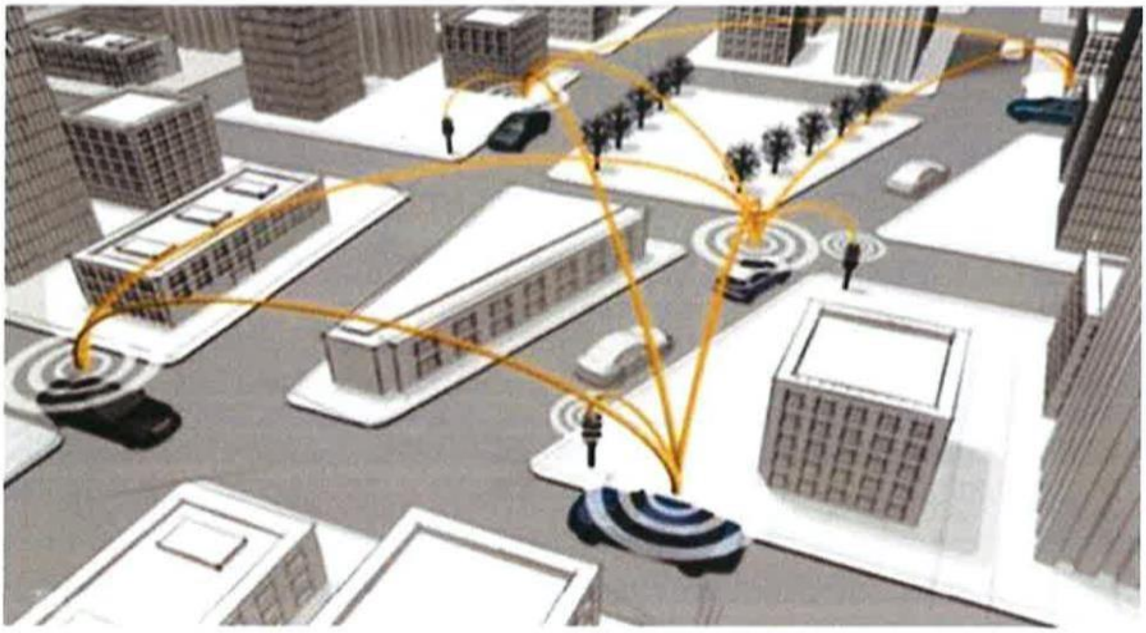
To date, various autonomies vehicle designs have become very popular. Currently there is a huge practice in this area. Broadly defined, "Automated vehicles, also termed autonomous, driverless, self-driving and robotic vehicles, are vehicles capable of sensing their environments and navigating without human input, thus fulfilling the capabilities of a traditional vehicle".

Initially, a V2V technology is widely known as a vehicle-to-vehicle communication, was developed to increase V2V sharing and data exchange from vehicle to vehicle. It enhances the potential for short-range communications and increases safety and awareness applications between interconnected vehicles systems and sensors. It enables vehicles to access information based on speed, distance, and efficiency from another V2V application accessed from an internet connection. It aims to alert drivers who are driving other V2V vehicles which could reduce the possibility of accidents.

The vehicle-to-infrastructure application is the most advanced and developed concept of autonomous vehicles technologies that can connect to modern traffic. It aims to obtain data and information related to traffic congestion and conditions including weather, bridge clearance.

*Required

V2V and V2I Technologies System.



1. Demographics

- 18-24
- 25-34
- 35-54
- 55+

2. **Gender** *

Mark only one oval.

- Male
- Female

3. **Do you currently live in?** *

Mark only one oval.

- Urban
- Suburban
- Rural area

4. **Driving experience** *

Mark only one oval.

- 1-3 (km/miles)
- 4-9 (km/miles)
- 10-15 (km/miles)
- 16-or more (km/miles)

5. **Weekly mileage** *

Mark only one oval.

- 0-49
- 50-99
- 100-199
- 200-499
- 500-or more

6. **Purpose of driving** *

Mark only one oval.

- Commute to Work
- Journeys/ Travel
- Leisure
- Other: ____________

7. **Previous accidents** *

Mark only one oval.

- I have never been involved in an accident
- Accident with minor damage only
- Accident with injury
- Accident with major damage

8. **Are you a professional driver?** *

Mark only one oval.

- Yes
- No

9. **If yes, please provide answers**

Mark only one oval.

- ( ) Local Courier driver
- ( ) National Courier driver
- ( ) Local Haulage driver
- ( ) National Haulage driver
- ( ) International Haulage driver
- ( ) Other (Please describes your driving/roll pattern)
- ( ) Other: ____________

10. **Driver assistance systems you have used** *

Mark only one oval.

- ( ) Automatic braking
- ( ) Automatic parking
- ( ) Blind spot detection
- ( ) Collision avoidance systems
- ( ) Other: ____________

11. **How much do you know about autonomous vehicles?** *

Definitions

Autonomous Vehicles (AVs): they are vehicles capable of sensing their environments and navigating without human input, thus fulfilling the capabilities of a traditional vehicle".

Vehicle-to-Vehicle (V2V): it can increase sharing and data exchange from vehicle to vehicle. It enhances the potential for short-range communications and increases safety and awareness applications between interconnected vehicles systems and sensors.

Vehicle-to-Infrastructure (V2I): it can connect to modern traffic. It aims to obtain data and information related to traffic congestion and conditions including weather, bridge clearance.

2. Technology Acceptance Model (TAM)

2.1. Behavioral intention to Use (BI)

12. **2.1.1. Assuming I had access to an AV/V2V/V2I, I intend to use it.** *

Mark only one oval per row.

	Strongly Disagree	Disagree	Somewhere Disagree	Neutral	Somewhere agree	Agree	Strongly Agree
AV	◯	◯	◯	◯	◯	◯	◯
V2V	◯	◯	◯	◯	◯	◯	◯
V2I	◯	◯	◯	◯	◯	◯	◯

13. **2.1.2. I expect that I would use AV/ V2V/ V2I in the future.** *

Mark only one oval per row.

	Strongly Disagree	Disagree	Somewhere Disagree	Neutral	Somewhere agree	Agree	Strongly Agree
AV	◯	◯	◯	◯	◯	◯	◯
V2V	◯	◯	◯	◯	◯	◯	◯
V2I	◯	◯	◯	◯	◯	◯	◯

17. **2.2.2. In my opinion, using AVs/ V2V/ V2I would be beneficial for me.** *

Mark only one oval per row.

	Strongly Disagree	Disagree	Somewhere Disagree	Neutral	Somewhere agree	Agree	Strongly Agree
AV	⬭	⬭	⬭	⬭	⬭	⬭	⬭
V2V	⬭	⬭	⬭	⬭	⬭	⬭	⬭
V2I	⬭	⬭	⬭	⬭	⬭	⬭	⬭

18. **2.2.3. I like the idea of using AVs/ V2V/ V2I.** *

Mark only one oval per row.

	Strongly Disagree	Disagree	Somewhere Disagree	Neutral	Somewhere agree	Agree	Strongly Agree
AV	⬭	⬭	⬭	⬭	⬭	⬭	⬭
V2V	⬭	⬭	⬭	⬭	⬭	⬭	⬭
V2I	⬭	⬭	⬭	⬭	⬭	⬭	⬭

19. **2.2.4. Using AVs/ V2V/ V2I will have a positive impact on society.** *

Mark only one oval per row.

	Strongly Disagree	Disagree	Somewhere Disagree	Neutral	Somewhere agree	Agree	Strongly Agree
AV	⬭	⬭	⬭	⬭	⬭	⬭	⬭
V2V	⬭	⬭	⬭	⬭	⬭	⬭	⬭
V2I	⬭	⬭	⬭	⬭	⬭	⬭	⬭

2.3. Perceived usefulness (PU)

20. **2.3.1. Using AV/ V2V/ V2I would enhance my effectiveness while driving.** *

Mark only one oval per row.

	Strongly Disagree	Disagree	Somewhere Disagree	Neutral	Somewhere agree	Agree	Strongly Agree
AV	◯	◯	◯	◯	◯	◯	◯
V2V	◯	◯	◯	◯	◯	◯	◯
V2I	◯	◯	◯	◯	◯	◯	◯

21. **2.3.2. AVs/ V2V/ V2I will contribute to a better traffic flow** *

Mark only one oval per row.

	Strongly Disagree	Disagree	Somewhere Disagree	Neutral	Somewhere agree	Agree	Strongly Agree
AV	◯	◯	◯	◯	◯	◯	◯
V2V	◯	◯	◯	◯	◯	◯	◯
V2I	◯	◯	◯	◯	◯	◯	◯

22. **2.3.3. Using AVs/ V2V/ V2I will increase my productivity.** *

Mark only one oval per row.

	Strongly Disagree	Disagree	Somewhere Disagree	Neutral	Somewhere agree	Agree	Strongly Agree
AV	◯	◯	◯	◯	◯	◯	◯
V2V	◯	◯	◯	◯	◯	◯	◯
V2I	◯	◯	◯	◯	◯	◯	◯

23. **2.3.4. Using AV/ V2V/ V2I will decrease traffic accident risk.** *

Mark only one oval per row.

	Strongly Disagree	Disagree	Somewhere Disagree	Neutral	Somewhere agree	Agree	Strongly Agree
AV	⬭	⬭	⬭	⬭	⬭	⬭	⬭
V2V	⬭	⬭	⬭	⬭	⬭	⬭	⬭
V2I	⬭	⬭	⬭	⬭	⬭	⬭	⬭

24. **2.3.5. Using AV/ V2V/ V2I will improve my daily efficiency.** *

Mark only one oval per row.

	Strongly Disagree	Disagree	Somewhere Disagree	Neutral	Somewhere agree	Agree	Strongly Agree
AV	⬭	⬭	⬭	⬭	⬭	⬭	⬭
V2V	⬭	⬭	⬭	⬭	⬭	⬭	⬭
V2I	⬭	⬭	⬭	⬭	⬭	⬭	⬭

25. **How do think will benefit when using AVs/ V2V/ V2I?** *

2.4. Driver Context (DC)

26. **2.4.1. Driving AVs/ V2V/ V2I in urban area will improves visibility.** *

Mark only one oval per row.

	Strongly Disagree	Disagree	Somewhere Disagree	Neutral	Somewhere agree	Agree	Strongly Agree
AV							
V2V							
V2I							

27. **2.4.2. Driving AVs/ V2V/ V2I vehicles in urban area will improve journey time when high traffic congestion.** *

Mark only one oval per row.

	Strongly Disagree	Disagree	Somewhere Disagree	Neutral	Somewhere agree	Agree	Strongly Agree
AV							
V2V							
V2I							

2.5. Perceived Ease of Use (PEOU)

28. **2.5.1. I expect learning to use AVs/ V2V/ V2I will be easy for me.** *

Mark only one oval per row.

	Strongly Disagree	Disagree	Somewhere Disagree	Neutral	Somewhere agree	Agree	Strongly Agree
AV							
V2V							
V2I							

29. **2.5.2. I believe my interaction with AVs/V2V/V2I would be clear and understandable.** *

Mark only one oval per row.

	Strongly Disagree	Disagree	Somewhere Disagree	Neutral	Somewhere agree	Agree	Strongly Agree
AV							
V2V							
V2I							

30. **2.5.3. Learning to operate AV/ V2V/ V2I would be easy for me.** *

Mark only one oval per row.

	Strongly Disagree	Disagree	Somewhere Disagree	Neutral	Somewhere agree	Agree	Strongly Agree
AV							
V2V							
V2I							

31. **2.5.4. It would be easy for me to become skillful at using AVs/ V2V/ V2I** *

Mark only one oval per row.

	Strongly Disagree	Disagree	Somewhere Disagree	Neutral	Somewhere agree	Agree	Strongly Agree
AV							
V2V							
V2I							

2.6. Innovativeness (INV)

32. **2.6.1. I keep myself informed about recent AVs/ V2V/ V2I developments.** *

Mark only one oval per row.

	Strongly Disagree	Disagree	Somewhere Disagree	Neutral	Somewhere agree	Agree	Strongly Agree
AV							
V2V							
V2I							

33. **2.6.2. If I heard about a new development in the area of AVs/ V2V/ V2I, I will be interested in trialing it for ways to trial it.** *

Mark only one oval per row.

	Strongly Disagree	Disagree	Somewhere Disagree	Neutral	Somewhere agree	Agree	Strongly Agree
AV							
V2V							
V2I							

34. **2.6.3. I like to give AVs/ V2V/ V2I a trial, even if they are not widely used yet.** *

Mark only one oval per row.

	Strongly Disagree	Disagree	Somewhere Disagree	Neutral	Somewhere agree	Agree	Strongly Agree
AV							
V2V							
V2I							

35. **2.6.4. I would like to experiment with AVs/ V2V/ V2I. Among my peers, I would be one of the first to try out autonomous vehicles.** *

Mark only one oval per row.

	Strongly Disagree	Disagree	Somewhere Disagree	Neutral	Somewhere agree	Agree	Strongly Agree
AV	◯	◯	◯	◯	◯	◯	◯
V2V	◯	◯	◯	◯	◯	◯	◯
V2I	◯	◯	◯	◯	◯	◯	◯

2.7. Compatibility (COP)

36. **2.7.1. I think using AVs/ V2V/ V2I will not fit well into my journey patterns.** *

Mark only one oval per row.

	Strongly Disagree	Disagree	Somewhere Disagree	Neutral	Somewhere agree	Agree	Strongly Agree
AV	◯	◯	◯	◯	◯	◯	◯
V2V	◯	◯	◯	◯	◯	◯	◯
V2I	◯	◯	◯	◯	◯	◯	◯

37. **2.7.2. Using AVs/ V2V/ V2I would be compatible with my driving habits.** *

Mark only one oval per row.

	Strongly Disagree	Disagree	Somewhere Disagree	Neutral	Somewhere agree	Agree	Strongly Agree
AV	◯	◯	◯	◯	◯	◯	◯
V2V	◯	◯	◯	◯	◯	◯	◯
V2I	◯	◯	◯	◯	◯	◯	◯

38. **2.7.3. I think using AVs/ V2V/ V2I is compatible with my everyday life.** *

Mark only one oval per row.

	Strongly Disagree	Disagree	Somewhere Disagree	Neutral	Somewhere agree	Agree	Strongly Agree
AV	◯	◯	◯	◯	◯	◯	◯
V2V	◯	◯	◯	◯	◯	◯	◯
V2I	◯	◯	◯	◯	◯	◯	◯

39. **2.7.4. I think using AVs/ V2V/ V2I is compatible with my personal communication devices.** *

Mark only one oval per row.

	Strongly Disagree	Disagree	Somewhere Disagree	Neutral	Somewhere agree	Agree	Strongly Agree
AV	◯	◯	◯	◯	◯	◯	◯
V2V	◯	◯	◯	◯	◯	◯	◯
V2I	◯	◯	◯	◯	◯	◯	◯

40. **2.7.5. Using AVs/ V2V/ V2I would fit well with all aspects of my life style.** *

Mark only one oval per row.

	Strongly Disagree	Disagree	Somewhere Disagree	Neutral	Somewhere agree	Agree	Strongly Agree
AV	◯	◯	◯	◯	◯	◯	◯
V2V	◯	◯	◯	◯	◯	◯	◯
V2I	◯	◯	◯	◯	◯	◯	◯

2.8. Trust (TR) and Safety (SF)

41. **2.8.1. AVs/ V2V/ V2I have enough safeguards to make me feel comfortable using it.** *

Mark only one oval per row.

	Strongly Disagree	Disagree	Somewhere Disagree	Neutral	Somewhere agree	Agree	Strongly Agree
AV	◯	◯	◯	◯	◯	◯	◯
V2V	◯	◯	◯	◯	◯	◯	◯
V2I	◯	◯	◯	◯	◯	◯	◯

42. **2.8.2. My trust in an AV/ V2V/ V2I will be based on the reliability of the underlying technologies.** *

Mark only one oval per row.

	Strongly Disagree	Disagree	Somewhere Disagree	Neutral	Somewhere agree	Agree	Strongly Agree
AV	◯	◯	◯	◯	◯	◯	◯
V2V	◯	◯	◯	◯	◯	◯	◯
V2I	◯	◯	◯	◯	◯	◯	◯

43. **2.8.3. Overall, using AV/ V2V/ V2I will have more privacy and security.** *

Mark only one oval per row.

	Strongly Disagree	Disagree	Somewhere Disagree	Neutral	Somewhere agree	Agree	Strongly Agree
AV	◯	◯	◯	◯	◯	◯	◯
V2V	◯	◯	◯	◯	◯	◯	◯
V2I	◯	◯	◯	◯	◯	◯	◯

44. **How will AVs/ V2V/ V2I be based on the car manufacturer's reputation improving safety and reliability?**

45. **What are your viewpoints regarding the future of AVs/ V2V/ V2I?** *

(Thank you for your Time and Cooperation)

Appendix C

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.848[a]	.719	.715	.70859

a. Predictors: (Constant), ATU-V2I, ATU-AV, ATU-V2V

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.436	.221		1.972	.050
	ATU-AV	.314	.066	.328	4.722	<.001
	ATU-V2V	.162	.104	.165	1.561	.120
	ATU-V2I	.398	.095	.405	4.215	<.001

a. Dependent Variable: BI

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.792[a]	.627	.621	.79322

a. Predictors: (Constant), PU-V2I, PU-AV, PU-V2V

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.259	.246		5.122	<.001
	PU-AV	.243	.089	.249	2.723	.007
	PU-V2V	.237	.134	.247	1.769	.078
	PU-V2I	.334	.125	.330	2.673	.008

a. Dependent Variable: ATU

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.752[a]	.566	.559	.85614

a. Predictors: (Constant), DC-V2I, DC-AV, DC-V2V

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.823	.244		7.473	<.001
	DC-AV	.323	.071	.381	4.549	<.001
	DC-V2V	.178	.101	.193	1.761	.080
	DC-V2I	.217	.092	.232	2.356	.020

a. Dependent Variable: ATU

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.657[a]	.432	.423	.97925

a. Predictors: (Constant), COP-V2I, COP-AV, COP-V2V

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.773	.322		5.504	<.001
	COP-AV	.058	.131	.054	.439	.661
	COP-V2V	.568	.195	.503	2.906	.004
	COP-V2I	.129	.164	.113	.790	.431

a. Dependent Variable: ATU

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.740[a]	.548	.541	.87337

a. Predictors: (Constant), TR&SF-V2I, TR&SF-AV, TR&SF-V2V

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.646	.261		6.304	<.001
	TR&SF-AV	.251	.084	.268	2.990	.003
	TR&SF-V2V	.332	.112	.352	2.966	.003
	TR&SF-V2I	.159	.111	.162	1.438	.152

a. Dependent Variable: ATU

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.745[a]	.555	.547	.86713

a. Predictors: (Constant), INV-V2I, INV-AV, INV-V2V

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.705	.252		6.766	<.001
	INV-AV	.145	.119	.154	1.219	.224
	INV-V2V	.408	.144	.425	2.830	.005
	INV-V2I	.180	.117	.188	1.539	.126

a. Dependent Variable: ATU

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.766[a]	.586	.580	.83552

a. Predictors: (Constant), PEOU-V2I, PEOU-AV, PEOU-V2V

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.325	.267		4.960	<.001
	PEOU-AV	.304	.097	.325	3.136	.002
	PEOU-V2V	.441	.160	.434	2.756	.006
	PEOU-V2I	.031	.152	.030	.206	.837

a. Dependent Variable: ATU