Measuring Behavioural Intention to Accept Autonomous Vehicles: A Structural Equation Model

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A thesis submitted in partial fulfilment of the requirements of London South Bank University for the degree of Doctor of Philosophy

April 2019

Dedication

I dedicate this thesis to my beloved mother in gratitude, to the memory of my beloved father, (1949-2006), to my children Willyam and Alanys, who are growing up in a future we are helping to create and to my family and friends who have supported me on this journey.

Acknowledgements

I express my deepest gratitude to my supervisors Prof. Ebad Banissi, Mr George Ubakanma, Dr Christos Chrysoulas, Prof. Dilip Patel and Dr Dave Protheroe for their invaluable assistance, support and guidance throughout the research of this thesis. I also want to thank Dr Matthew Bond for his help.

Declaration

I declare that this thesis is my own work and has not been submitted in any form for another degree or diploma at any university or other institution of tertiary education. Information derived from published or unpublished work of other has been acknowledge in the text and a list of references is given.

Signature

Date

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Abstract

For decades, the user acceptance of information technology has been a vital field of study for psychologists and sociologists investigating new insights into the acceptance of behaviour at individual and organisational levels. Despite numerous models being proposed to predict consumer use of the behaviour of technology; the latest models and theories are still not able to fully capture the complexity of the factors influencing people behavioural intention to adopt Autonomous Vehicles (AV).

The research adopts a pragmatic approach using multiple methods that was executed in the following phases. In phase I, the key factors influencing behavioural intention to use AV were identified using an initial survey with 408 participants, interviews were conducted with experts in the field of Psychology, Sociology and Computer Science, then the model was developed, and finally the hypothesis defined. In phase II, the conceptual model was empirically validated and refined by employing a survey research approach with another 482 participants. The constructs were operationalised by developing and validating the research instrument with content validity, reliability, construct validity approach and Structure Equation Modelling (SEM). In phase III a tool for information visualisation was developed bridging the gap between theoretical concepts and practical industry requirements.

The findings suggested that all the constructs included in the conceptual model significantly influence the consumers' behavioural intention (BI) to adopt AVs. Based on our evaluation we take the determinants self-efficacy, perceived safety, trust, anxiety and legal regulations into consideration and propose a theoretical AV technology acceptance model (AVTAM) by incorporating these determinants into the Unified Theory of Acceptance and Use of Technology (UTAUT2) model. The results show that anxiety is negatively correlated with BI. The contribution of this research towards theory is the development and validation of a research instrument that future studies can utilize to examine AV and other similar emerging technologies from a consumers' perspective. An added contribution to practice is the development of an information visualisation tool to further explain different group behaviours towards technology adoption.

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Publications List

The following papers are based on the research presented in this thesis. They have all been peer reviewed and published.

Chapters in Books

Seuwou, P. Banissi, E. Ubakanma, G. (2019) 'The Future of Mobility with Connected and Autonomous Vehicles in Smart Cities', Digital Twin Technologies and Smart Cities, Internet of Things (IoT), Springer International Publishing, ISBN 978-3-030-18732-3

Seuwou P., Banissi E., Ubakanma G., Sharif M.S., Healey A. (2016) Actor-Network Theory as a Framework to Analyse Technology Acceptance Model's External Variables: The Case of Autonomous Vehicles. In: Jahankhani H. et al. (eds) Global Security, Safety and Sustainability - The Security Challenges of the Connected World. ICGS3 2017. Communications in Computer and Information Science, vol 630. Springer, Cham

Seuwou P., Banissi E., Ubakanma G. (2016) User Acceptance of Information Technology: A Critical Review of Technology Acceptance Models and the Decision to Invest in Information Security. In: Jahankhani H. et al. (eds) Global Security, Safety and Sustainability - The Security Challenges of the Connected World. ICGS3 2017. Communications in Computer and Information Science, vol 630. Springer, Cham

Journal Articles

Seuwou, P., Patel, D., Ubakanma, G. (2014), 'Vehicular Ad hoc Network Applications and Security: A Study into the Economic and the Legal implications', International Journal of Electronic Security and Digital Forensics, Conference on Global Security, Safety and Sustainability, 9th ICGS3 Conference, Inderscience.

Conference Papers

Seuwou, P., Patel, D., Protheroe, D., Ubakanma, G. (2012), 'Effective security as an ill-defined problem in vehicular ad hoc networks (VANETs)', Road Transport Information and Control (RTIC 2012), IET and ITS Conference, E-ISBN 978-1-84919-674-1, IEEE.

Seuwou, P., Chrysoulas, C., Banissi, E., Ubakanma, G., (2020), 'Measuring Consumer Behavioural Intention to Accept Technology: Towards Autonomous Vehicles Technology Acceptance Model (AVTAM)

List of abbreviations

AV	Autonomous Vehicles
AVTAM	Autonomous Vehicles Technology Acceptance Model
AX	Anxiety
BI	Behavioural Intention
CTAM	Car technology Acceptance Model
CI	Cultural Influence
C-TAM-TPB	Combined TAM and TPB (Augmented TAM)
DTPB	Decomposed Theory of Planned Behaviour
EE	Effort Expectancy
FC	Facilitating Conditions
H	Habit
HM	Hedonic Motivation
IT	Information Technology
ICT	Information and Communication Technology
IDT	Innovations Diffusion Theory
LR	Legal Regulation
LIDAR	Light Detection and Ranging
MM	Motivational Model
MPCU	Model of PC utilization
PE	Performance Expectancy
PEOU	Perceived Ease Of Use
PS	Perceived Safety
PV	Price Value
SCT	Social Cognitive Theory
SE	Self-Efficacy
SI	Social Influence
SN	Subjective Norms
SPSS	Statistical Package for the Social Sciences
T	Trust
TAM	Technology Acceptance Model
TAM2	Technology Acceptance Model 2

TAM3	Technology Acceptance Model 3
TRA	Theory of Reasoned Action
TPB	Theory of Planned Behaviour
UTAUT	Unified Theory of Acceptance and Use of Technology
UTAUT2	Unified Theory of Acceptance and Use of Technology 2
V2I	Vehicle-to-Infrastructure
V2V	Vehicle-to-vehicle

Chapter 1 Introduction

1.1 Introduction

This chapter introduces the proposed research. The following section provides a background to Autonomous Vehicles (AVs) then provides a discussion of the importance of AVs and the research problem. Section 1.3 will provide the research questions the study is attempting to answer; section 1.4 will define the research aim and objectives. A discussion of the research approach that will be used to achieve the proposed aim and objectives are offered in Section 1.5. The research contributions of this study are then offered in Section 1.6. To familiarise the readers with the remaining dissertation, an overview is offered in Section 1.7. Finally, Section 1.8 provides a summary of this chapter.

1.2 Research Problem

1.2.1 Background to Autonomous Vehicles

The invention of the car has shaped our modern society since Karl Benz patented the three-wheeled Motor Car in 1886. Today, it is for many of us the primary mode of transportation and there are currently over 900 million of passenger cars on the road worldwide (World Bank, 2014). Every year, more than 1.2 million people die and up to 50 million people are injured because of road accidents (WHO, 2004). In 2004, 2005 & 2007, the DARPA Grand Challenge and Urban Challenge provided researchers a practical scenario in which to test the latest sensors, computer technologies and artificial intelligence algorithms (Wei, et al., 2013). These technological advancements are creating a continuum between conventional, fully human-driven vehicles and AVs also known as driverless vehicles, which partially or fully drive themselves and which may ultimately require no driver at all. Within this continuum are technologies that enable a vehicle to assist and make decisions for a human driver. Such technologies can be built with GPS sensing knowledge to help with navigation. They may use sensors and other equipment to avoid collisions, include crash warning systems, adaptive cruise control (ACC), lane keeping systems, and self-parking technology. They also have the ability to use a range of technology known as augmented reality, where a vehicle displays information to drivers in new and innovative ways. AVs rely on sensor data and artificial intelligence (AI) to interpret the data, to make decisions regarding vehicle operation, and to adapt to changing conditions. The advantage of AVs stems from their ability to rapidly process information and to adapt to their environment much faster than a human, and exchange information through vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communication technologies (Lim and Taeihagh, , 2018).

1.2.2 Outlining the importance of Autonomous Vehicles

Autonomous Vehicles have existed as prototypes and demonstrative vehicles since the 1970s. Meanwhile their introduction in 2010, their development and appeal has increased significantly. AVs have emerged as a potential solution to modern day transport problems. Widespread AV adoption can reduce environmental degradation through reduced emissions and energy consumption while providing beneficial economic and social outcomes through improved efficiency, traffic flow, road safety, and accessibility to transport, among other benefits. Many of these benefits stem from AVs' connected nature, which enables them to communicate with other vehicles and critical infrastructure to optimise traffic and maximise all associated benefits for sustainable smart cities.

The transportation business is a $4 trillion global industry (Seba, 2014). UK automotive is a vital part of the UK economy and typically generates more than £55 billion in annual turnover, delivering around £12 billion in net value to the economy (SMMT, 2013). This industry is inextricably linked with energy. Indeed, the internal combustion engine automobile will soon be disrupted, an event which will, in turn send disruptive shockwaves throughout the oil industry.

The first wave of disruption of the century old automotive industry is well underway with electric vehicles. The second disruptive wave, the self-driving car, will hit before the first wave is finished crashing. Transportation will never be the same again. Autonomous Vehicles (AVs) will be here much sooner than most people expect and will lead to major changes in transportation, our cities and society as a whole. Most car manufacturers and some technology companies are actively developing and testing AVs. Some preliminary versions of AVs are already commercially available in some parts of UK. This new auto technology will bring disruption with massive opportunities. Indeed, near autonomous cars followed by driverless vehicles (smart cars) will transform our commute to work and much more over the next two decades; electric and hybrid cars are set to become a large part of our fleet, changing the demand for motoring and disrupting our pay-as-you-go revenue base.

Most of these vehicles will be powered by electric power. Furthermore, we will expect a much safer and easier commute with fewer fatalities, dramatic accident reductions, reducing congestion. On the other hand, car-based technologies hold the promise of reducing the billions of pounds we spend on roads by improving how we use them and by saving lives. Public transport will also be challenged as car journeys become cheaper, safer and easier to make and without environmental emissions, lowering congestion. Some industries will have to reinvent themselves and others will disappear altogether. When designing infrastructure policies, there is a tendency to assume that the future is simply an extension of the past. AVs are a truly disruptive technology and we cannot forecast the future by simply extrapolating from the past. All of the above issues will change the forecasts for standard infrastructure and major infrastructure projects.

1.2.3 Outlining Research Problem

Autonomous cars are being researched by several major car companies as well as Google. Ford, General Motors, and Volvo all have developed prototypes of an autonomous vehicle with many of the qualities similar to Heinlein’s cars of the future. However, it is Google who has the most developed system, capable of driving with very little input from the operator. These companies are heavily researching and developing these technologies with the hopes of introducing them to the public market. Because this is a rapidly developing technology that has the possibility of substantially changing the way society operates, we found this area to be of particular interest. However, not all technologies predicted by popular media are immediately welcomed into society, and autonomous cars are one such technology (Lim and Taeihagh, 2018). As is typical with many advances, many people will oppose them and the changes that they will bring. Opponents of AVs argue over issues ranging from safety, personal freedom, technology dependence, and laws. They see the introduction of these cars to the market as a threat to their safety on the roads. There is no doubt that with the arrival of a new technology brings new challenges and problems. But what do the people think of these new AVs? Are they an affront to our freedom? Do they endanger the lives of the driver and those around them? The way the public perceives autonomous cars will very directly affect the way they will be introduced to the market and how quickly we'll be seeing them on the streets. The public's willingness to accept this technology will determine how car manufacturers develop and market them. Simply put, if the public is not accepting of certain aspects of the technology, car manufacturers will not develop these aspects. Conversely, if the public is more favourable in another way, the market will promote this aspect more than the others. In order to determine their likely development and possible areas of improvement, the researcher set out to gauge this public perception and measure the behavioural intention of potential consumers of this emerging technology. Because he believes that the public's opinion is strong indicator of how this new technology will develop, we predict the analysis of this opinion will allow him to gain insight into how the technology will likely be to progress. Several studies have identified that people don't like changes as most people are reluctant to alter their habits (Garvin and Roberto, 2005; Halvorson, 2012; Murphy, 2016) and there is a research gap on better understanding the main determinants of AV adoption. Therefore, it may be important for the understanding of the main factors that would influence people behaviour towards acceptance of the AVs.

1.3 Research Questions

1. What are the main factors influencing public acceptance of autonomous vehicles?
2. How could the proposed research model with the factors influencing people behavioural intention towards accepting autonomous vehicles be tested and validated?

3. How could the model be made useful for industry professionals?

1.4 Research Aims and Objectives

Researchers in the Information Systems (IS) field have been studying the adoption of Information and Communication Technologies (ICTs) at the organisational level for several years (Venkatesh and Brown, 2001). Relatively few studies have been focussed on evaluating the factors influencing AVs adoption. Therefore, the main aim of this study is to investigate consumer-level factors affecting behavioural intention to adopt Autonomous Vehicles.

To that end, the objectives of this research are as follows:

1. To develop a conceptual model of the determinants of autonomous vehicles acceptance based on the unified theory of acceptance and use of technology as a foundation.
2. To test the empirical validity of the proposed research model in a developed economy context i.e., United Kingdom.
3. To develop a tool to visualise the importance of numerous factors influencing the behaviour of potential consumers towards autonomous vehicles.

To address objectives **(1),** an initial questionnaire will be administered to potential customers and several interviews will be conducted with professionals and experts from the field of psychology, sociology and computer science. New determinants will be identified from the information available in the literature and thorough brainstorming. All possible constructs will be presented to all the participants and based on their answers a new model will be proposed. To address objective **(2)** the research will be testing the proposed model using another questionnaire as part of the second survey and will be using the statistical package SPSS and R programming for the structure equation modelling and to calculate the significance of each constructs. To address objective **(3)** the research will develop a web-based information visualisation tool using **three.js** (a JavaScript 3D library) and Tableau visual analytics software to represent all constructs and their influences on different age groups and genders. To conduct this investigation, an ethics application was submitted and approval from the University ethics committee was obtained.

1.5 Research Methodology used in this Thesis

The present study was divided in three phases. The purpose of phase I was to identify other possible constructs and moderating factors influencing behavioural intention to accept autonomous vehicles that have not been recognised in the past, using an inductive approach. This phase allowed the researcher to identify constructs for the proposed model based on a combination of the UTAUT2 (Venkatesh et al.,2012), the car technology acceptance research model (Osswald et al., 2012). To achieve this objective, the study used an explanatory sequential mixed method design. Indeed, quantitative data was collected first through a questionnaire, to identify other possible constructs or indicators capable of influencing behavioural intention of acceptance of technology which were not present in the previous models. For the study, the sampling frame included anyone who uses a car (not necessarily able to drive one) but presently living in UK, with the ability to respond to complex questions without the need of their parent or guardian's authorisation. The study used a convenience sampling method. Numeric data are collected from 408 participants using a questionnaire, (see Appendix B: Questionnaire for Survey 1), handed to people from various industries and different age groups and genders. This research attempts to build upon and extend our knowledge towards the understanding of how the public reacts when facing a disruptive technology like autonomous vehicles. The data was analysed in SPSS using descriptive statistical techniques. Based on the data collected from the survey, the results led us to the qualitative part of our investigation where the researcher selected purposely a total of 15 participants (psychologists, sociologists and computer scientists) from various universities and higher education providers in the UK including London South Bank University, King's College London, GSM London and University of Hertfordshire (see Appendices C, D, E: list of questions used for interviews with Sociologists, Psychologists and computer scientists respectively). These were academics or professionals who were considered to be able to answer the research questions. Face-to-face interviews or by Skype with all participants at their places of work were undertaken. The model was developed, supported and sequentially improved based on comments from these experts and practitioners. The hypotheses were also developed at this stage.

The purpose of phase II of this study was to test and validate the proposed model. In this process the study measured the influences of the factors identified in phase I using Structure Equation Modelling (SEM) estimating their direct or indirect effects on behavioural intention to use autonomous vehicles. This phase was deductive in nature to test the hypotheses developed. The study uses a convenience sampling method**.** 482 participants (population similar to those of survey 1) took part in the survey 2 (see appendix F for questionnaire 2). The data was analysed in SPSS and R programming**:** factor analysis was used to measures the validity of the questionnaire, and Cronbach's Alpha used to measure the reliability of the questionnaire. Furthermore, other regression analysis for hypothesis testing to measure the significant value of each proposed construct or determinants to validate the proposed model.

The main purpose of phase III was to exploit the extended unified theory of acceptance and use of technology, transforming its potential into a practical business solution that could be applied to real life problems and assist technology companies or marketing firms to easily predict potential consumers' adoption of their products.

1.6 Original contribution to knowledge

The following are the main contributions of this investigation:

1. Development of a model to predict people's behavioural intention to adopt autonomous vehicles. The model can also be adapted and applied to any other emerging technologies. **{Contribution 1}**

2. Development of an information visualisation technique allowing the application of our proposed model as a business solution for autonomous vehicle companies. This creates a graphical representation of consumer's behavioural intention to use technology. The software is used to measure people's behavioural intention to use technology in order to predict future use

behaviour. This tool can also be adapted and used for any other emerging technologies. **{Contribution 2}**

This study has achieved the broad objective of developing a model highlighting new determinants influencing people of behavioural intentions to adopt autonomous vehicles (emerging technologies). The proposed model has been tested and validated using structured equation modelling with R programming.

1.7 The Structure of the Thesis

To achieve the research aims and objectives, this study comprises seven chapters: **Chapter 1** provides a brief introduction to the background of the study along with the rationale. The chapter also outlines the objectives of this study together with the research questions, contributions, key terms and the structure of the study. **Chapter 2** presents a critical review examining the prominent models and theories of technology acceptance as well as Information Technology adoption proposed in the past few decades. **Chapter 3** aims to discuss research approaches in general and also those specific to this research. It will also provide the justification for the chosen research methodology, as well as detailed discussions on the specific methodological approach.

Chapter 4 presents the phase I of the study which consists of identifying the factors influencing behavioural intention to accept AV. **Chapter 5** presents the phase II of the study measuring behavioural intention to use AV. In this chapter, the model (AVTAM) proposed in chapter 3 will be tested and validated using structure equation model (SEM). **Chapter 6** presents the web service development based on the proposed extended UTAUT2 model. **Chapter 7** presents the discussion of the main constructs and connects the different components of the study. C**hapter 8** is the conclusion providing a summary of the main findings of the research, discussing its theoretical and practical implications. The limitations of the study and areas for future research are also discussed.

1.8 Summary

This chapter provided an introduction to the research problem that this research encompasses and established the focus of this study. It provides a background on the area of autonomous vehicles and went on to define the research aim and objectives that this research later addresses. A brief description of the research methodology and the contributions that this research will make were presented. Finally, brief descriptions of all eight chapters were provided. The next chapter will provide a literature review on the user acceptance on Information technology.

Chapter 2 Literature review on user acceptance of information technology

2.1 Introduction

In the field of Information Systems, it is known that information technology is underutilised in many organisations causing massive economic losses. Information technology acceptance and its use is an issue that has received the attraction of researchers and practitioners for several decades. They are interested in investigating the theories and models that show potential in predicting and explaining behaviour across many domains. The main objectives of these studies are to investigate how to promote usage, also examining what obstructs usage and the intention to use technology. Interaction between humans and technology is influenced by several social and psychological factors and characteristics. Because of the complexities involved in predicting human behaviour, research has generated a variety of theories and models to explain patterns of adoption and use of new technologies. Each prominent technology acceptance theory or model which has not been superseded by more recent research has different premises and benefits. It is therefore important to study them intentionally, since it is expected that theoretical concepts from these theories will help to provide a sound basis for the theoretical framework for creating a research model that could properly demonstrate the acceptance of technology.

This chapter is structured as follows. Section 2.2 provides a review of the current state to AV acceptance; it also explores the advantages and the barriers to AV adoption. Section 2.3 finally offers a critical review of technology acceptance literature to make explicit their major assumptions and contributions to the technology acceptance field. Section 2.4 describes previous models and theories introduced in the past with illustration. Section 2.5 compares the constructs and moderating factors of the key models discussed in section 2.4. Section 2.6 briefly discusses the car technology acceptance model (CTAM). In Section 2.7 the gap in the literature is identified. Finally, to conclude the chapter, Section 2.8 is provided.

2.2 Autonomous Vehicles Acceptance

Automation of vehicles and driverless technology has attracted a lot of people from the stakeholders to the media. Stakeholders have been yearning to develop and take the automated driving technology a notch higher and meet the increasing demands of consumers. Public exposure to the different forms of electric vehicles has slowly gained momentum in recent years with various manufacturers carrying out test runs and pilot programs in Europe. Such programs help towards examining the user acceptance of these modern vehicles and act as prerequisites to ensure such investment pay off. Many authors believe that customer acceptance is likely to be the biggest obstacle to autonomous vehicle penetration (Morgan Stanley, 2013; ERTRAC, 2015; Becker and Axhausen, 2017). At first, many consumers may be reluctant to put their lives in the hands of a robot. Recent studies and surveys have shown a split in opinion as to whether people would like autonomous capability to be available in their vehicles or not. User acceptance is a key ingredient to the successful adoption of autonomous vehicles. In the last three decades, the global car market has gone through some rapid changes especially in driver experiences, thanks to the technological advancement. For instance, a typical middle-class classic car has standard features such as automatic gearbox, an electronic stability program and power windows (Fraedrich and Lenz, 2016).

For the high-end vehicles, they can have intelligent features such as an automatic start up framework, self-parking technology and active lane assistance. The innovations have led to comfortable driving. However, the automobiles still need human interaction to foster their movement. Today’s innovations focus on automobiles that are fully autonomous and free from direct human interaction. Driverless vehicles are those that operate without direct input by the driver to control the acceleration, steering or braking and are designed in such a way that the controller does not continuously observe the roadway when the car is moving in self-driving mode. The driver-less vehicle technology has been too advanced; opening new opportunities for the automotive dealers, individual users and also the potential manufacturers (2025ad.com, 2018).

There are diverse factors that influence vehicle-purchasing behaviour amongst the people. There are the situational factors that include regulatory environments. Besides the situational factors, psychological factors also play an essential role in the purchase of autonomous vehicles and include the personal attitudes. The extensive adoption of electric cars can be understood through the examination of the different factors that influence consumer acceptance. The acceptance is critical towards the commercial success or failure of the AVs.

According to Fraedrich and Lenz, (2016), there are different factors that influence and motivate the environmentally conscious behaviours. The elements encompass the personal values; environmental concerns as well as the belief that one can make a difference in the use of such vehicles. Also, these factors contribute towards an individual's purchase intentions for the alternative fuel vehicles. Gas prices significantly impact the individual's interest in buying hybrid electric cars. There are other customer preferences such as reduced air pollution, reduced maintenance and better handling. There is no doubt that environmentalists and people that have strong preferences for energy security will automatically adopt the hybrid electric cars. In their research, Rödel *et al.*, (2014) concluded that among the top attributes considered before a new vehicle purchase include price, reliability and the fuel economy.

Different societies have distinctive attributes relating to their preferences for the autonomous vehicles. According to the unified theory of acceptance, the degree of technology acceptance varies. People in Hong Kong prioritize the environmental benefits of these innovations followed by the economic and social benefits. Negative factors have also been identified as barriers towards the purchase of the electric vehicles. These include lack of AV infrastructure, limited selection of the vehicles and the potential increases in the electrical rates. Results of the study by Cho et al., (2017) highlighted four determinant factors affecting purchasing behaviours of the potential buyers: high costs, charge inconvenience, psychological factors and short battery range. A study in China also revealed some deterministic factors or concerns when purchasing autonomous vehicles such as the cost of operations, overall buying cost, possible speeds and battery capacity. In the USA, the potential buyers considered the charge time and range as concerns other than the value of the hybrid vehicles. Findings by Niculescu, Dix, and Yeo, (2017) also show that the attributes, personal norms, the perceived behavioural control as well as the planning abilities influenced the decision to buy an autonomous vehicle. Customers will always be concerned about the potential advantages as well as the promises as indicated below:

2.2.1 Impacts and Potential Benefits of Autonomous Vehicles adoption

Most companies experimenting with automation today rely on Deep Learning to do so with a subfield of Artificial Intelligence within the family of Machine Learning. Machines that apply Deep Learning ‘learn by example,’ relying on extensive data collection to develop ever more complex and hierarchical algorithms for understanding the world around them. Thus, AVs require not only software development to improve the technology used, but also experienced driving on roads in order to develop a greater familiarity within a wider variety of scenarios and obstacles. The following section would be covering some of the potentials benefits brought by the adoption of AVs.

Safety Benefits

According to the National Highway Traffic Safety Administration (NHTSA) annual reports, over 90% of car accidents are linked with human error as a result of distractions, sickness or fatigue (2025ad.com, 2018). Thus, autonomous cars are capable of increasing traffic safety as all the critical functions of the driver are system oriented. Hence, a guarantee of safety for the users is a consideration when purchasing autonomous vehicles.

Time Savings

Hybrid electric cars are considerate and time efficient. They can optimize the choice of routes based on their ability to collect updated traffic information and thus a person can reach their desired destination faster compared to human-driven vehicles. Automated vehicles also reduce congestion through minimized road accidents and shortened travel times for the users.

Automation has significantly enhanced communication via the Vehicle-to-Infrastructure (V2I) and Vehicle-to-Vehicle (V2V) frameworks. V2V enhances cars to sense and anticipate any decision by the preceding vehicles to brake or accelerate. Anticipatory speed adjustments are enhanced through V2I when getting closer to other vehicles and when approaching traffic lights. Automation of cars has also improved the use of Adaptive Cruise Control (ACC) as well as sensors for automatic brakes. It is also believed that the highway capacity will considerably increase (from about 45 % to 300%). Speed of congested traffic can increase from 5% to 15%. V2I can enable the hybrid electric cars to improve acceleration, braking, and speed adjustments (2025ad.com, 2018).

The Internet of Things (IoT) will significantly influence the adoption of automated cars. Self-parking functionalities continue to be advanced with major improvements expected to be rolled out in the coming years so as to reduce damages as a result of parking accidents.

Fuel savings

The V2V and V2I communication increases fuel the economy by a considerable percentage when automated vehicles are used. Fuel savings are also enhanced through high utilization of highways and the ability for the vehicles to travel closely together. The use of AVs significantly lessens the environmental degradation due to reduced greenhouse emissions. Additionally, the reduction of these pollutants also minimizes the social costs associated with human health. Autonomous technology will improve the productivity levels of the individuals. The passengers of the autonomous cars participate in other social activities such as resting (sleeping), reading, watching movies or working. Designers are working towards customized AVs for mobile offices for people who travel a lot. Automotive technology has also enhanced social networking amongst friends and family. There is a possibility to engage in other things when not driving such as keeping in touch with other people. Much effort and time is required when a person is driving himself or when using public transport. AVs leverage the current technology helping to reduce the opportunity to the cost of time significantly.

Despite the advantages and promising trends associated with vehicle automation, some issues may arise during the development. Customer acceptance can be slow due to different concerns linked to advanced technology. Consumers may be reluctant to adopt driverless technology due to behavioural attachment and lifestyle. Furthermore, societal acceptance is pending with issues like safety, trust, security, privacy concerns, legislation, liability and cost. Some people enjoy self-driving and thus identify themselves with their vehicles. Giving up the lifestyle and freedom may not be appealing to all and it may be a challenge convincing them to switch to autonomous vehicles. Also, some people may have limited trust in the systems in terms of cyber security. Cyber-attacks are imminent, and users of these vehicles may be concerned about any information they provide for the operation of the system. There may be challenges to come up with a secure system that can have the capacity to detect as well as rectify any intrusions into the operating system.

The current traffic situation in major towns and cities can be a barrier towards achieving a reliable software and hardware. The complexities are due to many participants such as pedestrians, cyclists, vehicles not to mention the physical obstacles such as construction sites. Recognizing these objects can be difficult for adopted software due to varying sizes and the posture. Moreover, poor weather conditions can pose a myriad of challenges to the software and hardware particularly when sensors fail to detect some obstacles engulfed in fog, storms, rain, ice, or snow. Thus, the software used in the operation of these cars must undergo extensive testing to accommodate all of these issues.

2.2.2 Barriers to adoption of Autonomous vehicle

In the past few decades, considerable progress has been achieved in the field of computing, electronics and the car industry. One of the major motivations for developing AVs is the potential impact on vehicle safety. Current technologies utilize sensor arrays (LIDAR is used to a large extent) to create a 3-dimensional model of the space all around the car (Connor, 2011) It is estimated that over 90 percent of all accidents are due to human error or bad driving behaviour, whether it be reckless driving or driving while intoxicated (Olarte, 2011) AV is just an extension of existing technologies such as Vehicle-to-Vehicle (V2V) and Vehicle-to-Infrastructure (V2I) allowing communication between the vehicle and road side base stations. One goal of developing AV is to render these types of accidents a thing of the past. In spite of the various benefits of increased vehicle automation, some foreseeable challenges may include liability for damage, resistance of individuals to forfeit control of their cars and software reliability. AVs will have an important level of computer technology on board and may be connected to the internet, other vehicles and possibly their surroundings. As a result, cyber security issues need to be carefully considered as a cars computer or communication system between the cars could be potentially compromised. There will also be ethical issues surrounding the privacy and use of data and testing, certification and licensing. Other challenges will include implementation of a legal framework and establishment of government regulations for self-driving cars. Reliance on the autonomous drive will produce less experienced drivers when manual control is needed. The loss of driver-related jobs with reduced demand for parking services and for accident related services will be anticipated. There will be losses but there is an assumption that AV will increase vehicle safety. There is also going to be a reduction in jobs relating to car insurance and traffic police. However, because the transition to driverless cars is likely to be spread over many years, the loss of jobs is likely to be gradual and manageable.

Since Norman Bel Geddes envisioned self-driving cars in the 1939 World's Fair General Motors exhibit Futurama, autonomous vehicle technology has come a long way. Autonomous Vehicles (AVs) will be here much sooner than most people expect and will lead to major changes to transportation in our cities and within our society. Most car manufacturers (Mercedes, BMW and Tesla) and some other technology companies (Google, UBER) are actively developing and testing AVs but there are several barriers to the introduction of this disruptive technology.

Consumer acceptance—At first, many consumers may be reluctant to put their lives in the hands of a robot. Recent studies and surveys have shown a split in opinion on whether people would like autonomous capability to be available in their vehicles or not. Therefore, mass acceptance of this technology could take a long time. This could be the case particularly if there are accidents involving even semi-autonomous vehicles early in the adoption phase, whether it was the fault of the autonomous system or not (Shanker *et al* [Morgan Stanley], 2013; KPMG, 2015).

Legal (Legislation/Liability)

National and state governments will need to develop laws that allow cars to drive themselves on the streets. Existing laws concerning manufacturer defects are substantial enough for determining liability in an accident involving a car with some level of autonomy. However, a framework for determining liability on the transition of control from the vehicle to the driver of semi-automated technology would provide clarity including the application of current civil and criminal law. Amongst the potential implications of this are people who are otherwise not able/allowed to drive who could "get behind the wheel" of autonomous cars, and cars could technically be driven from one place to another with no occupants. If there is an accident involving an autonomous vehicle, whom would be liable for the consequences? The driver is still behind the wheel and therefore ultimately liable for the safety of the vehicle. Although even at this point it may be intensely debatable (McChristian and Corbett, 2016; KPMG, 2015; Shanker *et al*, 2013).

Social and Ethical Issues

Autonomous cars raise two kinds of ethical issues

(a) Can an autonomous car be programmed to respond to *every single conceivable scenario* on the road, including instances when it may be necessary to break or circumvent existing laws or rules to achieve a favourable outcome (breaking the speed limit on the way to the hospital (A&E), for example, or driving recklessly to get out of a dangerous situation)?

(b) While autonomous cars are likely to deliver significant socio-economic benefits, there is also a flipside in terms of many jobs being rendered obsolete.

Privacy and Data –Current data protection laws again are substantially sufficient to deal with personal locational data collected by vehicles. Consumers already have some experience of ‘opting in’ to data sharing on their smartphones. However, to unlock the societal benefits of data sharing it may be that some limited level of mandatory data sharing is desirable such as that being achieved through the EU’s e-call initiative expected to be implemented in 2018 (Shanker *et al*, 2013).

Technology—Practical hurdles to widespread adoption of autonomous vehicles may be great but to even get to that point, several technological challenges must be solved first. Most people believe that the path to fully autonomous vehicles contains many technological challenges. Vehicular Ad-Hoc Networks, (VANETs) are regarded as one of the most promising application scenarios for mobile ad-hoc networks (MANETs) (Schoch et al., 2006). Parno and Perrig predict that soon, most new vehicles will be equipped with short-range radios capable of communicating with other vehicles or with highway infrastructures at distances of at least one kilometre (Parno and Perrig, 2005). VANET could be defined as a communication network composed of vehicles (cars, buses, trucks and so on) and road side base stations. On-Board Units (OBUs) can talk to other OBUs and the road-side infrastructure formed by Road-Side Units (RSUs). The OBUs and RSUs, equipped with on-board sensory, processing and wireless communication modules, forming a self-organised network. VANET technology may be combined to AV technology to create connected autonomous vehicles (CAVs). The IEEE 802.11p is considered as the de facto standard that will support Intelligent Transportation Systems (ITS) applications in VANETs and CAVs. Nonetheless, this technology suffers from scalability issues, unbounded delays, and lack of deterministic quality of service (QoS) guarantees. A potential candidate for the job is the Long-Term Evolution (LTE) developed by 3GPP (3GPP, 2010). There are number of research studies which assess the feasibility of IEEE 802.11p and LTE standards to support vehicular networking applications (Araniti et al, 2013). The Internet of Things (IoT) refers to the connectivity of multiple devices through the internet. Autonomous cars utilise this connectivity when updating their algorithms based on user data. AVs require an enormous quantity of data collecting and processing. In this case, through IoT, AV shares information about the road (which has already been mapped out). This information includes the actual path, traffic, and how to navigate around any obstacles. With the IoT, and big data, data privacy and security will also be a concern.

Cost—Technology to build this type of vehicle may be very expensive. In early adoption stages, possibly only rich and famous people will be able to afford these vehicles but gradually, the cost of the components may be reduced later with concepts such as the Moore's Law, the price of the vehicle components may become cheaper making vehicles more affordable to the general public.

Cyber Security — The prospect of cars that can drive themselves inevitably raises cyber security concerns. Future AV and Connected Autonomous Vehicles (CAV) technologies will be part of the Internet of Things (IoT) and the Internet of Everything (IoE). What if an autonomous car can be hacked into and taken over? AVs face major cybersecurity risks if the communication networks, which are crucial for their safe operation, are not secure from hacking. Unauthorised access to these networks can have dire consequences such as undermining a vehicle's safety and utilising personal data for malicious intent (The Telegraph, 2017). AVs are especially vulnerable to cyber-attacks due to their ability to store highly sensitive data and transmit such data on external communication networks. These networks can be hacked in a multitude of ways for committing crimes or undermining the safety of the AV, which have tremendous impacts on road safety and social stability. AV could be used for criminal or terrorist purposes, such as delivering drugs, firearms or explosives such as a car bomb, kidnapping [or] driving into crowds of people. Insufficient cybersecurity of AVs can also expose a nation's critical infrastructure to cyber threats that can disrupt the delivery of critical services and have a detrimental impact on an entire society's wellbeing. As such, cybersecurity of AVs is crucial to the building of trust in the public and increasing the public's acceptance of AVs, which in turn can help increase its rate of adoption (Lim and Taeihagh, 2018).

Infrastructure—While autonomous cars' dependence on dedicated infrastructure is much lower than it was in the early prototype stages several years ago, some basic level of infrastructure including road markings and signage, GPS mapping, strong telecom networks and ideally some level of Vehicle-to-Grid (V2X) communication are still needed. Governments need to install key infrastructures such as Road Side Base Stations (RSUs) that could be traffic lights converted into intelligent road structures for smart cities and Car2X communications, involving V2V and V2I.

The transition from humans as drivers to humans as mere passengers in a car that drives itself is a major one. People generally have emotional connections with their vehicles. Therefore, are drivers willing to give up direct control over their vehicle and under what conditions? If automation of vehicles is not accepted by the users and users refrain from using the technology, the impact of automation on traffic flow efficiency, traffic safety and energy efficiency is mitigated. It is, however, not yet clear as to what extent users accept automation and what the determinants of consumer acceptance of automation are (Hoogendoorn, et al., 2013). Further, societal acceptance is pending with issues like safety, trust, security, privacy concerns, etc. Therefore, mass acceptance of this technology could take a long time. This could be the case particularly if there are accidents involving even semi-autonomous vehicles early in the adoption phase, whether it was the fault of the autonomous system or not. As a result, cyber security issues need to be carefully considered as a cars' computer or communication system between cars could potentially be compromised. There will also be ethical issues surrounding the privacy and use of data and testing, certification and licensing. Other challenges will include implementation of a legal framework and establishment of government regulations for self-driving cars. Reliance on autonomous drive will also produce less experienced drivers when manual control is needed. There will be a loss of driver-related jobs with reduced demand for parking services and for accident related services assuming increased vehicle safety. There is also going to be a reduction in jobs relating to car insurance and traffic police. However, because the transition to driverless cars is likely to be spread over many years, the loss of jobs is likely to be gradual and manageable.

2.3 Concept underlying user acceptance

When acceptance is talked of, what is meant in general terms as *"agreeing, accepting, approving, acknowledging; agreeing with someone or something"* (Fraedrich and Lenz, 2016). Information technology acceptance and use is an issue that has received the attraction of researchers and practitioners for several decades (Becker and Axhausen, 2017). They are interested in investigating the theories and models that shows the potential in predicting and explaining behaviour across many domains. Technology Acceptance Model is one of the most popular theories that is used widely to explain Information System usage. So many studies have been conducted which has led to the changes in the originally proposed model.

In their effort to explain system use, researchers first developed tools for measuring and analysing computer user satisfaction. As indicated by Bailey and Pearson (1983), it was natural to turn to the efforts of psychologists, who studied user satisfaction in a larger sense. For present purposes though, user acceptance is defined as the demonstrable willingness within a user group to employ information technology for the tasks it is designed to support. Thus, the concept is not being applied to situations in which users claim they will employ it without providing evidence of use, or to the use of a technology for purposes unintended by designers or procurers. Observably, there is a degree of fuzziness here since actual usage is always likely to deviate slightly from idealized planned usage. The essence of acceptance theory is that such deviations are not significant; that is, the process of user acceptance of any information technology for intended purposes can be modelled and predicted. In fact, users are often unwilling to use information systems which would result in impressive performance gains. Therefore, user acceptance has been viewed as the pivotal factor in determining the success or failure of any information system project. Several technology acceptance models have been developed in the past and they all follow the very same concept. Figure 2.1 below shows the basic concept underlying user acceptance models. They each have their own specific characteristics.

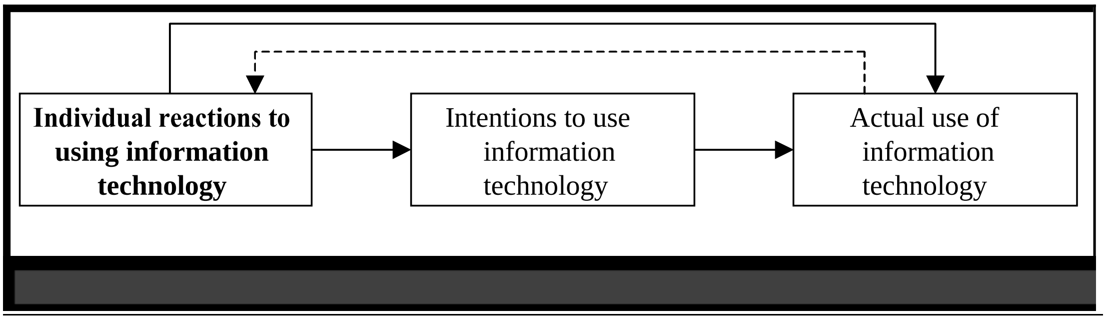


Figure 2.1Basic concept underlying user acceptance models (Venkatesh et al, 2003)

2.4 Acceptance models' historical timeline

The acceptance and use of Information System (IS) and Information Technology (IT) innovations has been a major concern for research and practice. Over the last several decades, a plethora of theoretical models have been proposed and used to examine IS/IT acceptance and usage (Dwivedi *et al.*, 2017). This section will review the historical development of acceptance models and theories used in predicting and understanding people acceptance behaviour. Thirteen key models will be discussed. Figure 2.2 illustrates the historical timeline. These acceptance models have been developed and evolved through rigorous validations and extensions over the years. The reason for covering the technology acceptance development (even though the focus of this research is the unified Theory of Acceptance and Use of Technology (UTAUT2)) is because of their interconnection and to give a clear idea about their development.

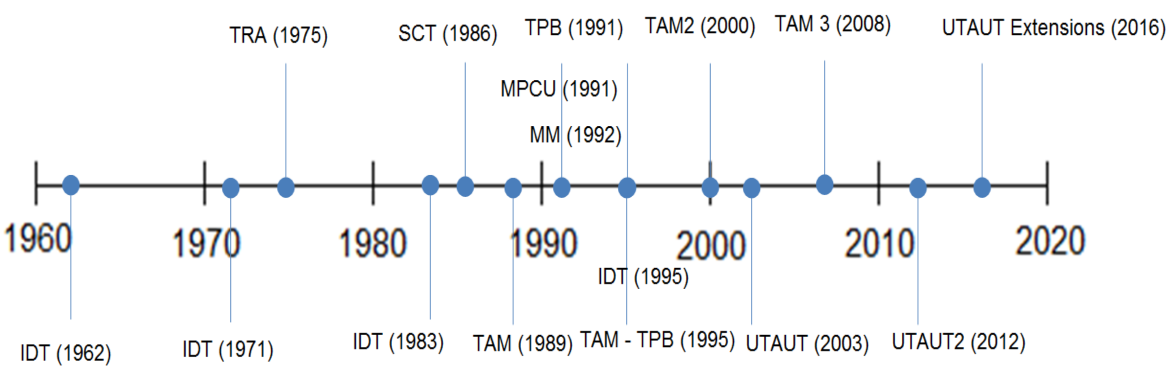


Figure 2.2 Acceptance Models historical timeline

2.4.1 Theory of Reasoned Action

The Theory of Reasoned Action (TRA) originates from learning theory and assumes that behaviour toward a particular object is approximated by an intention to perform that behaviour. The model was developed by Ajzen and Fishbein (1975) and later in 1980 as an improvement over Information Integration Theory (Fishbein, & Ajzen, 1975; Ajzen, & Fishbein, 1980; Davis, Bagozzi, & Warshaw, 1989). It integrated various studies on attitudes from social psychology with the aim of developing an integrated conceptual framework to predict and explain an individual's behaviour towards adoption in a general situational setting. The designers of this theory postulated that an individual's behavioural intention is the immediate determinant of behaviour, their attitude and their subjective norm are mediated through behavioural intention and their behavioural and normative beliefs are mediated through attitude and subjective norm. The TRA model can be seen as one of the earlier prediction models, but was not specifically aimed at the acceptance of technology, although it acted as a starting point for technology acceptance models (Davis, Bagozzi, & Warshaw, 1989). TRA was adopted in several studies and is a strong predictor of actual behaviour in different locations, but it has been criticised because it does not consider the individual's ability to control (Yusuf & Derus, 2013). Figure 2.3 below illustrates the Theory of Reasoned Action model.

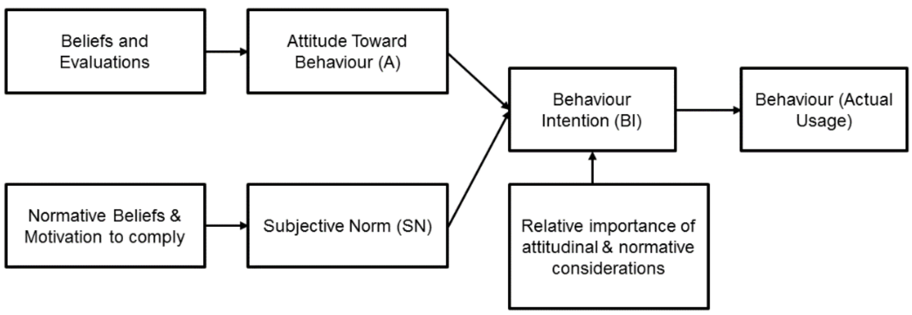


Figure 2.3 Theory of Reasoned Action (TRA) (Ajzen & Fishbein, 1980)

2.4.2 Social Cognitive Theory

The Social Cognitive Theory (SCT) was developed by Albert Bandura in 1986. It states that learning occurs in a social context with a dynamic and reciprocal interaction of personal factors, environmental factors and behaviours (Bandura, 1986). This theory is used in psychology, education and communication. It holds portions of an individual's knowledge acquisition that can be directly related to observing others within the context of social interactions, experiences and outside media influences. Furthermore, it posits that users acquire and maintain behaviour while considering the social environment in which they develop the behaviour. It gives prominence to the concept of self-efficacy (Compeau, Higgins & Huff, 1999). The theory theorises that when people observe a model performing behaviour and the consequences of that behaviour, they remember the sequence of events and use this information to guide subsequent behaviours. The social cognitive theory proposes that environmental factors, personal factors and behaviours are determined reciprocally (Bandura, 1989). The unique feature of SCT is the emphasis on social influence on external and internal social reinforcement. However, some limitations of SCT include the fact that the theory assumes changes in the environment which will automatically lead to changes in the person when this may not always be true. Furthermore, the theory heavily focuses on the processes of learning and in doing so disregards biological and hormonal predispositions that may influence behaviours, regardless of past experience and expectations. Figure 2.4 below illustrates the social cognitive theory.

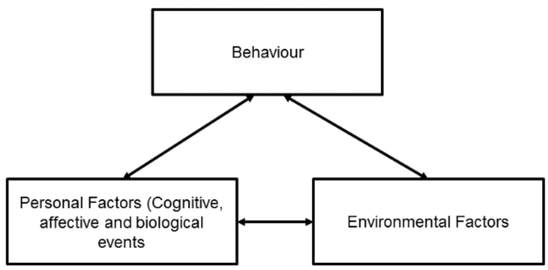


Figure 2.4 Social Cognitive Theory (SCT) (Bandura, 1986)

2.4.3 Technology Acceptance Model

Technology Acceptance Model (TAM) was introduced by Davis in 1989. TAM originated as an adaptation of the TRA and was developed more specifically later to predict and explain technology usage behaviour. TAM is specifically tailored for modelling user acceptance of information systems. The goal of TAM is to provide an explanation of the determinants of computer acceptance that is general as well as capable of explaining user behaviour across a broad range of end-user computing technologies and user populations (Davis, Bagozzi & Warshaw, 1989). Figure 2.5 below shows the Technology Acceptance Model.

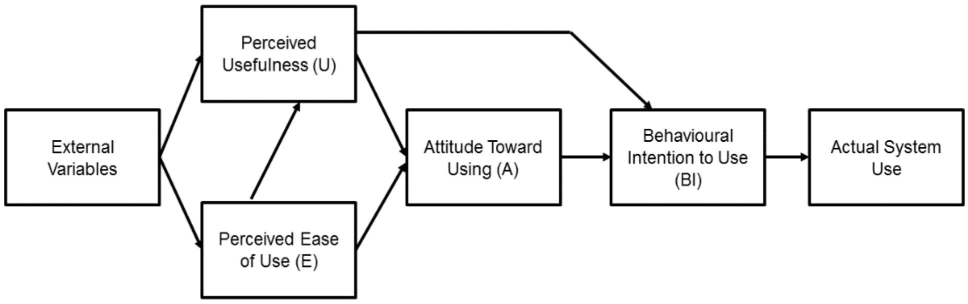


Figure 2.5 Technology Acceptance Model (TAM) (Davis, Bagozzi & Warshaw, 1989).

Two significant factors are perceived usefulness and perceived ease of use. Shroff stated that by manipulating these two determinants, system developers can have better control over users' beliefs about the system and so therefore can predict their behavioural intention and actual usage of the system (Shroff, Deneen, & Ng, 2011). In summary, TAM provided an explanation of the determinants of technology acceptance that enables an explanation of user behaviour across a wide scope of end-user information technologies and user populations (Davis, Bagozzi & Warshaw, 1989). In contrast with TRA, the TAM does not include subjective norms because of the weak psychometric results which are generated (Davis, Bagozzi & Warshaw, 1989; Wu et al, 2011). The TAM system can be seen as a theoretical foundation for a number of different technology acceptance models, which are following different streams of technology acceptance research. One of these streams leads to models that are slightly modified or extended models of the TAM with a number of added determinants to come to a more accurate prediction within a specific setting. Other streams of research are aimed to be more unified and thereby making use of some of the TAM determinants. Researchers of ICT have criticised this model for not including subjective norms, but in a critical review of the TAM, it was found that TAM is a useful theoretical model to understand and explain usage behaviour in IT implementation (Legris, Ingham & Collerette, 2003).

2.4.4 Theory of Planned Behaviour

The Theory of Planned Behaviour (TPB) is a theory that links beliefs and behaviour. The concept was introduced by Ajzen (1991) to improve on some of the limitations of the Theory of Reasoned Action (TRA) by including perceived behaviour. This theory examined the factors of attitude, subjective norms, perceived behavioural control and intentions on actual behaviour. Researchers have concluded that the TPB has a greater ability to predict behaviour than the TRA (Kok et al,1991; Liang, & Huang, 1998). Figure 2.6 below shows the theory of planned behaviour.

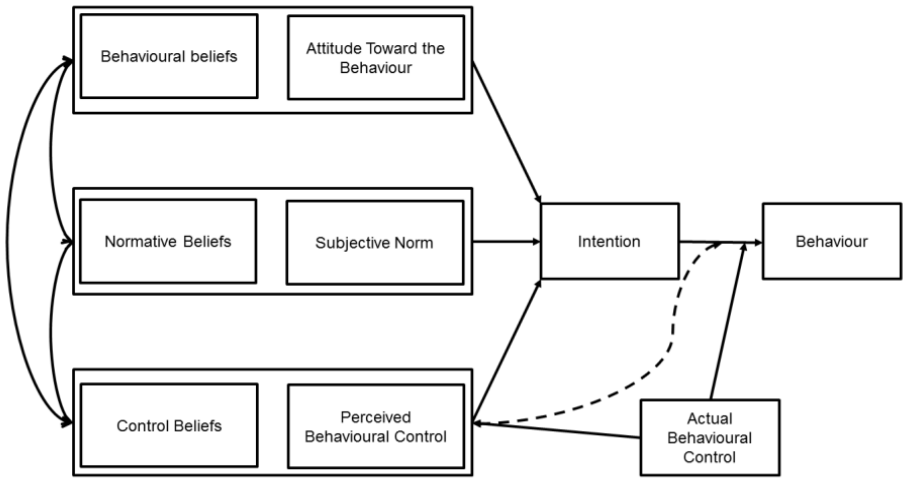


Figure 2.6 Theory of Planned Behaviour (TPB) Diagram (Ajzen, 2006)

Ajzen argued that some behaviour that is not under a person's volitional control might be problematic due to the differences in the individuals' abilities and in external forces. It is noticeable that when given a sufficient degree of actual control over their behaviour, people are expected to carry out their intentions when the opportunity arises. Examples of items that can be researched with the theory of planned behaviour are whether to wear a seat belt or whether to check oneself for disease. Many scholars have then concluded that the TPB has a greater ability to predict behaviour than the TRA (Kok et al,1991; Liang, & Huang, 1998).

2.4.5 Model of PC Utilization (MPCU)

Thompson, Higgin and Howell in 1991 established MPCU to explain problems of PC utilization. According to them, “behaviour is determined by what people would like to do (attitudes), what they think they should do (social norms), what they have usually done (habits), and by the expected consequences of their behaviour” (Thompson, Higgins, and Howell, 1991). This model resulted from Individual Behaviours Model by Triandis (1977). The Individual Behaviours Model determines one’s behaviours including attitudes, social norm, habits and the expected results of these behaviours. Attitudes cover cognitive, affective and behavioural components. In MPCU factors affecting PC utilisation include perceived consequences, effect, social factors and facilitating conditions. Perception results cover complexity, job fitness and long-term consequences. Thompson et al (1991) conducted empirical studies of knowledge of workers in the manufacturing industry (Thompson, Higgins, and Howell, 1991). The findings show only society, complexity, job fitness and long-term results have significant influence on PC utilization. Though MPCU relations were not proved to exist, scholars still had gained valuable studies based on the MPCU framework (see figure 2.7)

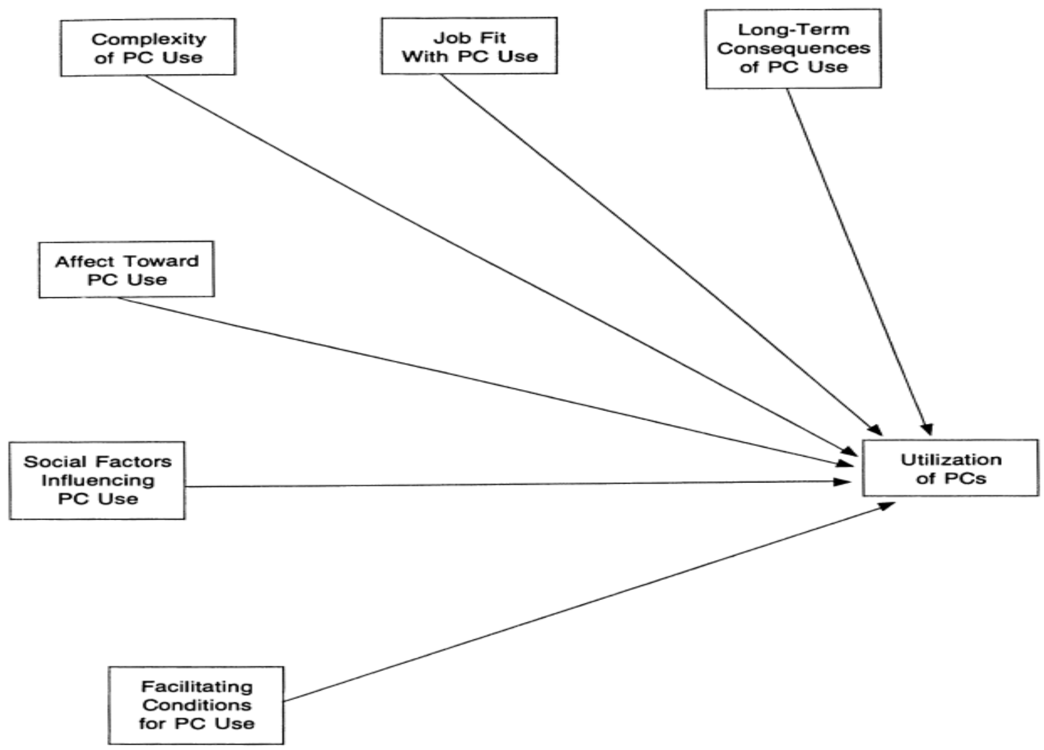


Figure 2.7 Model of PC Utilization (MPCU) (Thompson et al. 1991)

2.4.6 Motivation Model (MM)

Davis et al. in 1992 apply motivational theory to study information technology adoption and use (Davis, Bagozzi & Warshaw, 1992). The Motivation Model suggests that the individuals' behaviour is based on extrinsic and intrinsic motivations. Extrinsic motivation is defined as the perception that users want to perform an activity "because it is perceived to be instrumental in achieving valued outcomes that are distinctive from the activity itself, such as improved job performance, pay or promotions" (Davis, Bagozzi & Warshaw, 1992). Perceived usefulness, perceived ease of use and subjective norm are examples of extrinsic motivation. In this model, computer playfulness and enjoyment are determinants of intrinsic motivation (Davis, Bagozzi & Warshaw, 1992; Venkatesh, 2000) and perceived usefulness, perceived ease of use and subjective norm are determinants of extrinsic motivation. This model is based on the psychological aspects of technology acceptance and has supported the general motivation theory as an explanation for behaviour.

2.4.7 Innovative Diffusion Theory (IDT)

Innovations Diffusion Theory (IDT) has been used since the 1950s to describe the innovation-decision process. It has gradually evolved until the best well-known innovation-decision process was introduced by Rogers (Rogers, 1962; Rogers, 1983; Rogers, 1995; Rogers & Shoemaker, 1971). IDT studies the how, why and the rate new ideas and technology spread through cultures. Not just in information technology exclusively, this theory applies to other diffusion processes throughout society such as the acceptance of new technological products, food, music style, dressing style, ideals, political candidates or services. Research on the diffusion of innovation has been widely applied in disciplines such as education, sociology, communication, agriculture, marketing, and information technology, etc (Rogers, 1995; Karahanna & Straub, 1999; Agarwal, Sambamurthy & Stair, 2000). Theoretically, the diffusion of an innovation perspective does not have any explicit relation with the TAM, but both share some key constructs. It was found that the relative advantage construct in IDT is similar to the notion of the PU in TAM, and the complexity construct in IDT captures the PEU in the technology acceptance model, although the sign is the opposite

(Moore & Benbasat, 1991). Figure 2.8 shows a model of stages in the Innovation-Decision Process.

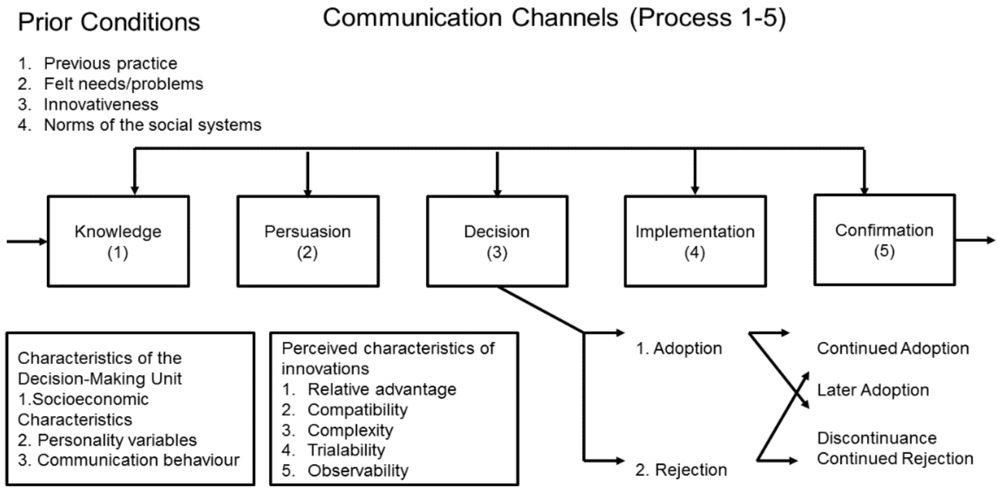


Figure 2.8 A model of stages in the Innovation-Decision Process (Rogers, 1995)

2.4.8 Decomposed Theory of Planned Behaviour (DTPB)

The Decomposed TPB (DTPB) also known as Combined TAM-TPB was introduced by Taylor and Todd in 1995 by linking the predictors of TPB with the constructs of perceived usefulness and ease of use from TAM (Surendran, 2012; Taylor, S & Todd, 1995a). This model more completely explores the dimensions of attitude belief, subjective norm (i.e., social influence) and perceived behavioural control by decomposing them into specific belief dimensions (Taylor, S & Todd, 1995b). The DTPB suggests that behavioural intention is the primary direct determinant of behaviour. Attitude is decomposed to be affected by perceived usefulness (relative advantage), perceived ease of use (complexity) and compatibility. The normative belief structure is affected by peer influence and superior influence. The control belief structure is affected by self-efficacy and facilitating conditions. Therefore, it seemed to have more capability in explaining usage behaviour although it is a less parsimonious model when compared to TPB. Figure 2.9 below illustrates the decomposed theory of planned behaviour:

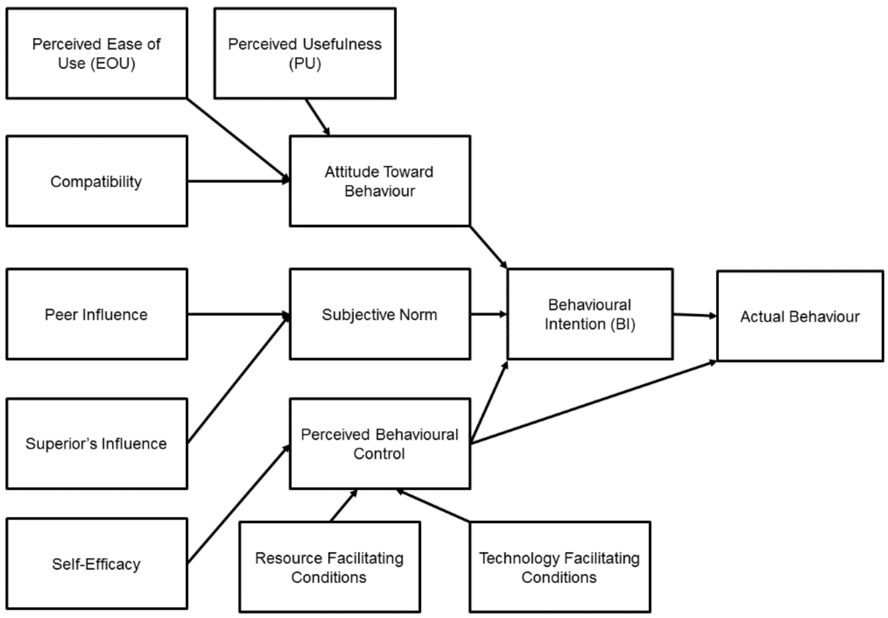


Figure 2.9 Decomposed Theory of Planned Behaviour (DTPB)

2.4.9 Technology Acceptance Model 2 (TAM2)

TAM2 was developed in 2000 by Venkatesh and Davis and it is a theoretical extension of Technology Acceptance Model (TAM) to: (1) include additional key determinants of TAM that explain perceived usefulness and usage intentions in terms of social influence and cognitive instrumental processes and (2) to understand how the effects of these determinants change with an increasing user experience of the target system over time. TAM2 keeps the concept of perceived ease of use from the original TAM as a direct determinant of perceived usefulness. All of these additional elements are believed to influence the acceptance of technology (See figure 2.10).

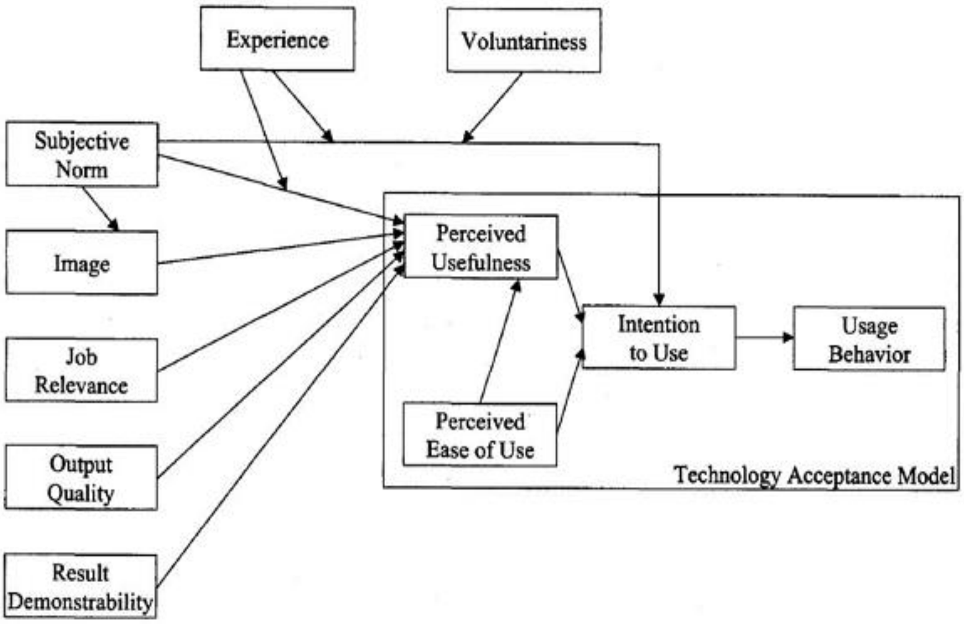


Figure 2.10 TAM2 – Extension of TAM (Venkatesh & Davis, 2000)

2.4.10 Unified Theory of Acceptance and Use of Technology (UTAUT)

Venkatesh et al in 2003 introduced The Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh, 2003). UTAUT resulted from the integration of eight existing technology acceptance models and theories (TRA, TAM, the motivational model, TPB, combined TAM-TPB, the model of PC utilization, innovation diffusion theory and social cognitive theory); with four core determinants of intention and usage, and up to four moderators of key relationships (performance expectancy, effort expectancy, social influence and facilitating conditions). The technology acceptance research literature has given very little attention to age as a moderating factor, but the findings from the study of UTAUT indicate that it moderates all of the key relationships in the model. In addition, gender which has received some attention is also a key moderating influence, which is consistent with the findings in sociology and social psychology literature (Levy, 1988; Dwivedi *et al*, 2017). The UTAUT has been criticised because of the high number of independent variables used to predict intentions and behaviour towards the usage of technology. Nevertheless, it is considered to more vigorous than other previous models used to evaluate and predict technology acceptance (See Figure 2.11).

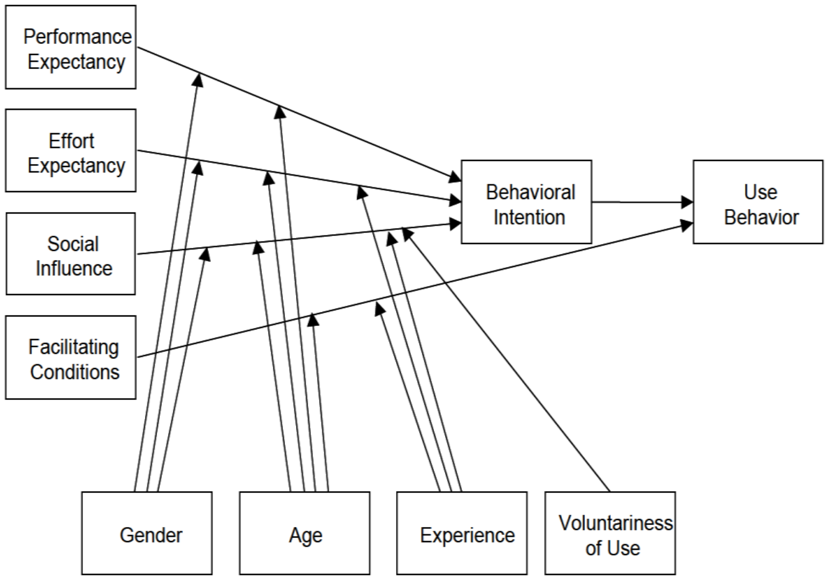


Figure 2.11 Unified Theory of Acceptance and Use of Technology UTAUT (Venkatesh, 2003)

2.4.11 Technology Acceptance Model 3 (TAM3)

TAM 3 was introduced by Venkatesh and Bala (2008). This model was developed by combining TAM2 (Venkatesh & Davis, 2000) and the model of the determinants of perceived ease of use (Venkatesh, 2000). TAM3, shown in Figure 11 presents a complete nomological network of the determinants of individuals' IT adoption and use. According to this model, the perceived ease of use is determined by computer self-efficacy, computer playfulness, computer anxiety, the perception of external control, perceived enjoyment and objective usability. The perceived usefulness is determined by subjective norms, job relevance, result demonstrability and image. However, one of the criticisms of the model is that there are too many variables and too many relationships between the variables (see figure 2.12).

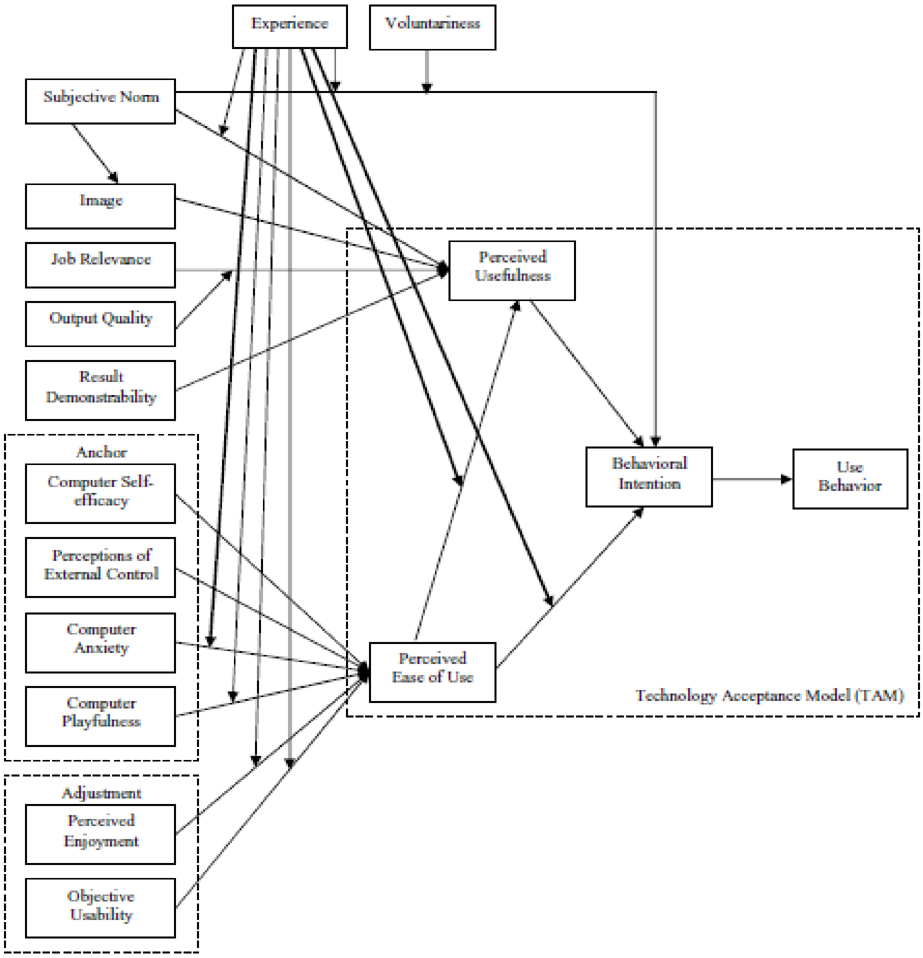


Figure 2.12 Technology Acceptance Model 3 (TAM3) (Venkatesh and Bala, 2008)

2.4.12 Unified Theory of Acceptance and Use of Technology 2 (UTAUT2)

The UTAUT2 was developed by Venkatesh et al. (2012) to extend the existing UTAUT model to other contexts such as the context of customer technologies (Venkatesh,Thong, & Xu, 2012). This model is an updated version of the UTAUT which was originally introduced to explain employee technology acceptance and use (Venkatesh,Thong, & Xu, 2012). Due to its main focus on employees and organisations, its unified purpose is arguable. Since the numbers of technology devices and applications have an enormous value (Stofega and Llamas, 2009), the UTAUT model was extended with three additional determinants that are more customer oriented. The first of these determinants is the Hedonic Motivation, which can be seen as the extent to which a user experiences enjoyment from using a system. The second added determinant is Price Value. This is based on the idea that when consumers are responsible for costs, these costs can determine whether or not consumers will adopt the system (Brown and Venkatesh, 2005; Coulter, Keith and Robin, 2007). Finally, the Behavioural Intention, in which the UTAUT2 model is classified as 'Habit', is the last determinant. It has been shown in different research that Habit has a direct effect on technology use. Similarly, to the original UTAUT model, age, gender and experience are taken into account, whilst the Voluntariness of Use has been removed. Instead a line between Facilitating Conditions and Behavioural Intention was drawn, which is influenced by age, gender and experience. As the model Figure 2.13 shows, Hedonic Motivation is also moderated by age, gender and experience, whilst the effect of Price Value is moderated by age and gender. Habit has both effects on Behavioural Intention and Use Behaviour, and is therefore affected by age, gender and experience. Venkatesh et al It expands the overall framework with regard to technology use; however, voluntariness has been ignored.

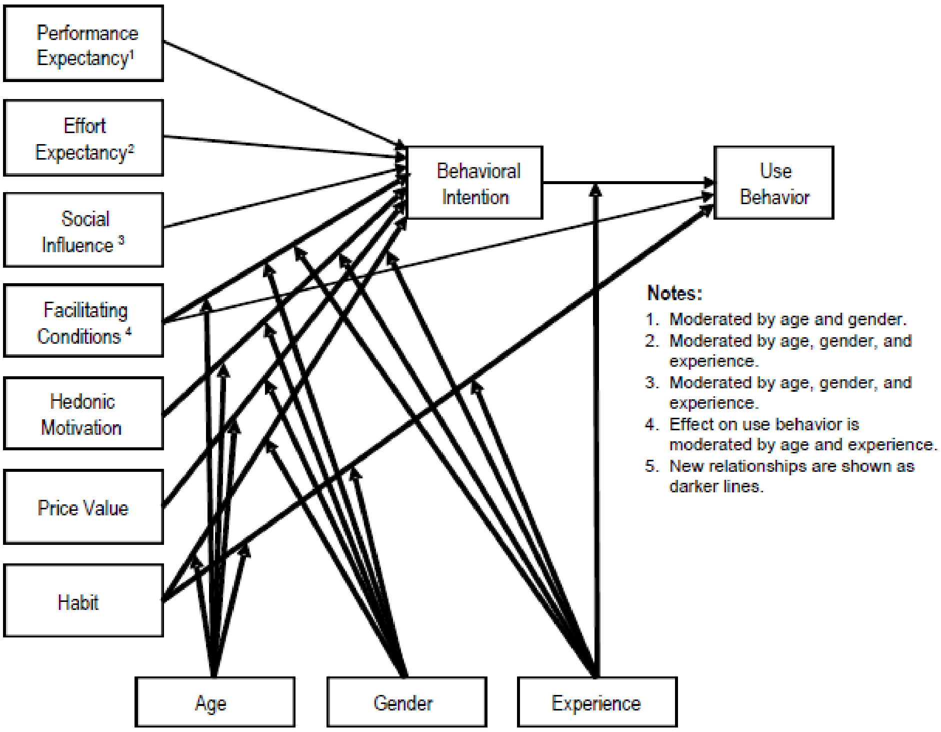


Figure 2.13 Unified Theory of Acceptance and Use of Technology 2 (UTAUT2) (Venkatesh, Thong, & Xu, 2012)

2.4.13 UTAUT Extensions

There have been several UTAUT extensions in the past few years which can be classified in four main types: exogenous mechanisms, new endogenous mechanisms, new moderating mechanisms and new outcome mechanisms. Figure 2.14 illustrates the four types of UTAUT extensions at a more abstract level and Table 1 below summarises the four types of UTAUT extension studies.

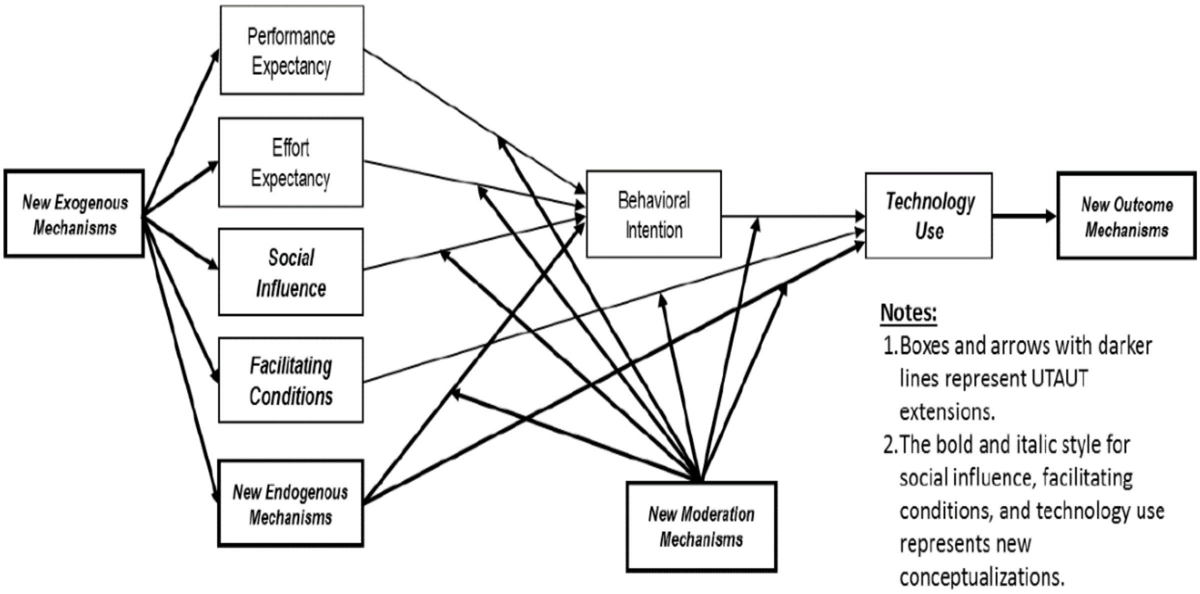


Figure 2.14 Types of UTAUT Extensions (Venkatesh, Thong & Xu, 2016)

2.5 User acceptance of information technology: A comparative study of technology acceptance models and theories

Issues related to technology, including diffusion, acceptance, adoption, and adaptation, have been the focus of research for different disciplines including Information Systems (IS), System Dynamics, Psychology, and Management Science. Table 2.1 represents a comparative study of technology acceptance models and theories developed since the 1960s.

Table 2.1 A comparative study of technology acceptance models and theories

Models & Theories	Characteristics	Core Constructs	Reference & Applications
Theory of Reasoned Action (TRA) (1975)	• Introduced by Ajzen and Fishbein in 1975 • Drawn from social psychology • One of the most fundamental and influential theories of human behaviour. • Links the perception, norms and attitudes to the intentions of a person in making a decision and from there predicts the person behaviour. • The starting point of TAM • Does not consider the individual's ability to control.	• Attitude toward behaviour • Subjective Norm	Fishbein and Ajzen 1975
Social Cognitive Theory (SCT) (1986)	• Developed by Albert Bandura • Proposes that environmental factors, personal factors and behaviours are determined reciprocally • Learning occurs in a social context with a dynamic and reciprocal interaction of personal factors, environmental factors, and behaviours	• Outcome Expectations Performance • Outcome Expectations Personal • Self-efficacy • Affect • Anxiety	Compeau and Higgins, 1995b
Technology Acceptance Model (TAM) (1986, 1989)	• Developed by Fred Davis in his doctoral study • TAM originated as an adaptation of the more generalised TRA and was developed more specifically later to predict and explain technology usage behaviour • TAM has been used to study the adoption of different technologies and it has become the most significant theory in this field • TAM is tailored to IS contexts and was designed to predict information technology acceptance and usage on the job. • In contrast with TRA, the TAM does not include subjective norms because of the weak psychometric	• Perceived Usefulness • Perceived Ease of Use • Subjective Norm	• The case of cellular telephone adoption (Kwon and Chidambaram, 2000) • Behavioural intention to use e-books (Wen-Chia Tsai, 2012)

	results which are generated • Researchers of ICT have criticised this • model for not including subjective norms,		
Theory of Planned Behaviour (TPB) (1991)	• Developed by Ajzen in 1991 as an extension of TRA, with the additional determinant of intention perceived behaviour control. • TPB has a greater ability to predict behaviour than TRA	• Attitude toward behaviour • Subjective Norm • Perceived behavioural control	• Ajzen 1991 • Taylor and Todd, 1995b
Model of PC Utilization (MPCU) (1991)	• Thompson, Higgins & Howell (1991) predicted PC utilisation behaviour model • Derived largely from Triandis' (1977) theory of human behaviour, this model presents a competing perspective to that proposed by TRA and TPB. • However, the nature of the model makes it particularly suited to redict individual acceptance and use of a range of information technologies. It predicts usage behaviour rather than intention	• Job-fit • Complexity • Long-term consequences • Affect towards use • Social factors • Facilitating conditions	Thompson et al. 1991, p. 129
Motivation Model (MM) (1992)	• This model is based on the psychological aspects of technology acceptance	• Extrinsic Motivation • Intrinsic Motivation	Applied by Davis, Bagozzi, & Warshaw to study ICT adoption and use (1992).
Innovative Diffusion Theory (IDT) (1962, 1971, 1983, 1995)	• Developed by Rogers in 1995. • Grounded in sociology and has been used since the 1960s to study a variety of innovations, ranging from agricultural tools to organisational innovation • Appropriate in both an individual or organizational context. • Is one of the most well-known theories associated with the adoption of new technology	• Relative advantage • Ease of use • Image • Visibility • Compatibility • Results demonstrability • Voluntariness of use	Moore and Benbasat, 1991, p. 195
Decomposed Theory of Planned Behavior (DTPB) or	• Developed by Taylor and Todd in 1995.	• Attitude toward behaviour • Subjective Norm	Taylor and Todd, 1995a

Combined TAM – TPB (1995)		• Perceived Behavioural Control • Perceived Usefulness	
Extension of TAM (TAM2) (2000)	• Developed by Venkatesh & Davis in 2000 by adding two more determinants to the original TAM (social influences and cognitive instrumental processes)	• Voluntariness • Experience • Subjective norm • Image • Job relevance • Output Quality • Result Demonstrability	Venkatesk and Davis, 2000
Unified Theory of Acceptance and Use of Technology (UTAUT) (2003)	• Developed by Venkatesh, Morris, Davis, G., & Davis, F. in 2003. • Integrates the components of eight technology acceptance models and theories: TRA, TAM, the motivational model, TPB, combined TAM-TPB, the model of PC utilization, innovation diffusion theory, and social cognitive theory. • It is considered to be more robust than other technology acceptance models in evaluating and predicting technology acceptance • This theory has been criticised for having too many independent variables for predicting intentions and behaviour	• Performance expectancy • Effort Expectancy • Social Influence • Facilitating conditions	Venkatesh, Morris, Davis, G., & Davis, F 2003
Technology Acceptance Model (TAM3) (2008)	• Developed by Ventakesh & Bala in 2008 • One of the criticisms of the model is that there are too many variables and too many relationships between the variables.	• Subjective Norm • Image • Job relevance • Output quality • Result demonstrability • Computer self-efficacy • Perceptions of external control	Ventakesh and Bala , 2008

		• Computer Anxiety • Computer Playfulness • Perceived Enjoyment • Objective usability	
Extending Unified Theory of Acceptance and Use of Technology (UTAUT2) (2012)	• Developed by Venkatesh , Thong, & Xu, in 2012 to pay particular attention to the consumer use context.	• Performance Expectancy • Effort Expectancy • Social Influence • Facilitating conditions • Hedonic Motivation • Price Value • Habit	Venkatesh , Thong, and Xu, 2012

Table 2.2 A mapping of previous constructs used in technology acceptance models and theories

Models & Theories	**Constructs**								
	PE	**EE**	**SI**	**HM**	**PV**	**FC**	**H**	**BI**	**UB**
TRA (1975)								*	*
SCT (1986)									
TAM (1989)								*	*
TPB (1991)								*	*
MPCU (1991)			*			*			
MM (1992)									
IDT (1962, 1971,									
DTPB (1995)	*	*	*	*		*		*	*
TAM 2 (2000)	*	*	*					*	*
UTAUT (2003)	*	*	*			*		*	*
TAM 3 (2008)	*	*	*	*				*	*
UTAUT2 (2012)	*	*	*	*	*	*	*	*	*

Table 2.2 is a map identifying some of the most important constructs used in the past and their relevance in today's models and theories. This table clearly illustrate that the cultural influences although identified in the literature as an important factor, has never been included in any of the previous models nor tested.

2.6 The Car Technology Acceptance Model (CTAM)

In 2012, Osswald, Wurhofer and Trösterer introduced the Car Technology Acceptance Model (CTAM). They theorize that along with the two determinants "perceived safety" and "anxiety", six further direct determinants from the UTAUT play a role within the car context: Performance Expectancy (PE), Effort Expectancy (EE), Social Influence (SI), Facilitating Conditions (FC), Self-Efficacy (SE). Figure 2.15 shows an overview of the CTAM model. The grey items represent the remaining determinants from the original UTAUT model described above

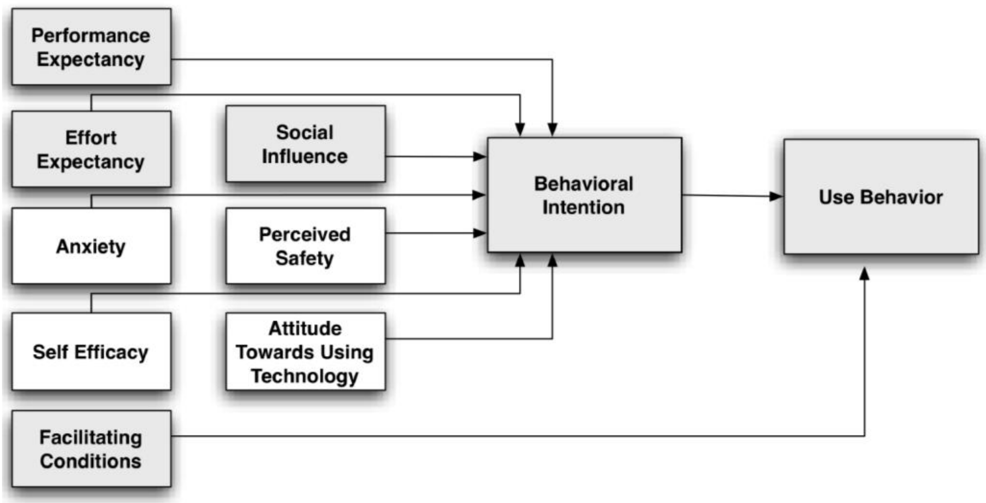


Figure 2.15 The Car Technology Acceptance Model (CTAM)

2.7 The Gap in the literature and the need for extending the Unified Theory of Acceptance and Use of Technology (UTAUT/UTAUT2) Model for Autonomous Vehicles context.

Information systems research has long since studied how and why individuals adopt new information technologies. Within this wide area of investigation there have been a number of streams of research (Dwivedi *et al*, 2016; Venkatesh, Morris, Davis, & Davis, 2003). One stream of research focuses on individual acceptance of technology by using intention or usage as a dependent variable (Compeau & Higgins, 1995a; Davis, Bagozzi, & Warshaw, 1989) whereas other streams have looked at satisfaction or net benefits to measure the success of an IS using IS success models (DeLone & McLean, 1992; 2003) and IS implementation success at the enterprise level (Leonard-Barton & Deschamps, 1988) or task-technology fit (Goodhue, 1995; Goodhue & Thompson, 1995).

Whilst each of these streams makes a significant contribution to the literature on a user acceptance level of IT, the theoretical models to be included in the current review, comparison, and synthesis employ intention and/or usage as the key dependent variable (Venkatesh et al., 2003). UTAUT is a model that has been used for several years in information systems. This model helps understand the drivers of acceptance of new information technologies by its users. Autonomous Vehicles are inevitable as technology advances. Consequently, investigating the main factors influencing their adoption becomes increasingly important.

Numerous researches revealed an underlying trend of general mistrust towards the AV connecting through all key categories: safety, legislation, cost, trust and anxiety (Dwivedi, 2017; Niculescu, Dix and Yeo, 2017; Morgan Stanley, 2013; ERTRAC, 2015; Becker and Axhausen, 2017) Such mistrust is natural since the technology is new and people have never experienced it before. Alternatively, mistrust can be a real handicap in bringing AVs to commercial success (Niculescu, Dix and Yeo, 2017). Several models, theories and conceptual models have been introduced in the past, but none of the models have included and tested important factors such as legal regulation, price value, hedonic motivation with regards to AV.

2.8 Summary

UTAUT/UTAUT2 has been widely used in information and communication technology research to help understand as well as explain user behaviours. TAM and UTAUT has succeeded in providing a robust model which is applicable across a broad range of end-user computing technologies. But, the study identified a significant body of literature that reports inconsistent results with these models and the lack of consideration of the security and legal requirement in acceptance of new technology makes these models incomplete. This chapter has also identified some barriers to the adoption of the autonomous vehicle. The study has summarised existing technology acceptance models and theories. The assumptions underlying these technology acceptance models and theories including factors relevant to each model were made explicit. The study has attempted to review the origins and the evolution of TAM from 1960 to 2016 and has established the need to extend the Unified theory of acceptance and use of technology. In the next chapter, the research methodology and the philosophy underlying the researcher ontological and epistemological position will be discussed.

Chapter 3 Research Methodology

3.1 Introduction

The previous chapter discussed relevant models and theories proposed in the past to measure technology acceptance. This chapter aims to provide an overview of the research approaches utilised in this study, which leads to selection of an appropriate research methods for guiding the validation of the conceptual model. The philosophical foundation utilised for guidance is pragmatism informed by a mixed method design. Additionally, the chapter provides justification of the use of interviews and questionnaires as appropriate data collection methods. This study was divided in three phases. During the first phase, data collection technique utilised to gather the data was the questionnaire, followed by series of interviews. The second phase was utilised to test and validate the conceptual model, and the final phase was the development of an information visualisation tool to further explain participants' responses to AV future adoption. Reasons for the aforementioned selection of the philosophical underpinning, type of research approach and data collection method are explained and justified within this chapter. It also outlines the pilot study, explains the sampling methods, describing the procedures of data analysis and ethical consideration, of the study.

This chapter is structured as follows. Initially, Section 3.2 provides an overview of the underlying research philosophy, exploring the researcher ontological and epistemological position and then provides justifications for the preferred stance. This is followed by an overview discussion of the selected mixed method approach in section 3.3, discussion of phase 1 of the investigation in 3.4, Phase 2 of the study in 3.6, the data analysis techniques selected in 3.5, ethical considerations in 3.8 and the chapter summary in 3.9.

3.2 Underlying Research Philosophy

The research philosophy a study adopts contains important assumptions about the way in which the researcher views the world. These assumptions will underpin the research strategy and the methods chosen as part of that strategy. As Johnson and Clark (2006) note, as Information System researchers we need to be aware of the philosophical commitments we make through our choice of research strategy since this has significant impact not only on what we do but what we understand what it is we are investigating.

There are two basic methodological paradigms in Social Science that influence the way research is conducted: positivism and interpretivism (Brotherton, 2008). Saunders et al. (2009) added realism and pragmatism. Positivism, which adopts a clear quantitative method of analysis to investigate phenomena, is dependent on the natural scientific approach to dealing with the truth. In contrast interpretivism is concerned with understanding the subjectivity of social phenomena and aims to demonstrate and investigate in-depth phenomena from a qualitative perspective (Noor, 2008; Gale and Beeftink, 2005). As Marshall (1996) stated, the choice of quantitative or qualitative research method should not be determined by the researcher's preferences but by their research questions.

The present study follows the pragmatism philosophy. Felizer (2010) argued that this approach has appeared as a response to the endless and unproductive debate between positivism / post-positivism and constructivism / interpretivism. Considered to be an alternative paradigm, pragmatism bypasses the debate on truth and reality, and is based on the assumption that multiple realities can be investigated empirically, with the focus more on solving practical problems in the ‘‘real world’’ (Felizer, 2010). Creswell et al. (2007) posted that pragmatism frees the researcher from the limitations of the chosen research paradigm. Felizer (2010) stated, it (pragmatism) does not believe to discover unvarying causal associations or truths but aims to investigate a particular question, a theory, or a phenomenon with the most suitable research method.

It is unavoidable that the debate on ontology and epistemology which follows has a competitive ring. The debate is often framed in terms of a choice between either the positivist or the interpretivist research philosophy. Pragmatism argues that the most important determinant of the epistemology and ontology a researcher adopts is the research question. One may be more appropriate than the other for answering particular questions. Moreover, if the research question does not suggest unambiguously that either a positivist or interpretivist philosophy is adopted, this confirms the pragmatist's view that it is perfectly possible to work with variations in the researcher's epistemology and ontology. Ontology is concerned with nature of reality. This raises questions of the assumptions researchers have about the way the world operates and the commitment that is held to particular views. In this study, the researchers view of the nature of reality or being could be described as external, multiple; a view chosen to best enable answering of research questions. He believes in multiple truths (Lynch, 2009; Pedersen & Wright, 2013).

According to Mayers (1997), epistemology refers to the assumptions about knowledge and how it can be obtained. It is also referred to as the researcher's view regarding what constitutes acceptable knowledge. In this study, the researcher believes that either or both observable phenomena and subjective meanings can provide acceptable knowledge dependent upon the research question. Focus on practical applied research, integrating different perspectives to help interpret the data.

3.3 Mixed-Methods Research

As mentioned above, this study uses mixed methods, based on the pragmatism paradigm and combines both inductive and deductive approaches. The inductive approach is used first to develop the conceptual model. Questionnaire and interviews instruments are used to collect the publics opinions about the introduction of AVs, ideas and understanding of the security and privacy issues; and the key factors that negatively or positively influence people acceptance of AVs as a disruptive technology. Then the deductive approach is used to test and validate the proposed model of the study and the statistical findings generated from the quantitative stage are used to support the generalisation of the study's results.

The researcher chose the mixed-methods approach as it works as a bridge between paradigms and offers a greater diversity of methods to the researcher to deal with complex problems (Giddings, 2006). Furthermore, the integration of qualitative and quantitative findings could provide this study with more support and more certainty, leading to greater confidence in the outcomes. Mixing methods can potentially benefit from the strengths of both quantitative and qualitative approaches (Ostlund et al., 2009). Jick (1979) asserted that, to overcome the complexity of social phenomena, it is important that mixed methods be employed to maximize our understanding of the human experience.

According to Macionis (2007, cited in Creswell, 2009), the three most commonly used research frameworks in the social sciences are (1) quantitative research conducted in the positivist tradition and primarily concerned with numerical data analyses, (2) qualitative research conducted in the constructivist tradition and primarily interested in the analysis of narrative data, and (3) mixed-methods research that works within other paradigms and is concerned with both types of data.

Bazeley (2004: 2) argued that "the qualitative and quantitative approaches are defined on the basis of the type of data used (textual or numeric; structured or unstructured), the logic employed (inductive or deductive), the type of investigation (exploratory or confirmatory), the method of analysis (interpretive or statistical), the approach to explanation (variance theory or process theory), and, for some, on the basis of the presumed underlying paradigm (positivist or interpretivist/critical; rationalist or naturalist)". According to Noor (2008), the adoption of a suitable research method should be based on the nature of the research problem.

According to Tashakkori and Teddlie (2010), by merging the characteristics of the quantitative and qualitative traditions, mixed-methods research provides answers to questions that cannot be answered with a single method. Bazeley (2004) provided the following reason for adopting mixed-methods research: "When evidence from different sources is conflicting, one has to determine how to weigh the different components—or, preferably, seek reasons for the discrepancy. Ultimately, mixed methods analysis is a process of piecing together bits of a puzzle to find answers to questions". Sandelowski (2002) clarified that mixed-methods research is not in itself a mixture of paradigms of investigation, but rather the paradigms are reflected in the techniques that the researchers decide to integrate, and how and why they integrate them.

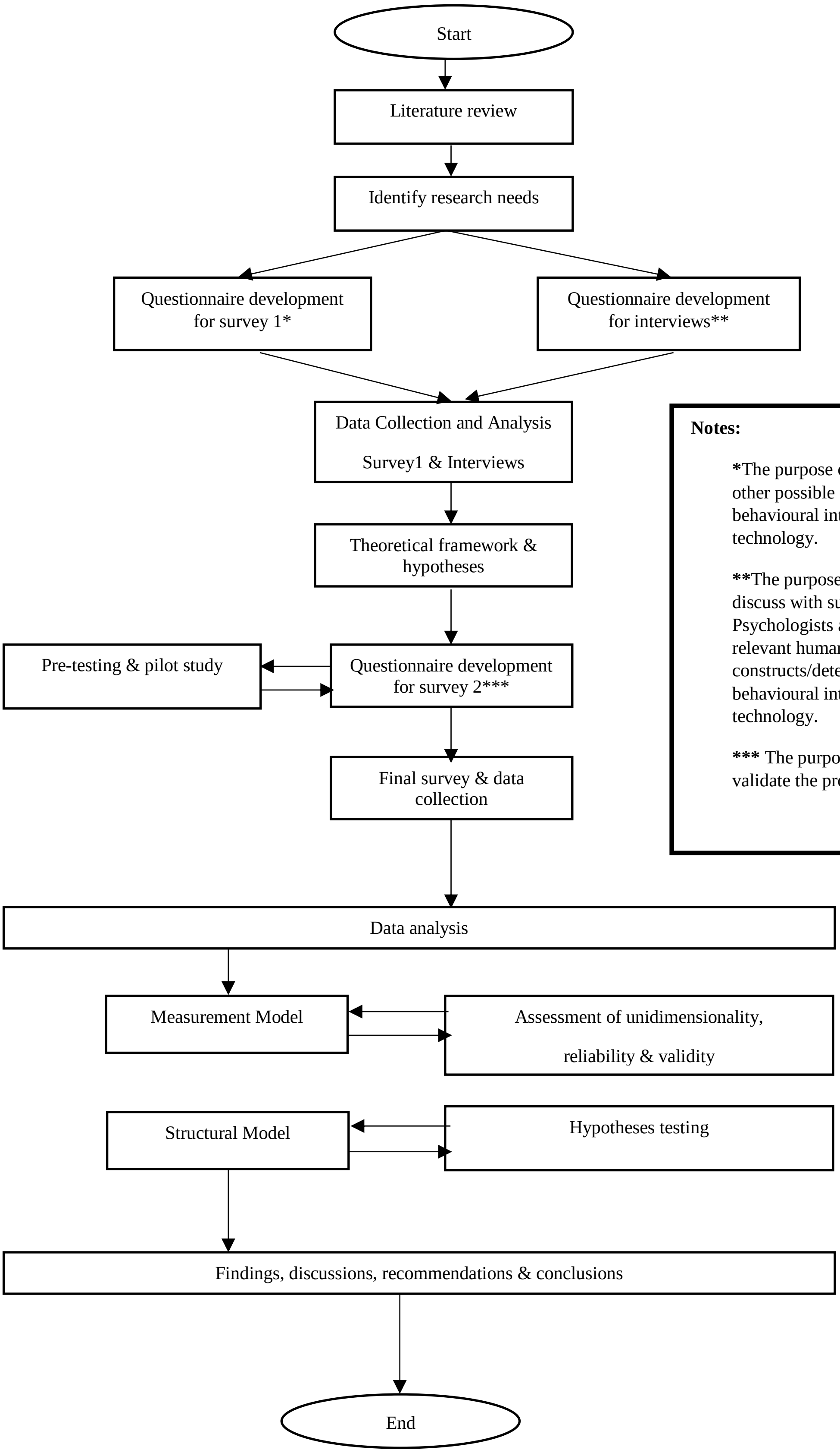
As a way of supporting the arguments that have been introduced above, there are other reasons why mixed methods research has been chosen for this study. Firstly, using mixed methods can generate a better understanding in validating the proposed model of the study (Greene, 2007). Secondly, the research deals with both the human and the abstract factors that influence consumer behavioural intention to accept AV, and so mixed methods are used in order to adequately address both areas. In looking at the human factors involved, in other to better understand consumer behaviour, qualitative methods are the more appropriate, while the abstract factors and the relationship between factors are better approached using quantitative methods. Therefore, the integration of quantitative and qualitative data in the form of a mixed methods approach has great potential to strengthen the rigour of the study and to enrich the analysis and findings of the research (Wisdom & Creswell, 2013). Johnson and Onwuegbuzie (2004) argued that mixed-methods research is an attempt to justify the rationale behind employing several approaches to answer research questions, rather than limiting or restricting researchers' choices (i.e., it rejects dogmatism).

Meanwhile, according to Creswell and Zhang (2009), mixed-methods research does have an important role to play in theory generation and development, case study research, the explanation of findings, cases of convergent evidence, and the explanation of outliers. Hesse-Biber (2010) determined five reasons (see Table 3.1) why investigators should consider using mixed methods (i.e., triangulation, complementarity, development, initiation and expansion). According to Macionis (2007), triangulation and complementarity support the tenet that mixed-methods research can provide outcomes that confirm or complement each other. Development, initiation and expansion, meanwhile, relate to the sequential use of mixed methods, where the results of one stage can lead to the design of the next.

Table 3.1 Rationales for using a mixed-methods research design

Source: Adapted from Hesse-Biber (2010), Macionis (2007).

Purpose	**Justification**
Triangulation	Reviewing and analysing evidence from different methods such that a study's findings are dependent on the convergence, verification and correspondence of that information.
Complementarity	Seeks interpretation, enhancement, clarification and explanation of the research findings from a single method, using the findings of the other method.
Development	Seeks to employ the findings from one method to develop and inform the other method, where the development incorporates sampling and measurement decisions.
Initiation	Seeks the detection of paradoxes and contradictions, new perspectives of frameworks, or the recasting of questions or findings from one method based on the questions or findings from other methods.
Expansion	Mixed-methods research adds scope and breadth to a study through the use of different methods for different components of the inquiry.



Notes:

***The purpose of survey 1 is to identify other possible constructs influencing behavioural intention of acceptance of technology.

****The purpose of the interview is to discuss with subject experts (Sociologists Psychologists and computer Scientists) relevant human and non-human constructs/determinants influencing behavioural intention of acceptance of technology.

***** The purpose of survey 2 is to test and validate the proposed model.

Figure 3.1 Research design of the study

Figure 3.1 shows a visual representation of the research design, illustrating the sequence of various techniques throughout the conceptual model development and the process of testing and validating the model.

3.4 Methods

Research methods are the tools used to gather the data (Dawson, 2006; Oppenheim, 1992). The choice of methods depends on the purpose of the research, the research questions, the resources available and the skills of the researcher (Arksey & Knight, 1999; Kumar, 1999). In this study, two types of data are collected to answer all research questions. They are both forms of primary data that are collected through semi-structured interviews and questionnaires. The study employs a mixed-methods design, which integrates quantitative and qualitative approaches organised in three phases.

The quantitative stage is undertaken first, the analysis of which is informed by a second stage of qualitative data collection, both stages undertaken as part of the first phase of the study. Based on the data collected during the 1st and 2nd stage, a model is developed and refined. This then led us towards a second phase undertaken in order to test and validate the proposed model. Both qualitative and quantitative methods are employed within this single study to demonstrate a more rigorous approach towards research (Ivankova et al., 2006; Ivankova and Stick, 2007; Collins et al., 2006). These two methods are useful ways of gathering respondents' views and opinions and are a means of exploring their world, especially with regard to the relationship between attitudes, mentality and motivation (Arksey & Knight, 1999). Although the interview differs from the questionnaire in the level of structure placed on the interaction (Harrell & Bradley, 2009) it might be better to complement the questionnaire with the interview (Arksey & Knight, 1999), as the questionnaire is a good way of checking the strength of the story that the interview seems to contain and it can also be useful for checking the interpretation of the interview data and as a way of exploring how widely views and understandings are shared (Arksey & Knight, 1999).

3.4 PHASE 1 (Part 1): The Quantitative (Survey 1)

3.4.1 Rationale behind using the survey technique

In the first phase, quantitative, numeric data are collected using a questionnaire survey. This research attempts to build upon and extend our knowledge towards understanding how the public react when facing a disruptive technology like autonomous vehicles. Many experts believe that customer acceptance is likely to be the biggest obstacle to autonomous vehicle penetration (Morgan Stanley, 2013; ERTRAC, 2015).The objective of the first stage of this study is to present a comprehensive analytical framework in which to examine how concerned are the public about the subjects of safety, trust, security and privacy associated to autonomous vehicles as well as this, it aims to explore the role of human and non-human agents involved in this ***assemblage*** with regards to public acceptance of autonomous vehicles. Furthermore, it explores how do factors such as the user's age and gender affect their ability to accept or reject the technology.

Generally, the survey strategy is associated with the quantitative research approach. It is a popular and familiar strategy especially in business and management studies and is most frequently adopted by researchers aiming to answer questions such as who, what, where, how much and how many. It therefore tends to be employed for exploratory and descriptive research. Survey is also popular as it enables the collection of a great amount of data from a sizeable population in a highly economical way (Saunders al., 2009). The sample survey design has been one of the most widely used data collection strategies. It is also one of the most controversial techniques. Moreover, the sample survey method has the ability to make competent use of limited research resources such as effort, time and money. The questionnaire falls within this category. It is often chosen when there is a need to study a large sample within a reasonable investment of time and effort (Podsakoff and Dalton, 1987). The main purpose of the questionnaire technique is to generalize from a sample population in order to make a statement about the entire population (Moser and Kalton, 1971; Robson, 2002).

3.4.2 Sampling Frame

For the purpose of the study, the sampling frame includes anybody who uses a car (not necessarily able to drive one) but presently living in UK, with the ability to respond to complex questions without the need of their parent or guardian's authorisation. In order to maximise the differentiation and understanding of different viewpoints, our target population was in London, the sample size was 408 participants from all age groups, race and cultural backgrounds with a minimum of 18 years of age. Data was collected from staffs and students at London South Bank University and in another higher education provider (GSM London, British Institute of Technology & E-commerce) and other random places across the capital. Other members of the public were also suitable to answer questions in the survey. No prior knowledge of autonomous vehicles was necessary as relevant information was provided at the beginning of the survey.

3.4.3 Questionnaire design

The survey questionnaire was designed and administered in order to collect and analyse the data required to achieve the researchers aims and objectives. It included valid measures of the research items and aimed to encourage the respondents' participation so as to supply high-quality data for the statistical analysis. The survey was conducted through different procedures in order to ascertain that the respondents were knowledgeable about the phenomenon under study, ensure that they could understand the questions as they were intended by the researcher, and would be keen to respond to them in the form established by the questionnaire.

Questions were developed using the free tool Google form and administered online and via email whenever possible and within social networking websites (Linkedin & Facebook). Indeed, by creating our questionnaire using Google form, the system generated a unique link that could be shared electronically.

The questionnaire was divided into four sections, but before anyone could start answering the question there was an introductory paragraph providing the purpose of the study explaining to the fellow participants how all information collected would be anonymous and confidential.

3.4.4 Presenting the questionnaire

As explained above, the questionnaire consisted of four sections, dealing with the issues of security, privacy, trust and looking at the public attitude towards the introduction of AVs. Furthermore, the questionnaire was exploring the role of human and non-human actants influencing the public acceptance or rejection of self-driving cars. In total, there were 39 questions/items. All of the items used in the questionnaire were steadily and cautiously developed through pre-testing before administering the survey to the target sample. During the pre-tests, the final items/questions were conceptually reviewed once more in order to improve their content validity (Berghman, 2006). Some changes have been made regarding the language, the length of the questions and order of the questions.

Content validity is defined according to Saunders et al. (2009) as the extent to which the measurement questions in a survey provide adequate coverage of the investigative questions. In other words, the measurement items of the questionnaire should represent a proper sample of the theoretical content domain of the construct (Hardesty and Bearden, 2004). At the same time, the face validity of the questionnaire was assessed. Hardesty and Bearden (2004) defined face validity as the extent to which a measure reflects what it is proposed to measure. To establish both content and face validity, initially, the survey questionnaire was given to 10 academic colleagues. They were asked to determine whether the questions were clear, understandable, and presented in a logical order (face validity) and asked to express their views on whether the 39 items/questions were representative of the research constructs (content validity). Specifically, they were asked about the following (Saunders et al., 2009): how long it took to complete the questionnaire; the clarity of the instructions; which, if any, which questions were unclear or vague; which, if any, questions they felt difficult about answering; whether in their view there were any major subject omissions; whether the layout of the questionnaire was clear and attractive. Furthermore, following Saunders et al. (2009), the researcher asked colleagues to evaluate the degree to which the items/questions were representative of the constructs' conceptual definitions. They reported that the statements were clear, easy to understand, came in a logical order, and that the items represented the research constructs.

3.4.5 Pilot study

Prior to using a questionnaire for data collection, it should be pilot tested. The researcher asked 10 of the target respondents to fill out the questionnaire as a test, following Saunders et al. (2009). The purpose of the pilot test is to refine the survey so that the target participants will have no difficulties in answering the questions and there will be no problem in recording the data. It can also help the researcher to obtain an evaluation of the questions' validity and the probable reliability of the data that will be collected. Thus, the initial analysis using the pilot test data can be carried out to guarantee that the data eventually collected will allow the research questions to be answered (Saunders *et al*., 2009).

3.5 PHASE 1 (Part 2): The Qualitative part (Interviews)

3.5.1 Rationale behind using the interview

The objective of the second phase of this study was to present a comprehensive analytical framework in which to examine the roles of, and the relationships between, human actants, non-human actants which are involved in or influencing public acceptance of AV. We were also exploring the cognitive process and cognitive indicators underpinning people thoughts when facing a technology that could be disruptive. Furthermore, it highlights a series of factors that may be useful in determining how actors are connected to form the autonomous vehicle assemblage (network of actants). By collecting this data and analysis the key pieces of the puzzle, we should be able to develop a model for understanding public acceptance of autonomous vehicles as a disruptive technology which could then be used for other disruptive technologies.

3.5.2 Sample and selection of participants

The main purpose of this phase of the study is first of all to explain the quantitative findings from the survey collected in parallel and explore the influences of human and non-human actants playing a role in the acceptance or rejection of autonomous vehicles as a disruptive technology. We were also looking at the cognitive process and cognitive indicators underpinning people's thoughts when facing a technology that could be disruptive. Those details were collected by means of a qualitative methodology. The sampling procedure for a follow-up qualitative phase should be based on the main purpose of the research. Firstly, in this study's qualitative phase the researcher selected purposively a total of 15 participants with 5 psychologists, 5 sociologists and 5 computer scientists from various universities and higher education providers in UK including London South Bank University, King's college London, GSM London and University of Hertfordshire. These were academics or professionals who were considered to be able to answer the research questions. Face-to- face interviews or by Skype with all participants at their places of work were undertaken. The researcher conducted these interviews between **October 2015 and January 2016.**

3.5.3 Data collection process

Unstructured, semi-structured and structured are the main forms of qualitative interviews (Bloom and Crabtree, 2006). The current study adopts a semi-structured format with opportunities of probing questions because this type enables the researcher to obtain sufficient information to address key issues represented by the questions of what, why, from what and how (Werlang and Botega, 2003). Semi-structured interviews are often used as the sole method of data collection for a qualitative research project and can be used to obtain data from individuals or groups (Bloom and Crabtree, 2006). Individual semi-structured interviews were employed in this study to answer questions. Overall, this study adopts a mixed methods design. Semi-structured questions, as the second stage of the design, allowed the respondents to express their own points of view and to describe situations, events and their experiences regarding the influences of human and non-human actants playing a role in the acceptance or rejection of autonomous vehicles as a disruptive technology. We were also exploring the cognitive process and cognitive indicators underpinning people thoughts. Laforest et al. (2009) pointed out that semi-structured in-depth interviews are suitable when working with small samples and are helpful for studying particular situations as is the technology in this study. They permit the researcher to obtain more details from the participants about their own views regarding the issue under study (Barter and Cormack, 1996). A set of semi-structured questions (see appendix C, D and E) were tailored precisely to the aims of this study in order to gather the data required to achieve those aims.

The researcher contacted all participants a few days before the interviews took place to explain the nature and aims of the research and to set an appropriate time to conduct a personal interview. Authorization was requested to make digital audio recordings of the interviews. Most respondent didn't have any problem with the audio recordings. Each interview lasted between 35 and 55 minutes. The researcher pilot-tested the interview protocol on three participants (selected from those who had completed the questionnaire in the quantitative phase of the study), whom were felt to have the experience, ability and knowledge to answer the questions. Based on the pilot interviews, the researcher changed the order of the questions slightly, and added some more probing questions.

3.5.4 Interview protocol development

The main goal in developing the interview protocol (see appendix C, D and E) was to explore in more detail the findings from the quantitative phase and also used to collect relevant data from professionals in the field of **sociology, psychology and computer science** reflecting their opinions, ideas and the understanding of the role played or the influences of human and non-human actants in the acceptance or rejection of autonomous vehicles as a disruptive technology. These groups of specialists were selected mainly because throughout the years they have been the one developing previous technology acceptance models and theories. The experts in those fields were consulted to help the researcher further refine the proposed constructs and achieve a common goal reflecting all relevant perspectives of the problem. The interviews were semi-structured and conducted either face-to-face or by Skype. Each interview took no longer than one hour, and all conversations were recorded with the permission of interviewees. Based on the characteristics of our mixed-methods design, the content of the interview questions was aligned with some research objectives and research questions. The questions designed for the psychologist were different from those designed for the sociologists and computer scientists. For the psychologist, the protocol consisted of twelve open-ended questions exploring the cognitive process and cognitive indicators underpinning people thoughts. The first question asked participants about their general view on self-driving cars. The second question asked about what the participants would identify as the key influences of psychology in the development of new technologies. The third question asked participants to explain the typical cognitive process that one experiences when facing an eventual technology that could be disruptive like the self-driving car. The forth question asked about the cognitive indicators that underpin people thoughts with regards to the acceptance or the rejection of a new technology. The fifth question asked if the changes in our environment influence our behavioural intentions towards acceptance or rejection of new technology that could be disruptive. The sixth question asked from a psychologist perspective, what measure(s) could be put in place to maximize the public acceptance of this new technology. The seventh question highlighted the issue that people are emotionally attached to their car, therefore with the introduction of autonomous vehicles and the car sharing services, what are the likely impacts on people’s behaviour and on our society as a whole. The eighth question asked about the key indicators showing that the public have accepted the technologies. The ninth question asked about what could be the changes in behaviour and psychological problems emerging from the introduction of this new technology. The tenth question was about the Knowledge Attitude and Practice model (KAP) and how it could be used to observe aspect of human thought and behaviour to develop a model for understanding and evaluating the acceptance of disruptive technologies. The eleventh question was about the key pieces of the puzzle that will underpin the mass adoption of autonomous vehicles. For the twelfth question, the participant was asked if there was anything he wanted to add regarding the human and non-human factors influencing public acceptance of disruptive technologies.

For the sociologist, the protocol consisted of eleven open-ended questions exploring the human and non-human actants influencing people acceptance or rejection or autonomous vehicles as a disruptive force. The first question asked participants about the key influences of sociology during the development of new technologies. The second question asked about factors more likely to influence people's behavioural intention with regards to acceptance of self-driving cars. The third question was about the influence of the cultural actant on people's acceptance of the technologies that could be disruptive. The forth question was about the influence of the structural actant on people's acceptance of the technologies that could be disruptive. The fifth question was about hypothetical problems faced by people within society due to the introduction of disruptive technologies such the self-driving car. The sixth question was about the influence of the human actant on people's acceptance of the technologies that could be disruptive. The seventh question was about the main indications that people have accepted and have adopted a new technology. The eighth question was about the measure that could be put in place to maximize people's acceptance of disruptive technologies. The ninth question was about the factors in modern society that influence people to reject disruptive technologies. The tenth question was about the key pieces of the puzzle that will underpin the mass adoption of autonomous vehicles. For the eleventh question, the participant was asked if there was anything he wanted to add regarding the human and non-human factors influencing public acceptance of disruptive technologies. At the end of the interviews, all of the participants were assured that the researcher would not include any personal identifiers in the transcribed data reports. The participants' names were therefore replaced with codes.

3.5.5 Qualitative data analysis

The purpose of this section is to present an explanation of the analysis and interpretive process used to answer the qualitative study questions. The digital recordings were transcribed within two or three days of each individual interview. The question asked was transcribed in italics and the participants' responses in plain text. Each transcript was also labelled with the participant's details: male=1, female=2, name of organization, and location, as well as a code number assigned to each participant by the researcher. Each transcribed interview was given a number and saved in a separate word-processor file. This study's approach to qualitative analysis is based on deductive thinking. Using the deductive approach means that researchers use existing theories to shape the approach used in the qualitative research process and in aspects of the data analysis, as opposed to the inductive approach that seeks to build up a theory based on the data collected (Saunders et al., 2009). This means that, in this study, the data categories and codes used to analyse the data are based on an existing theory and following a predetermined analytical framework, which is based on connecting actor-network theory. Thus, the categorisations used in this study are derived from some terms used in the conceptual framework.

3.6 PHASE 2: The Quantitative (Survey 2)

As a follow up to phase 1 of our investigation, the following conceptual model was the development.

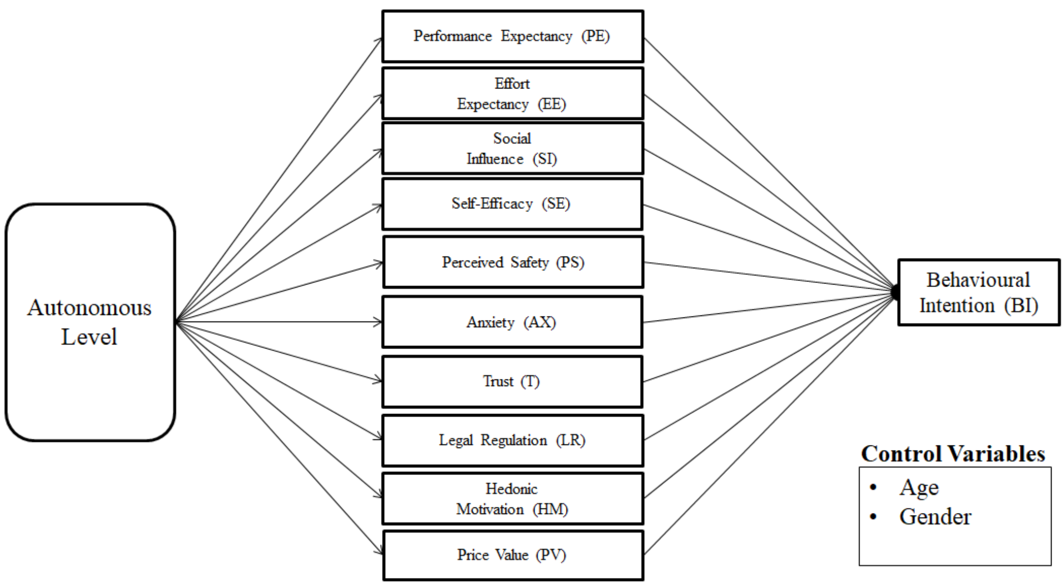


Figure 3.2 Proposed model

To validate the model, it was necessary to test the proposed constructs. And this is the objective of this survey.

The analysis of the articles suggests that the researchers investigating technology adoption used two main research approaches, namely the survey and case study. More than 77% of the articles reviewed employed the survey approach, which suggests that it is the most widely used approach in technology adoption research. This led this research to consider the survey approach. Further support was obtained from previous findings and evidence that the survey approach is more dominant in the IS area (Farhoomand, 1992; Mingers, 2001; 2003; Orlikowski and Baroudi, 1991). The remaining 23% of the research employed the case study method. No other approaches were employed to investigate the use or adoption of technology. Another interesting observation is that the case study approach was exclusively employed to study the organisational adoption of technology, while surveys were used to study a range of contexts.

3.6.1 Rationale behind using the survey technique

In the final phase of data collection, quantitative numeric data are collected using a self-administrated questionnaire survey also known as (SAQ). This refers to a questionnaire that has been designed specifically to be completed by a respondent without intervention of the researchers. The objective of this 3rd phase of this study is to test and validate the model below developed as a result of all activities conducted during the 1st and the 2nd phase of this investigation. The sample survey design has been one of the most widely used data collection strategies. It is also one of the most controversial techniques. Moreover, the sample survey method has the ability to make competent use of limited research resources such as effort, time and money. The self-administrated questionnaire falls within this category. It is often chosen when there is a need to study a large sample within a reasonable investment of time and effort (Podsakoff and Dalton, 1987). The main purpose of the questionnaire technique is to generalize from a sample population in order to make a statement about the entire population (Moser and Kalton, 1971; Robson, 2002).

3.6.2 Sampling Frame

For the purpose of the study, the sampling frame includes anybody who uses a car (not necessary able to drive one) but presently living in UK, with the ability to respond to complex questions without the need of their parent or guardian's authorisation. In order to maximise differentiation and understanding different viewpoints, our target population was in London, the sample size was 482 participants from all age groups, race and cultural backgrounds with a minimum of 18 years of age. Data was collected from staffs and students at London South Bank University and in other higher education institutions (GSM London, British Institute of Technology & E-commerce) and other random places across the capital. Other members of the public were also suitable to answer questions in the survey. No prior knowledge of autonomous vehicles was necessary as relevant information was provided at the beginning of the survey.

3.6.3 Questionnaire design

The survey questionnaire was designed and administered in order to collect and analyse the data required to achieve the research's aims and objectives. It included valid measures of the research items and aimed to encourage the respondents' participation so as to supply high-quality data for the statistical analysis. The survey was conducted throughout different procedures in order to ascertain that the respondents were knowledgeable about the phenomenon understudy , ensure that they could understand the questions as they were intended by the researcher, and would be keen to respond to them in the form established by the questionnaire.

Questions were developed using the free tool Google form and administered online and via email whenever possible and using social media network. Indeed, by creating our questionnaire using Google form, the system generated a unique link that could be shared electronically.

Autonomous Vehicle is an emerging technology which has not yet been deployed on our road. This technology is also known as self-driving car, which is the term used when designing this questionnaire. The questionnaire had an introductory paragraph included at the beginning explaining what self-driving car is all about. The introductory paragraph also clarified the purpose of the study and explained to participants how all information collected would remain anonymous and confidential. At the same time, participants had to confirm that they were at least18 years of age. Before anyone could start answering the question there was a very short YouTube video demonstrating to participants how self-driving cars (Google Car) works and what could be the benefits of this technology to future road users.

3.6.4 Presenting the questionnaire

The questionnaire was exploring consumers' behavioural intention of using self-driving cars. In total, there were 23 questions/items. All of the items used in the questionnaire were steadily and cautiously developed throughout pre-testing before administering the survey to the target sample. During the pre-tests, the final items/questions were conceptually reviewed once more in order to improve their content validity (Berghman, 2006). Some changes have been made regarding the language, the length of the questions and order of the questions.
Content validity is defined according to Saunders et al. (2009) as the extent to which the measurement questions in a survey provide adequate coverage of the investigative questions. In other words, the measurement items of the questionnaire should represent a proper sample of the theoretical content domain of the construct (Hardesty and Bearden, 2004). At the same time, the face validity of the questionnaire was assessed. Hardesty and Bearden (2004) defined face validity as the extent to which a measure reflects what it is proposed to measure. To establish both content and face validity, initially, the survey questionnaire was given to 10 academic colleagues. They were asked to determine whether the questions were clear, understandable, and presented in a logical order (face validity) and asked to express their views on whether the 23 items/questions were representative of the research constructs (content validity). Specifically, they were asked about the following (Saunders et al., 2009): how long it took to complete the questionnaire; the clarity of the instructions; which, if any, questions were unclear or vague; which, if any, questions they felt difficult about answering; whether in their view there were any major omissions; whether the layout of the questionnaire was clear and attractive. Furthermore, following Saunders

et al. (2009), the researcher asked colleagues to evaluate the degree to which the items/questions were representative of the constructs' conceptual definitions. They reported that the statements were clear, easy to understand, came in a logical order, and that the items represented the research constructs.

3.6.5 Pilot study

Prior to using a questionnaire for data collection, it should be pilot tested. The researcher asked 10 of the targeted respondents to fill out the questionnaire as a test, following Saunders et al. (2009). The purpose of the pilot test is to refine the survey so that the target participants will have no difficulties in answering the questions and there will be no problem in recording the data. It can also help the researcher to obtain an evaluation of the questions' validity and the probable reliability of the data that will be collected. Thus, the initial analysis using the pilot test data can be carried out to guarantee that the data eventually collected will allow the research questions to be answered (Saunders et al., 2009).

3.7 Methods of data analysis

In quantitative research, depending on the data collected (nominal, Non-parametric, Parametric) there are several possible tests that could potentially be applied to the data. For example, to compare groups (Nominal), Chi-square test may be appropriate. For non-parametric data (ordinal, non-normal interval/ratio), to measure correlate variables, Spearman's correlation coefficient may be used. To compare groups, Wilcoxon test, Kruskal-Wallis test, or Mann-Whitney test could be used. For parametric data (Normal interval/ratio), Pearson's correlation could be used to correlate variables, Paired t-test could be used. There are many other possible tests available to analyse data. Based on previous studies conducted in field of Information Systems (Davies *et al*, 1989; Venkatesh *et al*, 2012 Dwivedi *et al*, 2017) Structure Equation Modelling (SEM) has been selected overwhelmingly by previous researchers as the main technique used to test their proposed hypothesis. SEM is a multivariate statistical analysis technique that is used to analyse structural relationships. This technique is the combination of factor analysis and multiple regression analysis, and it is used to analyse the structural relationship between measured variables and latent constructs. Therefore, it was concluded that this study will use factor analysis approach to analyse the data of the questionnaire as well as structural equation modelling.

3.7.1 Factor Analysis (FA)

FA "consists of a number of statistical techniques, the aim of which is to simplify complex sets of data. In social science, Factor Analysis is usually applied to correlations (matrices) between variables" (Kline, 1994:3). It is an analytic statistical tool which can be used to discover the main underlying dimensions of a set of variables, attributes or responses (Oppenheim, 1992). According to Cohen et al. (2011) FA is a method of grouping together variables that have something in common and is a process by which the set of variables is reduced. It refers to a group of statistical procedures which are designed to determine the number of different constructs assessed by a group of measures. These unobservable constructs are referred to as common factors (Fabrigar & Wegener, 2011). Correlations, variance and covariance are important in order to understand FA (Kline, 1994). FA can be used when investigators want to know how many constructs a group of measured variables is assessing and what these constructs might be, but they are not yet at a point at which they want to test specific hypotheses about how the constructs might be casually related (Fabrigar & Wegener, 2011). FA is started by creating a correlation matrix, which is followed by a principle component analysis. However, this is not the final stage if there is a lack of meaning or if there are difficulties in interpretation. Different procedures have been developed to help investigators identify and interpret the underlying dimensions they may find (Oppenheim, 1992). This will require factor analysis "rotation" in which a number of attempts (called "iterations") are made to re-draw the factor loadings in such a way as to produce a more meaningful result (Devellis, 2003).

Types

There are two types of factor analysis. One is Exploratory Factor Analysis (EFA) and the other is confirmatory factor analysis (CFA). The former can be used when the researcher has few or no clear expectations about the underlying structure of correlations, whereas the latter can be used when the researcher has clear predictions about the number of common factors and the specific measures each common factor will influence (Fabrigar & Wegener, 2011).

- **Exploratory Factor Analysis (EFA)**

EFA can be used to determine the underlying structure of factors. The aim of it is to explore the field or to discover the main constructs or dimensions (Kline, 1994). It was first developed by Spearman in 1904. Unfortunately, EFA can produce confused or misleading results, leading some psychologists to reject it in favour of CFA (Kline, 1994). EFA can only suggest structures and does in fact require CFA as a second step (Kline, 1994). It is mainly well suited to two general types of research questions which are construct identification and measurement instrument construction (Fabrigar & Wegener, 2011). In EFA, the Kaiser-Meyer-Olkin (KMO) test which measures sampling adequacy value needs to be checked first, followed by factor extraction in which a choice is made between principal component analysis, principal axis or maximum likelihood. Maximum likelihood has the same mathematics of structural equation modelling. However, in a larger sample, there is no difference between maximum likelihood and principal component analysis. Principal component analysis is one method of considering a matrix of correlations and explains all the variance in any chapter, in particular correlation matrix, including the error variance (Kline, 1994). It can be used if researchers want an empirical summary of the data set. Moreover, it is a well-known method of extraction in EFA and is widely-used. In social science research, the aim of FA is to explain the observed correlations and this means that the factors must be interpreted and identified (Kline, 1994). When factor extraction is done, it is necessary to do factor rotation in order to make the result more meaningful. In other words, it is clear that rotating factors can change the factor loadings and also their meanings. There are two types of rotation, the orthogonal, in which the factors are uncorrelated and the oblique, in which the factors are correlated.

- **Confirmatory Factor Analysis (CFA)**

CFA is done to “confirm a particular pattern of relationships predicted on the basis of theory or previous analytic results” (Devellis, 2003:118). It is used to test hypotheses (Kline, 1994). It is clear that CFA can be of value in confirming hypotheses but much depends on the sample size and the indices of model fit. It is referred to as a measurement model in structural equation modelling. The structural model examines relationships between the latent variables, which can test complex psychological hypotheses (Kline, 1994). EFA is often used in the early stages of research to gather information about or to explore the interrelationships between a set of variables, whereas CFA is a more complex and sophisticated set of techniques used late in the research process to test or confirm certain hypotheses or theories concerning the structure of underlying groups of variables (Pallent, 2005). More details about both types are given in Chapter 5: Justifications for choosing FA in analysing the questionnaire findings.

This study used the analytic, relational survey design in order to explore the associations between particular variables (Oppenheim, 1992). Thus, FA is reasonable for this type of survey design. In order to not reach erroneous conclusions about a theory by misinterpreting what a scale measures (Devellis, 2003), FA has been used. Moreover, FA is a worthwhile analytic tool that can identify important properties of a scale. Therefore, it helps in determining empirically how many constructs (latent variables) underlie a set of items (Devellis, 2003). Additionally, FA is well-known tool for theoretical investigation, new discoveries and test construction (Kline, 1994). As a result, FA is an essential tool in scale development. It allows the data analyst to determine the number of factors underlying a set of items. In addition, one of the contributions of this study is to validate the instrument in which a number of new items are constructed. FA is used widely in scale development either to refine or reduce items to form a smaller number of comprehensible subscales or to reduce a large number of related variables to a more reasonable number (Pallent, 2005).

3.7.2 Structure Equation Modelling (SEM)

Structural Equation Modelling (SEM) is a “multivariate technique combining aspects of factor analysis and multiple regression that enables the researcher to simultaneously examine a series of interrelated relationships amongst the measured variables and latent constructs as well as between latent constructs” (Hair et al., 2010:634). SEM examines interrelated relationships among multiple dependent and independent variables (Cohen et al., 2011; Hair et al., 2010). Therefore, SEM was the most suitable for this study as it involves multiple independent-dependent relationships to test the goodness of the model fit and to verify the model and the relationships between the factors.

In this research, factor analysis and structural equation modelling are carried out. The second-generation statistical technique of structural equation modelling (SEM) is used, using the R Programming software. This includes the measurement model and structural model. Based on the model testing results, the relationships between the research variables of interest are tested. The reasons for selecting SEM for data analysis were that it offers a systematic mechanism to validate relationships between factors and to test relationships between the factors in the proposed model, and also because it offers powerful statistical techniques to deal with complex models (Cohen et al., 2011; Hair et al., 2010; Muijs, 2004) and also considers the measurement error of the model (Muijs, 2004). In SEM, relationships between latent factors and indicators are validated by using Confirmatory Factor Analysis (CFA), also known as a measurement model, and relationships between independent latent factors and the dependent factor are tested using the structural model (Cohen et al., 2011; Hair et al., 2010; Muijs, 2004).

In addition to factor analysis, descriptive statistics are used to analyse the questionnaire data. Descriptive statistics describe the data by providing a summary and by graphical plotting of numerical data (Thomas, 2013; Cohen et al., 2011). Quantitative analysis involves statistical techniques using SPSS to find the kurtosis, skewness, mean and the standard deviation of the data (Cohen et al., 2011).

3.8 Ethical Considerations

According to Fouka and Mantzorou (2011), when conducting a piece of research, it is important for the researchers to be aware of some ethical considerations, which include respect for privacy, respect for anonymity and confidentiality and beneficence, that is doing no harm. Ethical considerations can emerge in the design and undertaking of research and in the reporting of findings, and cover issues such as informed consent, openness and honesty, privacy and confidentiality (Veal, 2006).

The data collection started in October 2015, but before any data could be collected, the School of Engineering at London South Bank University required the author to obtain ethical approval covering the period of investigation. This ethical application was submitted in September 2015 to Research Ethical Committee (REC) at LSBU, and then granted in October 2015. It ensured the research conformed to each requirement of London South University ethical protocol. Once ethical approval was granted, the first phase of the research started with the survey. It was conducted mainly amongst participants in London aged 18 or over. The survey began in October 2015 and ended in January 2016. Participants were contacted by email with the link to have access to the online questionnaire. Emails were sent to staff members at London south Bank University and to students and staff members at GSM London. In parallel, participants for the interview were contacted and invited to take part in the research as part of the second phase conducted amongst academics from the department of Psychology and Sociology at London South Bank University and at GSM London. Initial letter was sent to managers to request permission to make contact with the members of staff. Once the request was approved, a written confirmation via-email was sent to individual participants with information about the research topic notifying them of their rights. If the participant requires further information or wishes to withdraw consent, they were provided further explanation about the research and that they had the right to withdraw from the study.

All respondents automatically received the information sheet for participating and the consent form by email with detailed information about the nature of the research. During data collection, participants were interviewed only after their approval had been obtained for conducting personal interviews. They were also informed by the researcher that, if any issues or comments were felt to be contentious or could possibly harm the participants, they would be referred to anonymously in the text. The data collected was saved and stored as electronic files on the personal drive of the researcher's password protected computer network and accessed only by the researcher. All interviews were audio-recorded with the participant's permission so that all appropriate information could be used. To maintain anonymity, no identifiable personal details were requested during the interview. Participant's names and location was removed from the research data/reports/research publications. Any details which could potentially identify the participant were also removed. Hardcopies such as field notes and transcripts were stored in a locked cupboard in the university research office within the vicinity of the researcher until moved to an electronic file. Data from interviews and survey were anonymised. Data recorded was fully transcribed and coded and was stored electronically and only the researcher and supervisor (s) had access to them. Participants were to be invited to receive a summary of the research findings.

3.9 Summary

This study employed an explanatory mixed methods design based on the pragmatism philosophy. The deductive (positivism) - inductive (post - positivism) approach is used to examine the casual relationships amongst the quantitative variables and qualitative data is employed to allow and facilitate interpretation of the quantitative findings in more depth. For quantitative data collection, a questionnaire survey is used looking at people's opinion regarding the introduction of self-driving cars in UK. A convenience sampling technique is used to select the research participants. Personal and telephone interviews with experts in the area of psychology and sociology are used for the qualitative data collection. The next chapter explores the main techniques used to identify the factors influencing participants behavioural intention to accept AV as part of Phase I of the study.

Chapter 4 Phase – I: Identifying factors Influencing Behavioural Intention

The purpose of this phase is to identify other possible constructs and moderating factors influencing behavioural intention to accept autonomous vehicles that have not been recognised in the past. This phase is linked to objective (2). The study will be using an inductive approach as this phase will allow us to identify constructs for the proposed model. To achieve this objective, a mixed methods approach will be used by reviewing and analysing evidence from different methods, to verify and validate the findings. The research follows the pragmatism philosophy, as the researcher started his investigation by reviewing previous models and theories from the literature, using the findings to develop a questionnaire whereby he gave the opportunity to respondents during the survey to provide other possible factors not initially identified that could also influence them. Based on the data collected from the survey, he conducted several interviews with experts in the field of psychology, sociology and computer sciences to refine the model and validate our findings see Figure 4.1.

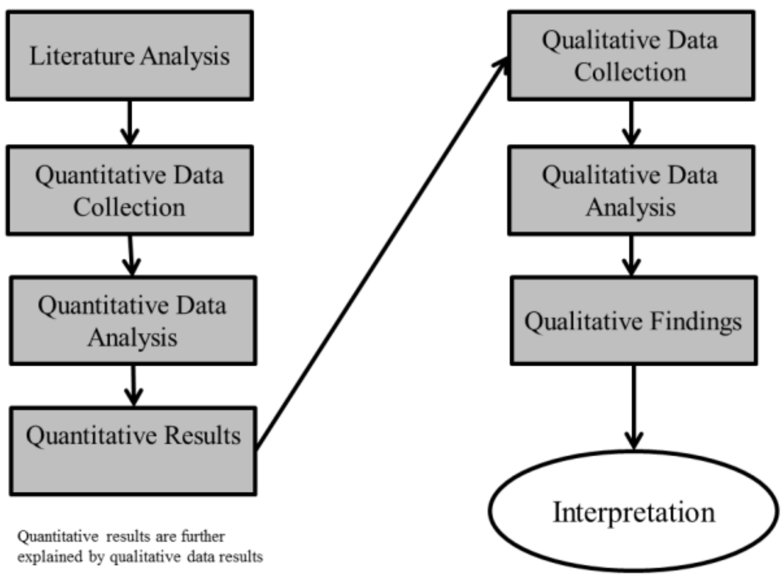


Figure 4.1 Exploratory Sequential Mixed Method Design

Table 4.1 Techniques used to identify factors influencing acceptance of AV

Data required	**Methods used to collect data**
An analysis of existing factors influencing behaviour intention to accept technology proposed by previous studies.	**Literature Analysis**
Information regarding the public's general opinions and concerns for autonomous vehicles deployment. Identify other factors influencing behaviour intention from participants' perspective.	**Survey**
Information on how users' mental models of social abilities are developed when facing innovative technologies, how are they refined to face the challenges of autonomous vehicles? What are other factors influencing behaviour intention from experts' perspective	**Interviews**

Table 3.1 shows the 3 main techniques used to identify the key factors influencing AV acceptance.

4.1 Literature Analysis

When acceptance is talked of, what is meant in general terms is "*agreeing, accepting, approving and acknowledging; agreeing with someone or something*" (Drosdrowski, 1993). This formulation encompasses a sense of "willingness for something," which gives an active component on acceptance. This differentiates it from simple acquiescence and the absence of resistance, but also from tolerance. The subject of technology acceptance is a decidedly inhomogeneous field; various scientific disciplines (e.g. psychology, sociology, economics, computer science etc…) are related to and have mutual bonds with it. Overall, acceptance research is still a relatively young but mature field (Fraedrich and Lenz, 2016). There have been several theoretical models proposed in the past, primarily developed from theories in psychology and sociology (Venkatesh et al. 2003) employed to explain technology acceptance and use. The purpose of this section is to review and synthesise ten theories/models of technology acceptance relevant to our scenario. This will give us a better understanding of technology acceptance constructs and moderating factors that have been proposed in the past and be able to evaluate their relevance for autonomous vehicles as a disruptive technology.

4.1.1 The Process

Meta-analysis was the set of techniques used to combine the results of several different research models and theories evaluated to create a single and more precise estimate of the factors influencing AV. The following eleven models/theories will be reviewed:

1. (Theory of Reasoned Action (TRA) – 1975
2. Innovation Diffusion Theory (IDT) - 1983
3. Social Cognitive Theory (SCT) - 1986
4. Technology Acceptance Model (TAM) - 1989
5. Theory of Planned Behaviour (TPB) – 1991
6. Model of PC utilisation (MPCU) - 1991
7. Motivational model (MM) - 1992
8. Decomposed Theory of Planned Behaviour (DTPB) or Combined TAM-TPB - 1995
9. Unified Theory of Acceptance and Use of Technology (UTAUT) - 2003
10. Unified Theory of Acceptance and Use of Technology (UTAUT2) – 2012
11. Car technology acceptance research model (CTAM) - 2012

Table 3.2 shows the core and most important factors introduced by different researchers since the 1960s.

4.2 Models from the literature

Table 4.2. Models and Theories of Individual Acceptance

Theory of Reasoned Action (TRA)	**Core Constructs**	**Definitions**
Drawn from social psychology, TRA is one of the most fundamental and influential theories of human behavior. It has been used to predict a wide range of behaviors (see Sheppard et al. 1988 for a review). Davis et al. (1989) applied TRA to individual acceptance of technology and found that the variance explained was largely consistent with studies that had employed TRA in the context of other behaviors.	Attitude Toward Behavior	"an individual's positive or negative feelings (evaluative affect) about performing the target behavior" (Fishbein and Ajzen 1975, p. 216).
	Subjective Norm	"the person's perception that most people who are important to him think he should or should not perform the behavior in question" (Fishbein and Ajzen 1975, p. 302).
Technology Acceptance Model (TAM)		
TAM is tailored to IS contexts and was designed to predict information technology acceptance and usage on the job. Unlike TRA, the final conceptualization of TAM excludes the attitude construct to better explain intention parsimoniously. TAM2 extended TAM by including subjective norm as an additional predictor of intention in the case of mandatory settings (Venkatesh and Davis 2000). TAM has been widely applied to a diverse set of technologies and users.	Perceived Usefulness	"the degree to which a person believes that using a particular system would enhance his or her job performance" (Davis 1989, p. 320).
	Perceived Ease of Use	"the degree to which a person believes that using a particular system would be free of effort" (Davis 1989, p. 320).
	Subjective Norm	Adapted from TRA/TPB. Included in TAM2 only.
Motivational Model (MM)		
A significant body of research in psychology has sup- ported general motivation theory as an explanation for behavior. Several studies have examined motivational theory and adapted it for specific contexts. Vallerand (1997) presents an excellent review of the fundamental tenets of this theoretical base. Within the information systems domain, Davis et al. (1992) applied motivational theory to understand new technology adoption and use (see also Venkatesh and Speier 1999).	Extrinsic Motivation	The perception that users will want to perform an activity "because it is perceived to be instrumental in achieving valued outcomes that are distinct from the activity itself, such as improved job performance, pay, or promotions" (Davis et al. 1992, p. 1112).
	Intrinsic Motivation	The perception that users will want to perform an activity "for no apparent reinforcement other than the process of performing the activity per se" (Davis et al. 1992, p. 1112).

Table 4.2 Models and Theories of Individual Acceptance (Continued)

Theory of Planned Behavior (TPB)	**Core Constructs**	**Definitions**
TPB extended TRA by adding the construct of perceived behavioral control. In TPB, perceived behavioral control is theorized to be an additional determinant of intention and behavior. Ajzen (1991) presented a review of several studies that successfully used TPB to predict intention and behavior in a wide variety of settings. TPB has been successfully applied to the understanding of individual acceptance and usage of many different technologies (Harrison et al. 1997; Mathieson 1991; Taylor and Todd 1995b). A related model is the Decomposed Theory of Planned Behavior (DTPB). In terms of predicting intention, DTPB is identical to TPB. In contrast to TPB but similar to TAM, DTPB "decomposes" attitude, subjective norm, and perceived behavioral control into its the underlying belief structure within technology adoption contexts.	Attitude Toward Behavior	Adapted from TRA.
	Subjective Norm	Adapted from TRA.
	Perceived Behavioral Control	"the perceived ease or difficulty of performing the behavior" (Ajzen 1991, p. 188). In the context of IS research, "perceptions of internal and external constraints on behavior" (Taylor and Todd 1995b, p. 149).
Combined TAM and TPB (C-TAM-TPB)		
This model combines the predictors of TPB with perceived usefulness from TAM to provide a hybrid model (Taylor and Todd 1995a).	Attitude Toward Behavior	Adapted from TRA/TPB.
	Subjective Norm	Adapted from TRA/TPB.
	Perceived Behavioral Control	Adapted from TRA/TPB.
	Perceived Usefulness	Adapted from TAM.

Table 4.2. Models and Theories of Individual Acceptance (Continued)

Model of PC Utilization (MPCU)	**Core Constructs**	**Definitions**
Derived largely from Triandis' (1977) theory of human behavior, this model presents a competing perspective to that proposed by	Job-fit	"the extent to which an individual believes that using [a technology] can enhance the performance of his or her job" (Thompson et al. 1991, p. 129).

TRA and TPB. Thompson et al. (1991) adapted and refined Triandis' model for IS con- texts and used the model to predict PC utilization. However, the nature of the model makes it particularly suited to predict individual acceptance and use of a range of information technologies. Thompson et al. (1991) sought to predict usage behavior rather than intention; however, in keeping with the theory's roots, the current research will examine the effect of these determinants on intention. Also, such an examination is important to ensure a fair comparison of the different models.	Complexity	Based on Rogers and Shoemaker (1971), "the degree to which an innovation is perceived as relatively difficult to understand and use" (Thompson et al. 1991, p. 128).
	Long-term Consequences	"Outcomes that have a pay-off in the future" (Thompson et al. 1991, p. 129).
	Affect Towards Use	Based on Triandis, affect toward use is "feelings of joy, elation, or pleasure, or depression, disgust, displeasure, or hate associated by an individual with a particular act" (Thompson et al. 1991, p. 127).
	Social Factors	Derived from Triandis, social factors are "the individual's internalization of the reference group's subjective culture, and specific interpersonal agreements that the individual has made with others, in specific social situations" (Thompson et al. 1991, p. 126).
	Facilitating Conditions	Objective factors in the environment that observers agree make an act easy to accomplish. For example, returning items purchased online is facilitated when no fee is charged to return the item. In an IS context, "provision of support for users of PCs may be one type of facilitating condition that can influence system utilization" (Thompson et al. 1991, p. 129).

Table 4.2. Models and Theories of Individual Acceptance (Continued)

Innovation Diffusion Theory (IDT)	**Core Constructs**	**Definitions**
Grounded in sociology, IDT (Rogers 1995) has been used since the 1960s to study a variety of innovations, ranging	Relative Advantage	"the degree to which an innovation is perceived as being better than its precursor" (Moore and Benbasat 1991, p. 195).

from agricultural tools to organizational innovation (Tornatzky and Klein 1982). Within information systems, Moore and Benbasat (1991) adapted the characteristics of innovations presented in Rogers and refined a set of constructs that could be used to study individual technology acceptance. Moore and Benbasat (1996) found support for the predictive validity of these innovation characteristics (see also Agarwal and Prasad 1997, 1998; Karahanna et al. 1999; Plouffe et al. 2001).	Ease of Use	"the degree to which an innovation is perceived as being difficult to use" (Moore and Benbasat 1991, p. 195).
	Image	"The degree to which use of an innovation is perceived to enhance one's image or status in one's social system" (Moore and Benbasat 1991, p. 195).
	Visibility	The degree to which one can see others using the system in the organization (adapted from Moore and Benbasat 1991).
	Compatibility	"the degree to which an innovation is perceived as being consistent with the existing values, needs, and past experiences of potential adopters" (Moore and Benbasat 1991, p. 195).
	Results Demon-strability	"the tangibility of the results of using the innovation, including their observability and communicability" (Moore and Benbasat 1991, p. 203).
	Voluntariness of Use	"the degree to which use of the innovation is perceived as being voluntary, or of free will" (Moore and Benbasat 1991, p. 195).

Table 4.2. Models and Theories of Individual Acceptance (Continued)

Social Cognitive Theory (SCT)	Core Constructs	Definitions
One of the most powerful theories of human behavior is social cognitive theory (see Bandura 1986). Compeau and Higgins (1995b) applied and extended SCT to the context of computer utilization (see also Compeau et al. 1999); while Compeau and Higgins (1995a) also employed SCT, it was to study performance and thus is outside the goal of the current research. Compeau and Higgins' (1995b) model studied computer use but the nature of the model and the underlying theory allow it to be extended to acceptance and use of information technology in general. The original model of Compeau and Higgins (1995b) used usage as a dependent variable but in keeping with the spirit of predicting individual acceptance, we will examine the predictive validity of the model in the context of intention and usage to allow a fair comparison of the models.	Outcome Expec-tations—Performance	The performance-related consequences of the behavior. Specifically, performance expectations deal with job-related outcomes (Compeau and Higgins 1995b).
	Outcome Expectations—Personal	The personal consequences of the behavior. Specifically, personal expectations deal with the individual esteem and sense of accomplishment (Compeau and Higgins 1995b).
	Self-efficacy	Judgment of one's ability to use a technology (e.g., computer) to accomplish a particular job or task.
	Affect	An individual's liking for a particular behavior (e.g., computer use).
	Anxiety	Evoking anxious or emotional reactions when it comes to performing a behavior (e.g., using a computer).

Table 4.2. Models and Theories of Individual Acceptance (Continued)

Unified Theory of Acceptance and Use of Technology (UTAUT)	**Core Constructs**	**Definitions**
The Theory was developed by Venkatesh, Morris, Davis, G., & Davis, F. in 2003. Its integrates the components of eight technology acceptance models and theories and it is more robust than other technology acceptance models in evaluating and predicting technology acceptance. The UTAUT has been used in various studies	Performance expectancy	"The degree to which a person believes that using a particular system would enhance his or her job performance."
	Effort Expectancy	"The degree to which a person believes that using a system would be free of effort."
	Social Influence	"The person's perception that most people who are important to him think he should or should not perform the behavior in question."
	Facilitating conditions	"Reflects perceptions of internal and external constraints on behavior and encompasses self-efficacy, resource facilitating conditions, and technology facilitating conditions."

Table 4.2. Models and Theories of Individual Acceptance (Continued)

Unified Theory of Acceptance and Use of Technology (UTAUT2)	**Core Constructs**	**Definitions**
The UTAUT2 was developed by Venkatesh , Thong, & Xu, in 2012 to pay particular attention to the consumer use context. It has proven to be a useful theoretical model in helping to understand and explain use behaviour is information system implementation. It has been tested in many empirical research studies and the tools used with the model have proven to be of quality and to yield statistically reliable results.	Performance Expectancy	"The degree to which a person believes that using a particular system would enhance his or her job performance."
	Effort Expectancy	"The degree to which a person believes that using a system would be free of effort."
	Social Influence	"The person's perception that most people who are important to him think he should or should not perform the behavior in question."
	Facilitating conditions	"Reflects perceptions of internal and external constraints on behavior and encompasses self-efficacy, resource facilitating conditions, and technology facilitating conditions."
	Hedonic Motivation	"The fun or pleasure derived from using a technology"

	Price Value	*value* as consumers' cognitive tradeoff between the perceived benefits of the applications and the monetary cost for using them (Dodds et al. 1991).
	Habit	the extent to which an individual believes the behavior to be automatic (e.g., Limayem et al. 2007).

Table 4.2. Models and Theories of Individual Acceptance (Continued)

Car Technology Acceptance Model (CTAM)	**Core Constructs**	**Definitions**
The Car Technology Acceptance Research Model (CTAM) was proposed by Osswald et al in 2012 and the model was based on recognized safety and anxiety factors with an expanded UTAUT model. When the CTAM was proposed, independent variables included the basic factors of the UTAUT such as Performance Expectancy (PE), Effort Expectancy (EE), Social Influence (SI), and Facilitating Conditions (FC). In addition, Anxiety (AX), Self-Efficacy (SE), and Perceived Safety (PS), Attitude towards Using Technology (ATT) were also included. Dependent variables included Behavioral Intention (BI) and Use Behavior (UB.	Anxiety	The authors define anxiety in the car context as the degree to which a person responds to a situation with apprehension, uneasiness or feelings of arousal. They point out the negative influence of anxiety on the attentional focus. Someone who is anxious may be less capable of handling a complex situation in which attention has to be divided over several objects or events. With regard to the automotive domain, anxiety seems to have an important influence on traffic safety.
	Self-Efficacy	The determinant self-efficacy is defined as a person's belief in his/her ability and competence to use a technology (e.g. a radio) to accomplish a particular task. It can play a major role in how one approaches a goal or a task as it is developed from external experiences and self-perception.
	Perceived Safety	Perceived safety is crucial when driving a car. The authors define perceived safety as the degree to which an individual believes that using a system will affect his or her well-being.
	Attitude Towards Using Technology	Attitude towards using technology is defined as an individual's overall affective reaction upon using a system. This determinant aims at reflecting the beliefs of the user regarding system usage and its effects.

Table 4.3 shows the key moderating factors introduced since the 1960s.

Table 4.3 Role of Moderators in Existing Models

Model	Experience	Voluntariness	Gender	Age
Theory of Reasoned Action	Experience was not explicitly included in the original TRA. However, the role of experience was empirically examined using a cross-sectional analysis by Davis et al. (1989). No change in the salience of determinants was found. In contrast, Karahanna et al. (1999) found that attitude was more important with increasing experience, while subjective norm became less important with increasing experience.	Voluntariness was not included in the original TRA. Although not tested, Hartwick and Barki (1994) suggested that subjective norm was more important when system use was perceived to be less voluntary.	N/A	N/A
Technology Acceptance Model (and TAM2)	Experience was not explicitly included in the original TAM. Davis et al. (1989) and Szajna (1996), among others, have provided empirical evidence showing that ease of use becomes nonsignificant with increased experience.	Voluntariness was not explicitly included in the original TAM. Within TAM2, subjective norm was salient only in mandatory settings and even then only in cases of limited experience with the system (i.e., a three-way interaction).	Gender was not included in the original TAM. Empirical evidence demonstrated that perceived usefulness was more salient for men while perceived ease of use was more salient for women (Venkatesh and Morris 2000). The effect of subjective norm was more salient for women in the early stages of experience (i.e., a three-way interaction).	N/A
Motivational Model	N/A	N/A	N/A	N/A

Table 4.3 Role of Moderators in Existing Models (Continued)

Model	Experience	Voluntariness	Gender	Age
Theory of Planned Behavior	Experience was not explicitly included in the original TPB or DTPB. It has been incorporated into TPB via follow-on studies (e.g., Morris and Venkatesh 2000). Empirical evidence has demonstrated that experience moderates the relationship between subjective norm and behavioral intention, such that subjective norm becomes less important with increasing levels of experience. This is similar to the suggestion of Karahanna et al. (1999) in the context of TRA.	Voluntariness was not included in the original TPB or DTPB. As noted in the discussion regarding TRA, although not tested, subjective norm was suggested to be more important when system use was perceived to be less voluntary (Hart-wick and Barki 1994).	Venkatesh et al. (2000) found that attitude was more salient for men. Both subjective norm and perceived behavioral control were more salient for women in early stages of experience (i.e., three-way interactions).	Morris and Venkatesh (2000) found that attitude was more salient for younger workers while perceived behavioral control was more salient for older workers. Subjective norm was more salient to older women (i.e., a three-way interaction).
Combined TAM-TPB	Experience was incorporated into this model in a between-subjects design (experienced and inexperienced users). Perceived usefulness, attitude toward behavior, and perceived behavioral control were all more salient with increasing experience while subjective norm became less salient with increasing experience (Taylor and Todd 1995a).	N/A	N/A	N/A

Table 4.3 Role of Moderators in Existing Models (Continued)				
Model	**Experience**	**Voluntariness**	**Gender**	**Age**
Model of PC Utilization	Thompson et al. (1994) found that complexity, affect toward use, social factors, and facilitating conditions were all more salient with less experience. On the other hand, concern about long-term consequences became increasingly important with increasing levels of experience.	N/A	N/A	N/A
Innovation Diffusion Theory	Karahanna et al. (1999) conducted a between-subjects comparison to study the impact of innovation characteristics on adoption (no/low experience) and usage behavior (greater experience) and found differences in the predictors of adoption vs. usage behavior. The results showed that for adoption, the significant predictors were relative advantage, ease of use, trial- ability, results demonstrability, and visibility. In contrast, for usage, only relative advantage and image were significant.	Voluntariness was not tested as a moderator, but was shown to have a direct effect on intention.	N/A	N/A
Social Cognitive Theory	N/A	N/A	N/A	N/A

4.1.3 Data Analysis

Based on a review of the extant literature, seven constructs appeared to be significant direct determinants of the intention or usage in one or more of the individual models. Performance Expectancy (PE), Effort Expectancy (EE), Social Influence (SI), Facilitating Conditions (FC), Hedonic Motivation (HM), Price Value (PV), Habit (H). The study adapts these constructs and extends the definitions from UTAUT2 to the autonomous vehicles. Here, ***Performance Expectancy*** is defined as the degree to which an individual believes that using autonomous vehicles will help him or her to attain gains in daily life activities, increase productivity, decrease possibilities of accidents on the road making driving more secure. PE also takes into consideration security features of the car; providing some level of satisfaction about trust, and privacy protection. ***Effort Expectancy*** is defined as the degree of ease associated with the use of autonomous vehicles. The ease is associated with learning how to use autonomous vehicles and how clear and understandable the interaction with the technology is. ***Social Influence*** is defined as the degree to which an individual perceives the importance others believes he or she should use in the technology. Social influence occurs when one's emotions, opinions, or behaviours are affected by others. Social influence takes many forms and can be seen in conformity, socialization, peer pressure obedience, persuasion, sales and marketing and review of information. Facilitating Conditions are defined as the degree to which an individual believes that technical infrastructure exists to support the use of the system. This support can be linked to the availability of necessary resources, the knowledge required to use the AVs, and the compatibility of the system with other technologies currently being used. Legislation, policies, law, liability, regulations and effort by the government and car manufacturers to better support users are only some of the elements covered by this construct. The empirical findings about the role of ***Habit*** in technology use have delineated different underlying processes by which it influences technology use. Related to the operationalization of habit as prior use, Kim and Malhotra (2005) found that prior use was a strong predictor of future technology use. Habit is the extent that individuals tend to execute behaviours automatically (Limayem, *et al*, 2007). ***Hedonic Motivation*** is defined as the fun or pleasure derived from using a technology, and it has been shown to play an important role in determining technology acceptance and use. ***Price Value*** is defined as the cost and pricing structure that may have a significant impact on consumers' technology use. In marketing research, the monetary cost/price is usually conceptualized together with the quality of products or services to determine the perceived value of products or services. The study follows these ideas and defines price value as consumers' cognitive tradeoff between the perceived benefits of the applications and the monetary cost for using them.

With regards to the moderating factors, Gender and Age have been selected. The experience was not adopted in this model because the technology has not yet been deployed.

4.1.4 Factors identified

At this stage of our investigation, the following factors have been identified (see table 4.4):

Table 4.4 Factors identified from document analysis

Constructs	Moderating factors
Performance Expectancy (PE)	Age
Effort Expectancy (EE)	
Social Influence (SI)	
Self-Efficacy (SE)	
Perceived Safety (PS)	
Hedonic Motivation (HM)	Gender
Price Value (PV)	
Trust (T)	
Anxiety (AX)	

4.2 Survey I

The purpose of this survey was firstly to examine public opinion regarding autonomous vehicle technologies. Secondly, to identify other possible constructs and moderating factors from the users perspective; with the potential to influence behavioural intention to accept autonomous vehicles that have not been recognised in the past.

4.2.1 Questionnaire design

The questionnaire was developed using the free tool Google form and administered online and via email whenever possible. The study also used social networking websites such as LinkedIn, Facebook and Twitter platforms. By creating our questionnaire using the online tool, it generates a unique link that could be shared electronically. The questionnaire was divided into four sections. Before anyone could start answering the questions there was an introductory paragraph providing the purpose of the study explaining to the participants how that all information collected would be anonymous and confidential. The four sections, dealt with the issues of security, privacy and trust, looking at the public attitude towards the introduction of autonomous vehicles. Furthermore, the questionnaire was exploring factors influencing the public acceptance or rejection of self-autonomous vehicles. In total there were 39 questions/items. All of the items used in the questionnaire were steadily and cautiously developed through pre-testing before being administered to a target sample.. The first section was looking at market adoption. Questions covered topics such as participants expectations in terms of autonomous vehicles benefits, security, privacy, trust and other concerns they had about the technology as well as how much they were willing to pay to have a completely autonomous enabled vehicle. Section 2 was about the impact this technology would have in various industries and how the world would be transformed as a result of the disruption. Section 3 was about factors that will most influence their decision to purchase or use the technology. The final section was about demographic questions to differentiate responses from different age groups, gender and educational achievement. It is important to clarify that participants also had the opportunity to propose other factors not included on the questionnaire list, but that could potentially influence their behavioural intention to accept or reject autonomous vehicles. Table 4.5 provides the list of questions in survey I. The full **questionnaire can be found in the Appendix B.**

Table 4.5 Brief Summary of the Questionnaire for Survey I (see Appendix B for the full questionnaire)

Section 1 – Market adoption
Q1. How knowledgeable were you about autonomous / driverless / self-driving vehicles before participating in this survey? *
Q2. What is your general opinion regarding autonomous and self-driving vehicles? *
Q3. How likely do you think it is that the following benefits will occur when using completely self-driving vehicles? *
Q4. How concerned would you be about driving or riding in a vehicle with self-driving technology? *
Q5. How concerned are you about the following issues related to self-driving vehicles?" *

Q6. How interested would you be in having a completely self-driving vehicle as the vehicle you own or lease? *

Q7. How much EXTRA would you be willing to pay to have completely self-driving technology on a vehicle you own or lease in the future? *

Section 2 – Industry impact and transformation

Q8. What industries will be affected by driverless vehicles deployment?

Q9. Assuming widespread adoption of driverless vehicles, which of the following will have the most impact in terms of determining faults in the event of accident? *

Section 3 – Public acceptance

Q10. What do you think would play an important role in the mass acceptance of autonomous vehicles? *

Q11. Amongst the following elements characterising various groups in our society, which key attributes do you think, will influence different groups in accepting or rejecting autonomous vehicles? *

Q12. Which of the following groups will have a major influence on the acceptance of autonomous vehicles? *

Q13. Which of the following factors will have a major influence on the acceptance of autonomous vehicles? *

Section 4 – Demographic questions

Q14. What is your gender? *

Q15. What is your age?

Q16. What is the highest qualification you have completed? *

4.2.2 Sampling

For the study, the sampling frame included anybody who uses cars (not necessarily able to drive one) but presently living in the UK, with the ability to respond to complex questions without the need of their parent or guardian authorisation. The study uses a **convenience sampling method.** The most respondents were staffs, parents or students attending higher education institutions. To maximise differentiation and understanding different viewpoints, our target population was in London. The target sample size was 350 from all age groups, races and cultural backgrounds with a minimum of 18 years of age. The above target sample size was based on other sizes identified in previous similar studies. See **table 4.6** below. **408** valid responses were received. Data was collected from staffs and students at London South Bank University and in another higher education providers (GSM London, British Institute of Technology & E-commerce) and other random places across the capital. Examples are parents at the researcher’s children’s school, family members, colleagues and friends. Other members of the public were also suitable to answer questions in the survey. No prior knowledge of autonomous vehicles was necessary as relevant information was provided at the beginning of the survey.

Table 4.6 Previous research of similar models (UTAUT and UTAUT2)

Author	Number of valid responses	Researched technology/setting	Data gathering
(Carlsson, Carlsson, Hyvonen, Puhakainen, & Walden, 2006)	157	Consumer technology	Likert Scale Questionnaire
(Wu, Tao, & Yang, 2007)	292	Consumer technology (3G mobile communication users)	Questionnaire (type of questionnaire not mentioned)
(Yu, 2012)	162	Consumer technology (Mobile Banking)	Likert Scale Questionnaire
(Tan, 2013)	196	Educational	Likert Scale Questionnaire
(Escobar-Rodríguez & Carvajal-Trujillo, 2014)	128	Consumer technology (Good and Service Tax Application system)	Likert Scale Questionnaire
Oliver Oechslein , Marvin Fleischmann, Thomas Hess, 2014	266	Social Recommender Systems	Likert Scale Questionnaire
(Slade, Williams, Dwivedi, & Piercy, 2015)	244	Consumer technology (Mobile payments)	Likert Scale Questionnaire
(Jorge Arenas-Gaitan, Begona Peral-Peral, Maria Angeles Ramon-Jeronimo, 2015)	415	Internet Banking and Commerce	Likert Scale Questionnaire

4.2.3 Pilot study

Prior to using the questionnaire for our actual data collection, it was pilot tested. The questionnaire was given to 9 people. These were colleagues and family members. The purpose of the pilot test was to refine the survey so that the target participants would have no difficulties in answering the questions and there would be no problem in recording the data. They all made important contributions in improving questionnaire design and helping the researcher to evaluate the questions' validity and accuracy.

4.2.4 Result of the Survey

Table 4.7 Demographic breakdown for the final 408 respondents

Demographic aspect		**U.K. (N=408)**	**Percentage (%)**
Age group	18 - 24	37	9.1
	25 - 34	152	37.3
	35 - 44	124	30.4
	45 - 54	59	14.5
	55 - 64	31	7.6
	65 & Over	5	1.2
Gender	Male	296	72.5
	Female	112	27.5

This survey was carried out to help us determine people's opinions regarding the introduction of autonomous and self-driving vehicles in the UK. **Table 4.7** represents the demographic breakdown of the group of **408** people who responded to the first survey.

4.2.4.1 Main factors influencing the participants acceptance of AV

The following factors were identified as aspects with the ability to influence participants:

Table 4.8 List of potential factors/moderating factors influencing acceptance of AV

Factors proposed by participants	Actual factors of the model
• Performance expectancy • Software installed (apps...) • Hardware (e.g. Engines, car ...) • Protocol (LTE, IEEE 802.11p…) • Technology accuracy	Performance Expectancy (PE)
• Facilitating conditions • Effort expectancy • Learning curve necessary	Effort Expectancy (EE
• Advertisement (Newspaper, TV, Internet, etc...) • Mass acceptance by celebrities • Social influence • Journalists • Politicians • Engineers • Scientists • Celebrities • Friends • Family members • Society • Culture • The system (e.g. Capitalism, Socialism ...)	Social Influence (SI)
• Job relevance • Social status • It totally depends on how safer I feel to be in an automated vehicle	Self-Efficacy (SE)
• Reassurance from car manufacturers (Safety, privacy, trust, security) • Passenger safety	Perceived Safety (PS)
• Worry • Concerns • Nervousness	Anxiety (AX)
• Reassurance from car manufacturers (Safety, privacy, trust, security) • Trust • Track record of the car over time • Confidence • Faith on the technology	Trust (T)
• Law enforcement • Legislators • Liability • Rules and regulations imposed by the government	Legal Regulation (LR)
• Voluntariness of use • Pleasure of using the technology	Hedonic Motivation (HM)

• Car insurance discount for autonomous car owners • Cheap Insurance premium • Cost of the vehicle • Maintenance cost	Price Value (PV)

Some factors available on table 4.8 were presented to the participants and they had the freedom of selection. They also had the opportunity to propose their own factors not available on the list.

4.2. Other findings from the survey I.

Note: *It is important to note that* ***Q*** *stands for the* ***Survey Question.***

The population selected for this survey were university students, lecturers and other higher education staff members. Regarding their level of familiarity with autonomous vehicles, most respondents who had previously heard of autonomous or self-driving vehicles had a positive initial opinion of the technology and had grand expectations of the benefits of the technology.

Ever heard of autonomous or self-driving vehicles (Q1). Respondents who had previously heard of autonomous or self-driving vehicles were more likely to expect crash-reduction benefits (Is that crash or cash reductions) and better fuel economy. These respondents were also less concerned about learning to use self-driving vehicles, and even less concerned about self-driving vehicles moving around while unoccupied. Those having previously heard of self-driving vehicles were more likely to say that they were interested in having this technology on their vehicle (s). Conversely, those who had not previously heard of self-driving vehicles were more likely to say they would not ride in such said vehicles.

Initial opinion of autonomous and self-driving vehicles (Q2). Predictably, a respondent's initial opinion of self-driving vehicles had a significant effect on nearly every response.

Ever heard of connected or self-driving vehicles. Opposite trends were found regarding whether respondents had ever heard of each vehicle type. While most individuals had previously heard of self-driving vehicles, a majority had not previously heard of connected vehicles.

Expected benefits. Similar trends were found regarding respondents' expectations for potential benefits of each vehicle type (Level). A majority felt that the expected benefits were likely to occur with all vehicle levels, with the exceptions being that most respondents felt that less traffic congestion and shorter travel time were each unlikely to occur with self-driving vehicles.

Most participants are very positive about the possibilities of fewer car accidents and they believe that with autonomous vehicles, driving time would be shorter than the current situation. In the future, after the full implementation of AV technology, car insurance rates will be lower than the present costs. Most participants are very concerned about drivers' liability in case of an accident. For example, if there was an accident involving an autonomous vehicle with only passengers and no driver, who would be penalised? The car manufacturer or the car owner?

However, many respondents expressed a high degree of concern about riding in autonomous vehicles, with security issues related to autonomous vehicles not performing as well as actual drivers. In general, respondents expressed an important level of concern about vehicles without driver controls; self-driving vehicles moving while unoccupied and self-driving commercial vehicles, buses, and taxis. Most participants are very concerned about the system security and the risk of being targeted by computer hackers or by any other third-party attackers if the security of the car is not robust enough. Most participants are very concerned about information collected about the location of their vehicles. Particularly if that information falls into the wrong hands, the attacker will be able to have a very clear picture of the user habits and possibly their lifestyle.

Most respondents expressed a desire to have this technology in their vehicle. However, the majority were also unwilling to pay anything extra for the technology; those who were willing to pay offered similar amounts. Most respondents do not want to pay anything extra. Higher proportion of people are willing to pay £500 - £999 extra to own this type of vehicles. A smaller group may be willing to pay more than £10000 to own such cars. Females expressed higher levels of concern with autonomous vehicles than the males did. Similarly, females were more cautious about their expectations concerning benefits from using self-driving vehicles.

Concerns (Q5). While respondents expressed concern about using each vehicle type, a higher level of concern was expressed regarding the use of self-driving vehicles. However, concern was high in both studies regarding data privacy for our respondents.

Interest in owning (Q6). Interest in having connected-vehicle technology was much higher than the interest in having self-driving technology on respondents' vehicles.

Willingness to pay (Q7). A higher percentage of respondents were willing to pay extra for connected-vehicle technology. However, those who were willing to pay for self-driving technology were willing to pay more than those who would pay for connected vehicle technology.

Gender (Q14). For all but one question regarding concerns with self-driving vehicles (the single exception being data-privacy concerns), females were more likely to express higher levels of concern compared to males. Similarly, females generally felt that the majority of the expected benefits with self-driving vehicles were unlikely to occur. (In contrast, a majority of males felt that the expected benefits were likely to occur.)

Age (Q15). Younger respondents were more likely to expect less traffic congestion, shorter travel time, and lower insurance rates with self-driving vehicles. They were also less concerned about commercial self-driving vehicles than older respondents. Younger respondents were more interested in having self-driving technology on their vehicle, and less likely to say that they would not ride in self-driving vehicles.

Education (Q16). Higher education levels were associated with higher expectations that self-driving vehicles will result in fewer crashes, reduced severity of crashes, less traffic congestion, shorter travel times and lower insurance rates. Individuals with a bachelors degree were less concerned about self-driving commercial vehicles than those with higher or lower education levels. Higher levels of education were associated with greater interest by respondents in having self-driving-technology on their vehicle and being less likely to say that they would not ride in self-driving vehicles.

4.3 Interview

Following the review of the literature on technology acceptance models and theories, it was clear that 3 main fields of study were to be involved in the discussion of factors influencing acceptance of Autonomous Vehicles. Therefore, the purpose of using this second data collection technique was to discuss the topic with subject experts in psychology, sociology and computer science to triangulate the findings, to get other perspectives and to present a comprehensive analytical framework in which to examine the roles of, and the relationships between, human factors and non-human factors which are involved in or influencing public acceptance of the autonomous vehicle. At this stage, the researcher had some ideas about the shape of our proposed model. He also wanted to refine the proposed model/theory, to help the development of the questionnaire for the subsequent quantitative survey used to test the model. He wanted to confirm the relevance of and sharpen the hypotheses for the study. Face-to-face interviews were conducted with experts working in various universities and higher education providers in the UK including London South Bank University, King's college London, GSM London and University of Hertfordshire. By collecting this data and the analysis of the key pieces of the puzzle, the researcher should be able to develop a model for understanding public acceptance of autonomous vehicles as a disruptive technology which could then be used for other disruptive technologies.

4.3.1 Sample and selection of participants

The main purpose of this phase of the study was to first validate the findings from the survey and to expand our current list of possible factors influencing people or playing a role in the acceptance or rejection of autonomous vehicles as a disruptive technology. The researcher was also looking at the cognitive process and cognitive indicators underpinning people's thoughts when facing a technology that could be disruptive. Those details were collected by means of a qualitative method. Firstly, in this study's qualitative phase the researcher selected purposively a total of 15 participants with 5 psychologists, 5 sociologists and 5 computer scientists from various universities and higher education providers in UK including London South Bank University, King's college London, GSM London and University of Hertfordshire. These were academics or professionals considered to be able to answer complex questions on human behaviour facing new technology. Face-to- face interviews or by Skype with all participants at their places of work were undertaken. The researcher conducted these interviews between **October 2015 and January 2016.**

4.3.2 Data collection process

The current study adopts a semi-structured format with opportunities of probing questions because this type enables us to obtain sufficient information to address key issues represented by the questions of what, why, from what and how. It allowed the respondents to express their own points of view and to describe situations, events and their experiences regarding the influences of human and non-human actants playing a role in the acceptance or rejection of autonomous vehicles as a disruptive technology. The researcher was also exploring the cognitive process and cognitive indicators underpinning people's thoughts. The researcher contacted all participants a few days before the interviews took place to explain the nature and aims of the research and to set an appropriate time to conduct a personal interview. Authorization was requested to make digital audio recordings of the interviews. Most respondent didn't have any problem with the audio recordings. Each interview lasted between 35 and 55 minutes. The researcher pilot-tested the interview protocol on three participants (selected from those who had completed the questionnaire in the quantitative phase of the study), whom were felt to have the relevant experience, ability and knowledge to answer these questions. Based on the pilot interviews, the researcher changed the order of the questions slightly, adding some more probing questions.

4.3.3 Interview protocol development

These groups of specialists were selected mainly because throughout the years experts from their fields have been the professionals developing previous technology acceptance models and theories. The experts from those fields were consulted to help the researcher further refine the proposed constructs and achieve a common goal reflecting all relevant perspectives of the problem. The questions designed for the psychologist were slightly different from those designed for the sociologists and computer scientists. For the psychologist, the protocol consisted of twelve open-ended questions exploring the cognitive process and cognitive indicators underpinning people's thoughts. The first question asked participants about their general view on self-driving cars. The second question asked about what the participants would identify as the key influences of psychology in the development of innovative technologies. The third question asked participants to explain the typical cognitive process that one experiences when facing an eventual technology that could be disruptive like the self-driving car. The fourth question asked about the cognitive indicators that underpin people's thoughts with regards to the acceptance or the rejection of an innovative technology. The fifth question asked if the changes in our environment influenced our behavioural intentions towards acceptance or rejection of innovative technology that could be disruptive. The sixth question asked from a psychologist perspective, what measure(s) could be put in place to maximize the public acceptance of this innovative technology. The seventh question highlighted the issue that people are emotionally attached to their car, therefore with the introduction of autonomous vehicles and the car sharing services, what are the likely impacts on people's behaviour and on our society. The eighth question asked about the key indicators showing that the public have accepted the technologies. The ninth question asked about what the changes in behaviour and psychological problems could be emerging from the introduction of this new technology. The tenth question was about the Knowledge Attitude and Practice model (KAP) and how it could be used to observe aspects of human thought and behaviour to develop a model for understanding and evaluating the acceptance of disruptive technologies. The eleventh question was about the key pieces of the puzzle that will underpin the mass adoption of autonomous vehicles. For the twelfth question, the participant was asked if there was anything he wanted to add regarding the human and non-human factors influencing public acceptance of disruptive technologies.

For the sociologist, the protocol consisted of eleven open-ended questions exploring the human and non-human actants influencing people acceptance or rejection or autonomous vehicles as a disruptive force. The first question asked participants about the key influences of sociology during the development of innovative technologies. The second question asked about factors more likely to influence people's behavioural intention with regards to acceptance of self-driving cars. The third question about the influence of the cultural actant on people's acceptance of the technologies that could be disruptive. The fourth question asked about the influence of the structural actant on people's acceptance of the technologies that could be disruptive. The fifth question was about hypothetical problems faced by people within society due to the introduction of disruptive technologies such as the self-driving car. The sixth question was about the influence of the human actant on people's acceptance of the technologies that could be disruptive. The seventh question was about the main indications that people have accepted and have adopted an innovative technology. The eighth question was about the measure that could be put in place to maximize people's acceptance of disruptive technologies. The ninth question was about the factors in modern society influencing people to reject disruptive technologies. The tenth question was about the key pieces of the puzzle that will underpin the mass adoption of autonomous vehicles. For the eleventh question, the participant was asked if there was anything he wanted to add regarding the human and non-human factors influencing public acceptance of disruptive technologies. At the end of the interviews, all participants were assured that the researcher would not include any personal identifiers in the transcribed data reports. The participants' names were therefore replaced with codes.

For the computer scientists, the protocol consisted of ten open-ended questions exploring topics such as safety, privacy of information, trust, security, software and hardware of the technology. The first question asked participants about their general opinion on self-driving cars. The second question asked about the real reasons of the introduction of self-driving cars in the market. The third question was about their opinion concerning the cyber-security issues and hacking in relation to self-driving cars. The fourth question was about their opinion concerning the issue of trust in relation to self-driving cars. The fifth question was about their opinion concerning the issue of privacy of information in relation to self-driving cars. The sixth question was about which organisation should own the data collected on users and passengers. The seventh question was about the issue of cost of the technology. The eighth question was about the legal implications and the liability issues. The ninth question was about the dangers related to the deployment of this technology. The tenth question was about the human factors that would influence the introduction of this innovative technology.

At the end of the interview, the researcher spent a few minutes discussing the proposed model. Several important suggestions were provided. It is at this stage that socioeconomic status or social class were identified as possible moderating factors.

4.3.4 Qualitative data analysis

The digital recordings were transcribed within two or three days of each individual interview. The questions asked were transcribed in italics and the participants' responses in plain text. Each transcript was also labelled with the participant's details, the name of organisation and location, as well as a code number assigned to each participant by the researcher. Each transcribed interview was given a number and saved in a separate word-processor file. This study's approach to qualitative analysis is based on inductive thinking. The researcher used a specialist software called "NVIVO" for our qualitative data analysis. Answers provided by each interviewee were coded and later analysed.

When asked about the influence of culture as an actant or construct, most sociologists interviewed believe that culture will play a major role on people's behavioural intentions to accept autonomous vehicles. The following quote is from a sociologist:

"This for me is a more difficult question to answer. I find it quite hard to think how they will influence people's acceptance, only as far as media. I bring in media again, because media is part of the culture, the media is affected by one's arts and beliefs. It also depends on what the extent of your population bases and geographical bases of your definition of what a culture is. You know there is a western culture, eastern culture, even if one is looking through the United Kingdom it might be a regional culture, a London based trendy culture versus stereo type again or a northern England, more traditional culture. So I think the answer really depends on one context of the definition of culture. I can only relate to myself, I don't feel any cultural attachment to any country. For example, I am British, I live in Switzerland and I am married to an American, so I feel very international. I feel the influence of a very international culture. So if I bring it to my individual self, I don't think that there are any particular cultural factors that would influence my acceptance of technology, I

would be more as I said before to do with the impact and the rational for such a technology."

The computer scientists were very enthusiastic about the technology as it can be expressed in the quote below:

"Autonomous Vehicles is something that is good. I think we should expect it as part of the evolution of the technology. The automobile industry hasn't moved on in the way it should have in the past so of 100 years and I think autonomous vehicles and the self-driving should really make a revolutionary impact on the way we sort of travel and the way we sort of transport."

At the same time computer scientists were very worried about the issues of trust, cyber security, privacy and who should actually keep the data collected by these vehicles.

"Trust is a big question. The way the German manufacturers are going at the moment, with the VW, I think people have lost with car manufacturers anyway, the issue is … to me, it is inevitability. It is almost like: there are certain things in life that inevitably will change."

The psychologists were a bit worried about the impact of such technology on people. Some psychologists were completely against the technology and were ready to strongly oppose their introduction into the market.

"I am a bit worried about the impact on the society, in terms of cognitive prospective and individual intellect; about people's cognitive processes going into sleep mode. The psychologists will play a significant role in persuading people to accept the technology. For me I will fight this with everything I have got. This is dangerous for humanity, it will make us lazy."

Some other psychologists believed this technology will change the way we do things, the way we act, the way we interact with society, the way we work and thus appreciate life in general.

"This will affect our cognitive processes; the initial staging emotions in human brain will change, fear, refusal to adapt which will manifest in different ways, generally boycotting, questioning. In terms of the cognitive indicators, fear of something new, how much do we know about the technology? Measures put in place to maximise mass

acceptance will be important. The majority parts of human decisions are guided by emotion. The best way is to have advertisements that tap into the subconscious and emotional parts of individual's brains to create an automatic non force attachment, acknowledgment and acceptance."

They also believe that car sharing may not be positively accepted.

"*Car sharing schemes may have a negative impact: decrease the emotional attachment, the car will become like public transport…"*

To the question on what may be some of the key indicators that people have accepted the technology? Psychologists responded as follows:

"Once it is fully produced or prior to the production. If it is prior to the production; contributing to social media, discussion and blogging about this technology, initial discussion is an indicator that there is interest which is usually 3 stages: the initial stage would be showing interest wanting to talk about it, 2nd stage would be about individual identifying pro and cons, forming the attachment, 3rd stage will be about making decisions, and the buying process."

The qualitative part of this investigation was very interesting. The views from different academic groups (psychologists, sociologists and computer scientists) were sometime in opposing directions. For example, most computer scientists were very excited about the introduction of this disruptive technology, but several psychologists were strongly opposed to the introduction of such technology because of the negative impact on human abilities particularly being reduced. They were all very worried about the issues of security, trust, privacy, liability. The cultural influence was another aspect of the model with conflicting opinions. Some sociologists and psychologists reported that culture will not have any influence while computer scientists thought it may influence people behavioural intention particularly referring to acceptance of new information systems in large organisation and the confrontation with the company culture. Other participants were not completely sure. The concept of socioeconomic status or social class was proposed by two sociologists. It was also highlighted that scientists have had enormous difficulties measuring the social class. Some psychologists highlighted that 95% of human decisions are based on emotions. They described the typical cognitive process people go through when they are confronted with an innovative technology. The phases are fear for change, refusal to adapt which manifests in diverse ways. The initial stage is boycotting and questioning the innovative technology coming into place. They may later be influenced by friends, trusted family members, celebrities, and the media who generally tap on their subconsciousness and later have a huge impact on their action.

4.3.5 Factors identified

At this stage of our investigation, the following factors have been identified and confirmed (see table 4.9):

Table 4.9 Factors identified from document analysis

Table 4.9 Factors identified from document analysis	
Constructs/Determinants	**Moderating factors**
Performance Expectancy (PE)	Age
Effort Expectancy (EE	
Social Influence (SI)	
Self-Efficacy (SE)	
Perceived Safety (PS)	
Anxiety (AX)	Gender
Trust (T)	
Legal Regulation (LR)	
Hedonic Motivation (HM)	
Price Value (PV)	

At the end of this stage, a new moderating factor was identified, and the other proposed constructs were confirmed.

4.4 Proposed Model and Hypothesis development

The proposed model below was based on data collected from Survey I, data available in the literature and data collected from the interviews with the experts and professionals. The model went through several versions and was refined with the input of academic experts from various fields.

4.4.1 The proposed model

Figure 4.2 provides a brief description of the research model constructs.

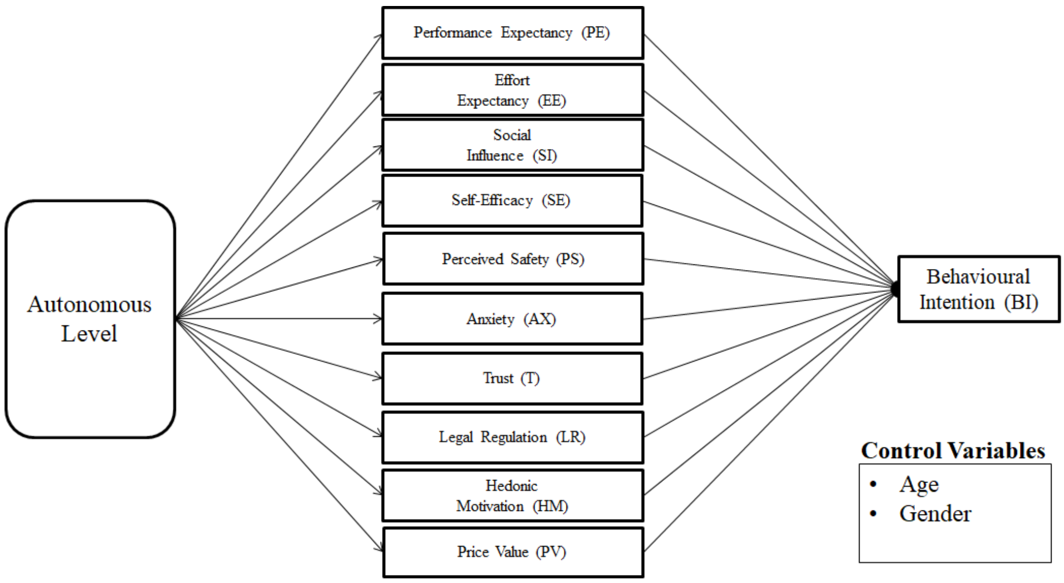


Figure 4.2. Proposed Research model for Measuring consumers' behavioural intention to adopt Autonomous Vehicles: (AVTAM)

4.4.2 Hypothesis Development

Based on the proposed model, the following hypothesis were identified

Performance Expectancy (PE)

Performance expectancy is defined as the degree to which an individual believes that using autonomous vehicles will help him or her to attain gains in daily life activities, increase productivity, decrease possibilities of accidents on the road and makes driving more secure. PE also takes into consideration security features of the car; providing some level of satisfaction about trust, and privacy protection. Gender and age is theorised to play a moderating role. The influence of performance expectancy on behavioural intention will be moderated by gender and age, such that the effect will be stronger for men and in particular, younger men. Even as these constructs evolved in the literature, some authors acknowledged their similarities: usefulness and extrinsic motivation (Davis et al. 1989, 1992), usefulness and job-fit (Thompson et al. 1991), usefulness and relative advantage (Davis et al. 1989; Moore and Benbasat 1991; Plouffe et al. 2001), usefulness and outcome expectations (Compeau and Higgins 1995b; Davis et al. 1989), and job-fit and outcome expectations (Compeau and Higgins 1995b).

H1: *Performance Expectancy will be positively related to behavioural intention of using autonomous vehicles.*

Effort Expectancy (EE)

Effort Expectancy is defined as the degree of ease associated with the use of autonomous vehicles. The ease is associated with learning how to use autonomous vehicles and how clear and understandable the interaction with the technology is. The influence of effort expectancy on behavioural intention will be moderated by gender, age and experience. It is suggested that effort expectancy is more salient for women than for men. The gender differences predicted here could be driven by cognitions related to gender roles. Increased age has been shown to be associated with difficulty in processing complex stimuli and allocating attention to information. Thus, the study proposes that effort expectancy will be most salient for women, particularly those who are older and with relatively little experience with autonomous vehicles. The influence of effort expectancy on behavioural intention will be moderated by gender, age and experience, such that the effect will be stronger for women, particularly younger women and particularly at early stages of experience. There is substantial similarity amongst the construct definitions and measurement scales. The similarities among these constructs have been noted in prior research (Davis *et al.* 1989; Moore and Benbasat 1991; Plouffe *et al.* 2001; Thompson *et al*. 1991).

H2: *Effort Expectancy will be positively related to behavioural intention of using autonomous vehicles.*

Social Influence (SI)

Social Influence is defined as the degree to which an individual perceives the importance that others believe he or she should use the technology. Social influence occurs when one's emotions, opinions, or behaviours are affected by others. Social influence takes many forms and can be seen in conformity, socialisation, peer pressure obedience, persuasion, sales and marketing and review of information. Furthermore, social influence as a direct determinant of behavioural intention contains the explicit or implicit notion that the individual's behaviour is influenced by the way in which they believe others will view them as a result of having used autonomous vehicles. The impact of social influence on behavioural intention will be moderated by gender, age and experience, such that the effect will be stronger for women, particularly older women, particularly older women in mandatory stages of experience. The following elements are included in this factor: journalists, expert reviewers, friends, family and media. Social influence as a direct determinant of behavioural intention is represented as a subjective norm in TRA, TAM2, TPB/DTPB and C-TAM-TPB, social factors in MPCU, and image in IDT. Thompson et al. (1991) used the term social norms in defining their construct and acknowledging its similarity to subjective norm within TRA. While they have different labels, each of these constructs contains the explicit or implicit notion that the individual's behaviour is influenced by the way in which they believe others will view them as a result of having used the technology.

H3: *Social Influence will be positively related to behavioural intention of using autonomous vehicles***.**

Self-Efficacy (SE)

The determinant self-efficacy is defined as a person's belief in his/her ability and competence to use a technology (e.g. a radio) to accomplish a particular task. It can play a major role in how one approaches a goal or a task as it is developed from external experiences and self-perception. In the Autonomous car context, people with high self-efficacy - those who believe they can perform well - are more likely to view a difficult task as something to be mastered rather that something to be avoided. Aligning results from this construct with results from the perceived safety construct, the researcher believes that this will gives us an interesting insight into how an information system-related task is judged based on users' personality characteristics.

H4: *Self-Efficacy will be positively related to behavioural intention of using autonomous vehicles***.**

Perceived Safety (PS)

Perceived safety is defined as the degree to which an individual believes that using a system will affect his or her well-being. The researcher named the construct perceived safety considering the self-reflective character of perceiving a situation hazardous. Within the autonomous car, this also compromises the judgment of one's own driving skills and safety feeling in relation to other drivers. The impact of perceived safety is assumed as critical in the process of predicting the behavioural intention to use, as the user will estimate the potential effect of safety-related consequences through using the technology on public road and dangerous environments. The following elements are included in this factor: vehicle security and safety, cyber security concerns.

***H5**: Perceived Safety will be positively related to behavioural intention of using autonomous vehicles.*

Anxiety (AX)

The emotional aspect of technology usage is expected to be captured through a construct called anxiety. Anxiety is defined as an individual's apprehension or even fear when he or she is faced with the possibility of using computers (Rana *et al*., 2016; Simonson, Maurer, Montag-Torardi, & Whitaker, 1987). In the autonomous car context as the degree to which a person responds to a situation with apprehension, uneasiness or feelings of arousal. The factors Anxiety and Behavioural Anxiety differs with regards to their origin, as Anxiety was derived from a computer anxiety construct described within the SCT and were used earlier in the UTAUT validation. Behavioural Anxiety otherwise reflects anxiety in a more general understanding towards the autonomous vehicle or system behaviour which addresses e.g. the fear to lose control of the car. A substantial body of research in IS and psychology has revealed the relevance of computer anxiety by demonstrating its impact on attitudes (e.g., Howard & Smith, 1986; Igbaria, 1990; Igbaria & Chakrabarti, 1990; Igbaria & Parasuraman, 1989; Morrow, Preix, & McElroy, 1986; Parasuraman & Igbaria, 1990). For example, Igbaria (1990) suggested that individuals high in computer anxiety will have negative attitudes toward using a computer (Dwivedi *et al*, 2017; Rana *et al*, 2016).

***H6**: Anxiety will be negatively related to behavioural intention of using autonomous vehicles.*

Trust (T)

The acceptance of the truth of statements from AV manufacturers without the evidence or investigation; is the belief in the reliability, truth or ability of the car. The belief is that the users can trust the cars and the algorithm then to function as advertised whilst still protecting consumers' privacy.

***H7**: Trust will be positively related to behavioural intention of using autonomous vehicles.*

Legal Regulation (LR)

The rules or directives made and maintained by an authority and transportation regulatory bodies. The following elements are included in this factor:

Legislation, policies, law, liability, regulations, effort by the government and car manufacturers to better support users

***H8**: Legal Regulation will be positively related to behavioural intention of using autonomous vehicles.*

Hedonic Motivation (HM)

Hedonic Motivation is defined as the fun or pleasure derived from using a technology, and it has been shown to play an important role in determining technology acceptance and use. In IS research, such hedonic motivation (conceptualized as perceived enjoyment) has been found to influence technology acceptance and use directly (e.g., van der Heijden 2004; Thong et al 2006). In the consumer context, hedonic motivation has also been found to be an important determinant of technology acceptance and use (e.g., Brown and Venkatesh 2005; Childers et al. 2001). Thus, we add hedonic motivation as a predictor of consumers' behavioural intention to use the technology.

The influence of hedonic motivation on behavioural intention will be moderated by gender, age and experience.

H9: *Hedonic Motivation will be positively related to behavioural intention of using autonomous vehicles.*

Price Value (PV)

The cost and pricing structure may have a significant impact on consumers' technology use. In marketing research, the monetary cost/price is usually conceptualized together with the quality of products or services to determine the perceived value of products or services (Zeithaml 1988). We followed these ideas and define price value as a consumers' cognitive trade-off between the perceived benefits of the applications and the monetary cost for using them. The price value is positive when the benefits of using a technology are perceived to be greater than the monetary cost and such a price value has a positive impact on intention. Thus, price value has been added as a predictor of behavioural intention to use autonomous vehicles. The following elements are included in this factor: Cost of the vehicle, operational cost and maintenance cost, cost of network protocols being used LTE/WAVE/Wifi.

H10: *Price Value will have a significant influence on behavioural intention of using autonomous vehicles***.**

Behavioural Intention (BI)

Behavioural intention is defined as an individual's intention to perform a given act which can predict corresponding behaviours when an individual acts voluntarily. Besides that, behavioural intention is the subjective probability of carrying out behaviour and also the cause of certain usage behaviour [9]. Thus, intentions show the motivational factors that influence behaviour and are indicators of how hard people are willing to try and the effort they put in to engage in a particular behaviour. Also, it was found that behavioural intention is to be the main factor of individual mobile services usage and that usage intentions are rational indicators of future system use.

Figure 4.3 represents the key hypothesis developed to test the proposed model.

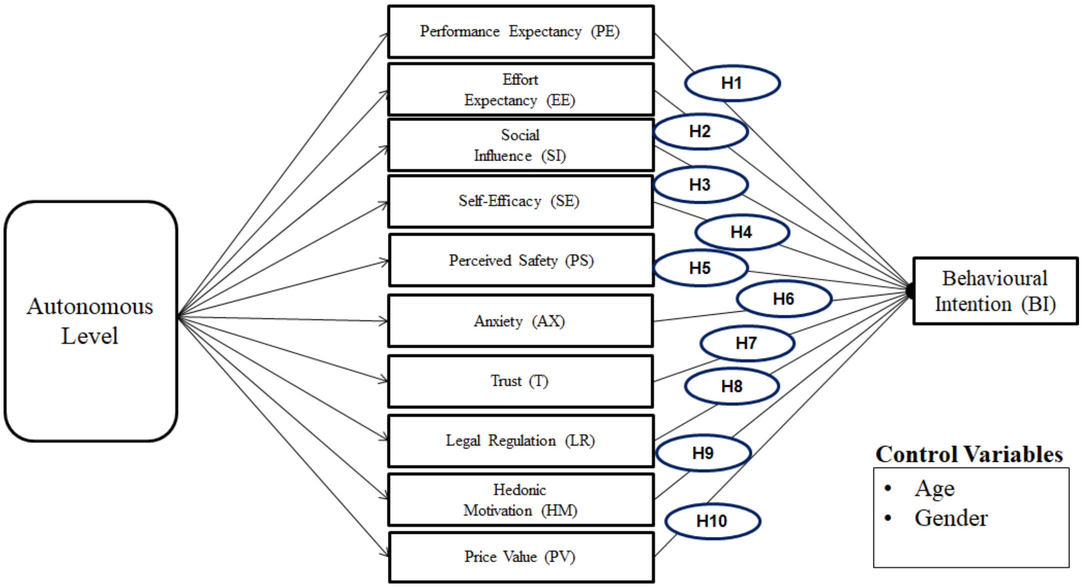


Figure 4.3. Proposed Research model hypothesis (H1 – H10)

4.5 Ethical Considerations for Phase I

According to Fouka and Mantzorou (2011), when conducting a piece of research it is important for the researchers to be aware of some ethical considerations, which include respect for privacy, respect for anonymity, confidentiality and beneficence that is doing no harm. Ethical considerations can emerge in the design and undertaking of research and in the reporting of findings, and cover issues such as informed consent, openness, honesty, privacy and confidentiality (Veal, 2006).

The data collection started in October 2015. Before any data could be collected, the School of Engineering at London South Bank University required the author to obtain ethical approval covering the period of investigation. This ethical application was submitted in September 2015 to Research Ethical Committee (REC) at LSBU, and then granted in October 2015. It ensured the research conformed to each requirement of London South University ethical protocol. Once ethical approval was granted, the first phase of the research started with the survey. It was conducted mainly amongst participants in London aged 18 or over. The survey began in October 2015 and ended in January 2016. Participants were contacted via email with the link to have access to the online questionnaire. Emails were sent to staff members at London south Bank University and to students and staff members at GSM London. In parallel, participants for the interview were contacted and invited to take part in the research as part of the second phase conducted amongst academics from the department of Psychology and Sociology at London South Bank University and at GSM London. Initial letters were sent to managers to request permission to make contact with the members of staff. Once the request was approved, a written confirmation via-email was sent to individual participants with information about the research topic and notifying them of their rights. If the participant requires further information or wishes to withdraw consent, they were provided with further explanation about the research or that they had the right to withdraw from the study.

All respondents automatically received the information sheet for participating and consent forms via email with detailed information about the nature of the research. During data collection, participants were interviewed only after their approval had been obtained for conducting personal interviews. They were also informed by the researcher that, if any issues or comments were felt to be contentious or could possibly harm the participants, they would be referred to anonymously in the text. The data collected was saved and stored as electronic files on the personal drive of the researcher's password protected computer network and accessed only by the researcher. All interviews were audio-recorded with the participant's permission so that all appropriate information could be used. To maintain anonymity, no identifiable personal details were requested during the interview. Participant's names and location were removed from the research data/reports/research publications. Any details which could potentially identify the participants were also removed. Hardcopies such as field notes and transcripts were stored in a locked cupboard in the university research office within the vicinity of the researcher until moved to an electronic file. Data from interviews and the survey were anonymised. Data recorded was fully transcribed and coded and was stored electronically and only the researcher and supervisor (s) had access to them. Participants were to be invited to receive a summary of the research findings.

4.6 Summary

The purpose of this phase was largely to identify all possible factors influencing people's behavioural intention to Adopt Autonomous Vehicles. The researcher started this phase with a brainstorming activity, followed by an investigation of material already available in the literature and finally he did an initial survey and series of interviews with experts and professionals in the field of psychology, sociology and computer science. These groups were selected because of their connection with previous models and theories developed in the past.

Response from the survey demonstrates that most respondents had previously heard of autonomous or self-driving vehicles, had a positive initial opinion of the technology, and had also grand expectations about the benefits of the technology. However, many respondents expressed important levels of concern about riding in self-driving vehicles, security issues related to self-driving vehicles, and self-driving vehicles not performing as well as actual drivers. Respondents also expressed important levels of concern about vehicles without driver controls; self-driving vehicles moving while unoccupied self-driving commercial vehicles, buses, and taxis. The majority of respondents expressed a desire to have this technology in their vehicle. However, a majority was also unwilling to pay extra for the technology; those who were willing to pay offered similar amounts. Females expressed higher levels of concern with self-driving vehicles than did males. Similarly, females were more cautious about their expectations concerning benefits from using self-driving vehicles.

Chapter 5 Phase – II: Measuring Behavioural Intention to Use Autonomous Vehicles

5.1 Introduction

The overall drive of this research study was to examine as well as extend the body of knowledge and understanding regarding forthcoming user acceptance of Autonomous Vehicles (AV). The purpose of this phase of the study is to test and validate the proposed model. In this process the study will be measuring the influence of the proposed factors while estimating their direct or indirect effects on behavioural intention to use autonomous vehicles. As a result of Phase I of the study, a conceptual model and hypotheses concerning the user acceptance of autonomous vehicles was developed. In order to examine the key determinants of an AV acceptance, users will be asked to respond to 10 survey questions measuring the different constructs included in the proposed theoretical model, 7 other questions linked to demographic information and moderating factors and 1 final open question. This chapter outlines the methodology adopted, the data collected and statistical analysis methods that were used in this research study and the result.

5.2 Research Methodology

The researcher employed a quantitative data collection method using the survey approach to collect data concerning the people's behavioural intention to use autonomous vehicles. The wording of questionnaire items included in the survey measuring constructs of the proposed model, presented in the previous chapter, was adapted as necessary from the previous published literature to fit within the context of this study. Data analysis for the final conceptual model was performed by Structured Equation Modelling (SEM) using the R Studio programming software/platform and SPSS for descriptive statistics. The primary intent of this statistical approach is that it allows a researcher to model and predict relationships between constructs in a hypothesised manner.

5.2.1 Philosophical Perspectives

The research paradigm offers a framework within which a researcher works. Therefore, the research framework is considered as a basic belief system, which guides researcher(s) or investigator(s) (Guba and Lincoln, 1994). Although a researcher may be conscious or unconscious, about using any research paradigm, s/he will still have to commit to the established rules and standards (Kuhn, 1996). Thus, every research methodology is a part of a paradigm (Guba and Lincoln, 1994). Guba and Lincoln (1994) pointed out that the basis for research paradigms are ontology, epistemology and methodology. Ontology is related with what exists and the nature of the world whereas epistemology is a theory that deals with how the knowledge of the external reality is acquired (Sekaran, 2003).

In this phase, my ontological position is objectivism and my epistemological stance is positivism. This scientific paradigm contributes to the application of the methods of the natural sciences to the study of certain phenomena. This approach tends to view reality as objective and something that can be measured and uncovered by a neutral researcher (Gall et al., 2007; Lichtman, 2006).

5.2.2 Research design adopted in this phase

In order to empirically test and validate the hypotheses in the proposed model, this study used the positivist's (quantitative) approach to being consistent with the topic. In fact, Hussey and Hussey (1997) suggested that the normal process under a positivistic approach is to study the literature to establish an appropriate theory and construct hypotheses. The research design helps a researcher to draw boundaries for the research, which consists of defining study settings, types of investigations that need to be carried out, the unit of analysis and other issues related to the research. The researcher employed a quantitative data collection method and survey approach to obtain data concerning the forthcoming usage of autonomous vehicles by intended users. A cross-sectional study employing a survey method was carried out for collecting the data. The survey method was used because it is designed to deal more directly with the respondents' thoughts, feelings and opinions, especially where collecting information regarding attitudes and beliefs is concerned (Yin, 1994; Zikmund, 2003). In addition, survey method offers more accurate means of evaluating information about the sample and enables the researcher to draw conclusions about generalising the findings from a sample to the population (Creswell, 1994). Moreover, survey method is considered to be quick, economical, and efficient and can easily be administered to a large sample (Churchill, 1995; Sekaran, 2000; Zikmund, 2003). In addition, this research study employed a two-step approach in the structural equation modelling (SEM) analysis (Kline, 2005; Hair *et al.*, 2006). In the first step, measurement model evaluation was conducted, in order to examine the unidimensionality, the validity and reliability of the latent constructs using confirmatory factor analysis (CFA) (Hair et al., 2006). In the next step, the Structural Model procedure was employed in order to examine the hypothesised relationships between the latent constructs in the proposed research model. Table 4.1 presents the overall approach employed in this phase. Indeed ontologically, this phase is objectivistic; epistemologically the researcher follows a positivistic stance. This phase is designed to test the model, therefore deductive in nature. The strategy adopted is a survey with questionnaire as a research instrument.

Table 5.1 Research philosophy, approach and strategy of this phase

Research Philosophy	Positivism
Research Approach	Deductive
Research Strategy	Survey (quantitative)
Time horizon	Cross-sectional
Data Collection Method	Questionnaire

5.2.3 Sampling strategy

For the purpose of the study, the sampling frame includes anybody who uses a car (not necessarily able to drive one) but presently living in UK; with the ability to respond to complex questions without the need of their parent or guardian's authorisation. In order to maximise differentiation and understanding different viewpoints, our target population was mainly in London, the sample size was 482 participants from all age groups, race and cultural backgrounds with a minimum of 18 years of age. The study uses a convenience sampling method. Data was collected from staffs and students at London South Bank University and in other higher education institutions (GSM London, British Institute of Technology & E-commerce), the researcher's contacts on LinkedIn, Facebook, Twitter and other random places across the capital. Other members of the public were also suitable to answer questions in the survey. No prior knowledge of autonomous vehicles was necessary as relevant information was provided at the beginning of the survey.

5.2.4 Pilot study

Prior to using the questionnaire for our actual data collection, it was pilot tested. The questionnaire was given to 7 people. These were colleagues, friends and family members. The purpose of the pilot test was to refine the survey so that the target participants would have no difficulties in answering the questions and there would be no problem in recording the data. They all made important contributions in improving questionnaire design and helping the researcher in the evaluation of the questions' validity and accuracy.

5.2.5 Questionnaire design

The survey questionnaire was designed and administered in order to collect and analyse the data required to achieve the research aims and objectives. It included valid measures of the research items and aimed to encourage the respondents' participation so as to supply high-quality data for the statistical analysis. The survey was conducted through different procedures in order to ascertain that the respondents were knowledgeable about the phenomenon under study, ensuring they could understand the questions as they were intended by the researcher, and would be keen to respond to them in the format established by the questionnaire. The researcher imbedded a short YouTube video at the beginning of the questionnaire to demystify AV as an emerging technology for participants not familiar with the technology. Furthermore, detailed explanation of the technology and the level of automation were also provided.

Questions were developed using the free tool Google Forms and administered online and via email whenever possible and using social media network. Indeed, by creating our questionnaire using Google Forms, the system generated a unique link that could be shared electronically.

Autonomous Vehicle is an emerging technology which has not yet been deployed on our road. This technology is also known as a self-driving car, which is the term used when designing this questionnaire. The questionnaire had an introductory paragraph included at the beginning explaining what self-driving cars are all about. The introductory paragraph also clarified the purpose of the study and explaining to participants how all information collected would be anonymous and confidential. At the same time, participants had to confirm that they were at least18 years of age. Before anyone could start answering the question there was a very short YouTube video demonstrating to participants how self-driving cars (Google Car) worked and what could be the benefits of this technology to future road users.

To test the hypothesis and validate the proposed model, the researcher has designed series of questions (Observable Variables) to help us measure our constructs (Independent variables) (PE, EE, SI, SE, PS, AX, T, LR, HM, PV) which are variables that are not directly observed but are rather inferred. The researcher has developed a series of Likert scale questions (Venkatesh, 2012) referred to as Observable Variables that could be easily measured see example below in figure 4.1:

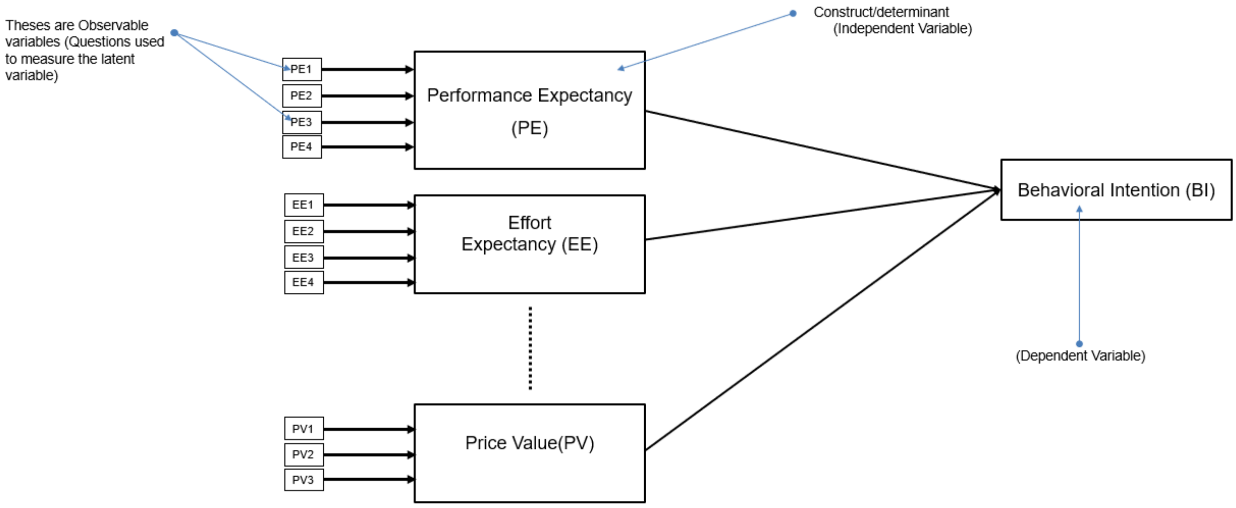


Figure 5.1 PE1 – PE4; EE1 – EE4 represents series of questions asked to respondents. In this instance, allowing us to measure the dependable variable (BI) or latent variable rather difficult to measure such as Behavioural Intention (BI).

Factors were measured on a seven-point Likert scale with 1 = strongly disagree and 7 = strongly agree, based on five items adapted from Davis (1989), Davis et al. (1989), Davis (1993), Venkatesh and Davis (2000), and Moon and Kim (2001) as follows. The proposed model has 10 constructs/determinants. These are independent variables difficult to measure. In order to measure these variables, it was necessary to develop sets of 3 to 6 observables easier to measure that would help the researcher quantify each constructs. The example above represents different constructs with their respective observable variables.

Table 5.2 below represents the list of questions used to measure the key independent variables and their respective sources.

Table 5.2 Items Used in Estimating Autonomous Vehicle Technology Acceptance Model (AVTAM)

Item	Source
Performance Expectancy (PE)	(Ryu and Kwon, 2005) (Venkatesh et al, 2012) (Cho et al, 2017)
PE1: I would find self-driving cars useful in my daily life.	
PE2: If I use self-driving cars I will reach my destination safely	
PE3: Using self-driving cars would enable me to accomplish my goals more quickly.	
PE4: Using self-driving cars would increase my productivity.	
Effort Expectancy (EE)	(Venkatesh et al, 2012) (Cho et al, 2017)
EE1: Learning how to use self-driving car would be easy for me.	
EE2: Interaction with self-driving cars would be clear and understandable.	
EE3: I would find self-driving cars easy to use.	
EE4: It would be easy for me to become skilful at using self-driving cars.	
Social Influence (SI)	(Osswald et al., 2012) (Kim and Yoon, 2011) (Venkatesh et al, 2012) (Cho et al, 2017)
SI1: I would be proud to show the system to people who are close to me.	
SE2: People whose opinions are important to me would like the system too.	
SE3: In general, people who I like would encourage me to use the system.	
SI4: I would take into consideration the advice from people important to me when making plans to use self-driving cars.	
Self-Efficacy (SE): I could complete a task or activity using the system…	(Osswald et al., 2012)
SE1: ..if there was no one around to tell me what to do.	
SE2: .. if I could call someone for help if I got stuck.	
SE3: .. if I had a lot of time.	
SE4: .. if I had just the built-in help facility for assistance.	
Perceived Safety (PS)	(Osswald et al., 2012)
PS1: Using the system requires increased attention.	
PS2: The system distracts me from driving.	

PS3: I feel save while using the system.	
PS4: Using the system decreases the accident risk.	
PS5: I can use the system without looking at it.	
PS6: I believe using self-driving car might be dangerous	
Anxiety (AX)	(Osswald et al., 2012)
AX1: I have concerns about using the system.	
AX2: I think I could have an accident because of using the system.	
AX3: The system is somewhat frightening to me.	
AX4: I fear that I do not reach my destination because of the system.	
AX5: I am afraid that I do not understand the system.	
Trust (T)	(Ryu and Kwon, 2005)
T1: I believe self-driving car will be verified professionally	
T2: I believe self-driving will be reliable	
T3: I believe self-driving car functions will be working in regard to my expectation	
T4: I believe that when using self-driving car, my privacy would be protected.	
Legal Regulation (LR)	Author contribution
LR1: I believe that robust guidelines will be in place to regulate autonomous car manufacturers	
LR2: I believe that robust regulations will be put in place to protect self-driving car users	
LR3: I believe that public liability insurance will protect users from personal damage	
Hedonic Motivation (HM)	(Venkatesh et al, 2012)
HM1: Using self-driving cars would be fun, compared to traditional cars.	
HM2: Using self-driving cars would be enjoyable, compared to traditional cars.	
HM3: Using self-driving cars would be very entertaining, compared to traditional cars.	
Price Value (PV)	(Venkatesh et al, 2012)
PV1: I believe that self-driving car would be reasonably priced.	
PV2: I believe that self-driving car would be good value for the money.	

PV3: I believe that purchasing a self-driving car would be a sound purchase.	
Behavioural Intention (BI)	(Osswald et al., 2012) (Joo, 2013) (Venkatesh et al, 2012)
BI1: I intend to use self-driving car when it becomes available.	
BI2: I believe that using self-driving car in the future will be a good idea.	
BI3: I have a plan to use self-driving car in the future.	

5.2.6 Ethical considerations

It is very important to address ethical issues in any kind of research despite the fact that it is a very difficult and strenuous process (Busher and Clarke, 1990). "The application of moral knowledge and wisdom then turns out to be governed as much by reflective judgment as by rule-following and the practicing of skills" (Lovlie, 1993, p. 76). Since researchers are human beings, so they are open to making mistakes and sometimes do not become successful in addressing all ethical issues (Cohen et al., 2000). In order to avoid making mistakes in addressing ethical issues, it has been suggested that the researchers "need two attributes: the sensitivity to identify any ethical issue and the responsibility to feel committed to acting appropriately in regard to such issues" (Eisner and Peshkin, 1990, p. 244).

In this phase of the study, ethical issues were seriously considered during the research process to ensure the integrity of research. In accordance with this London South Bank University requires all projects involving human subjects must have approval from the University's Research Ethics Committee before conducting the fieldwork. According to the University's Ethics Policy Guidelines, the researcher is required to fill in the ethics form, which must be signed by the researcher and approved by the research student's supervisors. The researcher's ethics application was approved by South Bank University ethics committee and later by GSM London Research Ethics committee as the questionnaire was sent to staff and students at both institutions.

In conformity with the ethics requirements, a covering letter was also attached with the questionnaire stating the purpose of the study. The name and the address of the researcher and his university were included in the covering letter to increase respondent's confidence and to ensure respondents know to whom they were dealing with (Cooper and Schindler, 2001). The respondent's information was kept confidential and they were not described in any way that allows them to be identified. To maintain the confidentiality and privacy of the respondents, only aggregate results were used in reporting results of this study. Participant's personal information had not been identified in any of the study findings. In addition, the data collected were not being used for any purpose other than as stated in the study objectives, which were only aimed for academic research fulfilling the requirements of a PhD thesis.

5.2.7 Data analysis plan

According to Coorley (1978), the main goal of "*the statistical techniques are to assist in establishing the plausibility of the theoretical model and to estimate the extent to which the various explanatory factors seem to be influencing the dependent variable*" (p.13). The primary purpose of this research study was to identify and investigate the factors that will affect the forthcoming user acceptance of autonomous vehicles. In order to achieve these objectives, this thesis used two different statistical software tools/packages. Statistical Package for Social Sciences (SPSS) was used for analysing the preliminary data, explained in the following sub-section. **R Programming** version 3.5.2 (Free Software used for statistical computing) for Structural Equation Modelling (SEM) was used for measurement model analysis and structural model to test the proposed hypothesised model explained in Chapter Three. The following sub-sections describe and provide justification for using these statistical software and the techniques mentioned above. Statistical Package for Social Sciences (SPSS), version 21.0, was used to analyse the quantitative data obtained from the survey questionnaire. This software package is widely accepted and used by researchers in different disciplines including social sciences, business studies, and information systems research (Zikmund 2003). This tool has been used to screen the data of this research study in terms of data coding, treatment of missing data, identification of outliers (i.e., Mahalanobis Distance (D^2)) test and to find out the data normality (i.e. using kurtosis and skewness statistics). Each one of these techniques are explained and discussed in the following sections. In addition, SPSS was also applied to perform descriptive statistics such as frequencies, percentages, mean values, and standard deviations. These analyses were performed for each variable separately and to summarise the demographic profile of the respondents in order to get preliminary information and the feel of the data (Sekaran, 2000). Furthermore, before applying SEM, SPSS was used to conduct Exploratory Factor Analysis (EFA) (Tabachnick and Fidell, 2007; Miller et al., 2002; Bryman and Cramer, 2005). For the first stage of data analysis is to summarise information from many variables in the proposed research model into a smaller number of factors, which is known as factor / dimension reduction (Hair et al., 2006). EFA is however discussed in more detail in Chapter 5. Data collection in this quantitative survey mainly used nominal and ordinal scales, which would return data in a form appropriate for this technique (Kline, 2005).

Table 5.3 represents a summary of all statistical analysis used to help the researcher test the hypotheses.

Table 5.3 Summary of statistical test applied to the data

Statistics	Software package	Purpose of use	Remarks	Reference (s)
Little's chi-square statistics ($\chi 2$)	R programming version 3.5.2	to diagnose the randomness of missing data	insignificant value of the test suggests that the data may be assumed to be missing completely at random (MCAR)	Little (1988)
Mahalanobis Distance (D2)	R programming version 3.5.2	to investigate the multivariate outliers	a very conservative statistical significance test such as $p < 0.001$ was employed to be used with D2 measure	Kline (2005); Hair et al. (2006)
Kurtosis and Skewness	R programming version 3.5.2	to find out data normality	the maximum acceptable limits of observation values up to ±1 for the skewness and up to ±3 for the kurtosis were used.	Hair et al (2006); West et al. (1995); Kline (2005)
Descriptive statistics (i.e. frequencies, means, standard deviations, and so on)	SPSS 21	To summarize demographic information and items analysis	these analyses were performed for each variable separately and to summarise the demographic profile of the respondents in order to get preliminary information and the feel of the data	Sekaran (2000)
Cronbach's Alpha	SPSS 21	To examine the internal consistency of each measure	a minimum cut off of 0.7 for Cronbach's alpha reliability coefficients was employed	Nunnaly (1978); Hair et al. (2006)
Pearson's Correlations	R programming version 3.5.2	To obtain preliminary information about relationships between latent factors	correlation vary from no to excellent relationship depending on the r value	Fink (1995)
Levene's test	R programming	To test the homogeneity of variance in the data	the p-value of Levene's test greater than some	Levene (1960)

	version 3.5.2		critical value (typically 0.05), suggests homogeneity of the variance in the data	
Exploratory factor analysis (EFA)	R programming version 3.5.2	to summarise information from many variables in the proposed research model into a smaller number of factors	principal components analysis (PCA) and orthogonal model with varimax rotation was employed to perform EFA	Tabachnick and Fidell (2007); Miller et al. (2002); Bryman and Cramer (2005)
Confirmatory factor analysis (CFA)	R programming version 3.5.2	to assess unidimensionality, reliability and validity of constructs used in the model	the minimum cut off criteria for factors loadings >0.7, AVE >0.5, and reliability >0.7 were used for assessing the convergent validity. nomological validity was assessed using correlations (estimates). Positive and significant estimates indicated nomological validity. for discriminant validity, the average variance extracted (AVE) for each construct was compared with the corresponding squared inter construct correlations (SIC); the AVE larger than the SIC indicates discriminant validity	(Hair et al., 2006)
Path analysis (SEM)	R programming version 3.5.2	to examine the hypothesised relationships between the latent constructs in the proposed model	critical ratio (CR) estimates value >= 1.96 suggests significance of the causal path between latent constructs	Kline (2005); Hair et al. (2006)

Missing data

Missing data is a very common problem in all types of survey research because it usually involves a large number of samples (Bryman and Cramer, 2005). Hair et al. (2006) Note that missing data causes two main problems: (a) it minimises the ability of a statistical test to imply a relationship in the data set, and (b) it creates biased parameter estimates. The potential effects of missing data depend on the frequency of occurrence, the pattern of missing observations, and the reasons for the missing value (Tabachnick and Fidell, 2001). Hair et al. (2006) point out that if the pattern of missing data is systematic (i.e. non-ignorable or is not missing at random), any technique used to treat this missing data could possibly generate biased results whereas, if the missing data is scattered in a random fashion with no distinct pattern (i.e. missing completely at random = MCAR), any remedy to treat this problem is assumed to yield acceptable results.

Although there are no clear set guidelines regarding what constitutes a large amount of missing data; Kline (2004, p. 75*)* suggested that missing values should probably constitute less than 10% of the total data. According to Cohen and Cohen (1983), 5% or even 10% of missing data on a particular variable is not large. Olinsky et al. (2003) pointed out that if the percentage of cases with missing observations is less than approximately 5%, and the pattern is ignorable, most simple analyses should yield reliable results.

This study followed steps suggested by Byrne (2001) for dealing with incomplete (missing) data, which were: (1) investigation of the total amount of missing data, (2) investigation of the pattern of missing data, (3) and finding out appropriate techniques to deal with missing data. During the data collection phase, all important questions were mandatory if the participants wished to submit his/her responses. During the data cleaning, all suspicious data were removed from the list of observations in the dataset.

Outliers

Kline (2005) and Hair et al. (2006) described outliers as cases with scores that are distinctively different from the rest of the observations in a dataset. Researchers have warned that problematic outliers can have dramatic effects on the statistical analysis such as model fit estimates and parameter estimates (West et al., 1995) and they can create a negative variance (Dillon et al., 1987). There are two main types of outliers:

univariate and multivariate outliers. A univariate outlier is the case that has an extreme value on one variable whereas a multivariate outlier is a case with an unusual combination of values on two or more variables (Tabachnick and Fidell, 2001; Kline 2005). Although, there is no absolute judgement of an extreme value, a commonly accepted rule of thumb is that scores more than three standard deviations away from the mean may be considered as outliers (Kline, 2005). The univariate outlier can be detected easily by diagnosing frequency distributions of Z-scores (Kline, 2005).

In this study, univariate outliers were not identified because the study utilized a Likert scale with 7 categories ranging from 1 - strongly disagree to 7 - strongly agree. However, if respondents answered strongly disagree or strongly agree, these response options might become outliers as they are the extreme points of the scale.

Presence of multivariate outliers in data can be checked by Mahalanobis distance (D^2) test, which is a measure of distance in standard deviation units between each observation compared with the mean of all observations (Byrne, 2001; Kline, 2005; Hair et al., 2006). A large D^2 identifies the case as an extreme value on one or more variables. A very conservative statistical significance test such as $p < 0.001$ is recommended to be used with D^2 measure (Kline, 2005; Hair et al., 2006). In this research study, researcher measured Mahalanobis distance using R Programming and then compared the critical $\chi 2$ value with the degrees of freedom (df) equal to number of independent variables and the probability of $p < 0.001$.

Normality

Normality is defined as the "shape of the data distribution or an individual metric variable and its correspondence to the normal distribution, which is the benchmark for statistical methods" (Hair et al., 2006; p. 79). Violation of normality might affect the estimation process or the interpretation of results especially in SEM analysis. For instance, it may increase the chi-square value and may possibly cause underestimation of fit indices and standard errors of parameter estimates (Hair et al., 2006). One approach to diagnose normality is through visual check or by graphical analyses such as the histogram and normal probability plot that compares the observed data values with a distribution approximating the normal distribution. If the observed data distribution largely follows the diagonal lines then the distribution is considered as normal (Hair et al., 2006). Beside the shape of distribution, normality can also be inspected by two multivariate indexes i.e. skewness and kurtosis. The skewness portrays the symmetry of distribution whereas the kurtosis refers to the measure of the heaviness of the tails in a distribution (also known as peakedness or flatness of the distribution) compared with the normal distribution. In normal distribution, the scores of skewness and kurtosis are zero. Hair et al (2006) pointed out that skewness scores outside the -1 to +1 range demonstrate substantially skewed distribution. However, West et al. (1995) and Kline (2005) suggests that values of the skew index greater than three (3.0) are indicated as extremely skewed and a score of the kurtosis index from about 8.0 to over 20.0 describes extreme kurtosis. In this study, the researcher set the maximum acceptable limit of observation values up to ±1 for the skewness and up to ±3 for the kurtosis. Thereafter, the researcher used factor analyses and structural equation modelling for inferential statistical analyses.

5.3 Data Analysis and Results

The Statistical Package for Social Sciences (SPSS), version 21 and R Programming version 3.5.2, will be used to analyse the quantitative data obtained from the survey questionnaire. This software package is widely accepted and used by researchers in different disciplines including social sciences, business studies, and information systems research (Zikmund 2003). Therefore, this tool has been used to screen the data of this research study in terms of data coding, treatment of missing data (i.e., using ANOVA), identification of outliers (i.e., Mahalanobis Distance (D^2)) test and find out the data normality (i.e. using kurtosis and skewness statistics). Each one of these techniques are explained and discussed in the following sections. In addition, SPSS will also be applied to perform descriptive statistics such as frequencies, percentages, mean values, and standard deviations. These analyses will be performed for each variable separately to summarise the demographic profile of the respondents and to get preliminary information and the feel of the data (Sekaran, 2000). Furthermore, before applying SEM, SPSS was used to conduct Exploratory Factor Analysis (EFA) for the first stage of the data analysis to summarise information from many variables in the proposed research model into a smaller number of factors, which is known as factor / dimension reduction (Hair et al., 2006). EFA is however discussed in more detail below. Data collection in this quantitative survey mainly used nominal and ordinal scales, which would return data in a form appropriate for this technique (Kline, 2005).

5.3.1 Sample (socio-demographics) Characteristics

Sample characteristics were analysed using frequency distributions (Table 5.4). Analysis shows gender groups are evenly represented with 56.6% males and 43.4% females. The most represented age groups are 45 – 54 years (22%), 35 – 44 years (21.6%) see figure 5.3. With respect to levels of education, 78.8% of respondents had achieved a higher educational degree, with 13.7% PhD holder.

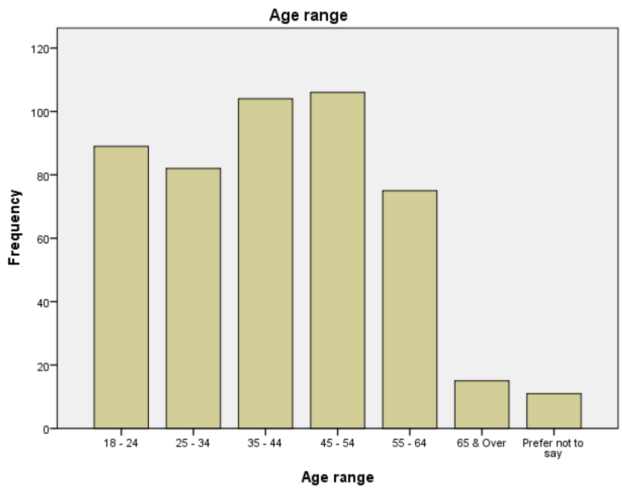


Figure 5.2 Age Range for Participants

Table 5.4 Demographic breakdown for the final 482 respondents

Demographic aspect		**U.K. (N=482)**	**Percentage (%)**
Age group	18 - 24	89	18.5%
	25 - 34	82	17%
	35 - 44	104	21.6%
	45 - 54	106	22%
	55 - 64	75	15.6%
	65 & Over	15	3.11%
	Prefer not to say	11	2.3%
Gender	Male	272	56.4%
	Female	210	43.6%
Level of driving Experience	No driving experience	51	10.6%
	Novice	42	8.7%
	Intermediate	80	16.6%
	Experienced	296	61.4%
	Expert	13	3.7%
Level of Autonomy	Level 0	38	7.9%
	Level 1	52	10.8%
	Level 2	173	35.9%
	Level 3	109	22.6%
	Level 4	110	22.8%
Education	No formal qualifications	1	0.2%
	GCSE or equivalent	10	2.1%
	A level or equivalent	91	18.9%
	Bachelor degree	148	30.7%
	Master degree	151	31.3%
	PhD	66	13.7%
	Other	15	3.1%

5.3.2 Reliability of the questionnaire (Cronbach's Alpha)

For this study, the Cronbach's Alpha method was used to measure internal consistency that is how closely related a set of items are as a group. This statistical test is also considered to be a measure of scale reliability.

Equation 5.1 Formula for Cronbach's alpha

$$\textbf{Cronbach's Alpha } \alpha = \frac{N.C}{\bar{V} + (N-1).\bar{C}}$$

N = the number of measurements for one variable
$\bar{C}$ = inter-item covariance among measurements
$\bar{V}$ = the average variance

R programming was used to run this test. Cronbach's Alpha is recommended to be 0.70 or above, to prove satisfactorily reliable (Bryman and Bell, 2015, p169). The study started with the Cronbach's alpha internal consistency, but the problem was with the Perceived Safety (PS), so it was necessary to look at the questions/observable variables measuring the construct PS, and reversed the score for the following questions:

- *Using the system requires increased attention.*
- *The system distracts me from driving.*
- *I believe using a self- driving car might be dangerous.*

The *Cronbach's alpha* for Perceived Safety (PS) was 0.22 before the reversing, but then the scores were reversed for these questions accordingly- and it was done in the

Excel file which is loaded into the R. After this *Cronbach's alpha* = 0.80. All the internal consistency alphas are in the next table (Table 5.5)

Table 5.5 Cronbach's alpha

#	Measure	Cronbach's Alpha
1	Performance Expectancy	0.91
2	Effort Expectancy	0.93
3	Social Influence	0.82
4	Self-Efficacy	0.86
5	Perceived Safety	0.80
6	Anxiety	0.88
7	Trust	0.85
8	Legal Regulation	0.90
9	Hedonic Motivation	0.96
10	Price Value	0.87
11	Behavioral Intention	0.92

As the recommended value for the optimal consistency is 0.7 and more, this assumption is good, as the minimal Cronbach's alpha in our case is 0.80 for the Perceived safety, so the researcher proceeded to the next test.

5.3.3 Mahalanobis distance

In missing data analysis, Little's Test (Little 1988) is useful for testing the assumption of Missing Completely at Random (MCAR) for multivariate partially observed quantitative data. In order for participants to submit their completed questionnaire, all important questions used to measure the constructs were made mandatory. During the test, as there was no missing data, the researcher didn't have any problem, so the study could proceed to the next test.

5.3.4 Correlations Matrix

Table 5.6 below presents the correlation matrix showing the correlation coefficients between different constructs part of the proposed model.

Table 5.6 Correlations Matrix

Measure	PE	EE	SI	SE	PS	AX	T	LR	HM	PV	BI	Gender	Age
PE	1	0.66	0.73	0.55	0.68	-0.51	0.64	0.55	0.58	0.56	0.81	-0.29	-0.01
EE	0.66	1	0.62	0.62	0.6	-0.5	0.57	0.48	0.45	0.49	0.63	-0.15	-0.02
SI	0.73	0.62	1	0.6	0.48	-0.38	0.55	0.54	0.53	0.5	0.72	-0.21	0
SE	0.55	0.62	0.6	1	0.42	-0.33	0.53	0.46	0.42	0.4	0.55	-0.16	0.07
PS	0.68	0.6	0.48	0.42	1	-0.74	0.6	0.43	0.36	0.51	0.7	-0.35	0.1
AX	-0.51	-0.5	-0.38	-0.33	-0.74	1	-0.45	-0.3	-0.3	-0.43	-0.57	0.3	-0.14
T	0.64	0.57	0.55	0.53	0.6	-0.45	1	0.72	0.5	0.54	0.66	-0.26	-0.03
LR	0.55	0.48	0.54	0.46	0.43	-0.3	0.72	1	0.45	0.5	0.55	-0.22	0.01
HM	0.58	0.45	0.53	0.42	0.36	-0.3	0.5	0.45	1	0.42	0.64	0.01	-0.02
PV	0.56	0.49	0.5	0.4	0.51	-0.43	0.54	0.5	0.42	1	0.66	-0.31	0.13
BI	0.81	0.63	0.72	0.55	0.7	-0.57	0.66	0.55	0.64	0.66	1	-0.3	0.09
Gender	-0.29	-0.15	-0.21	-0.16	-0.35	0.3	-0.26	-0.22	0.01	-0.31	-0.3	1	-0.15
Age	-0.01	-0.02	0	0.07	0.1	-0.14	-0.03	0.01	-0.02	0.13	0.09	-0.15	1

The most correlated variables are PE & BI (0.81), so with the higher performance expectancy there is higher behavioural intentions, and PE & PS (0.73) and the least correlated variable is the Age. The anxiety is negatively correlated and that is good, the maximum is for Perceived safety (-0.74), which corresponds to what could be expected, as higher Perceived Safety implies less Anxiety.

5.3.5 Skewness and Kurtosis

Skewness is a measure of symmetry, or more precisely, the lack of symmetry. A distribution, or data set, is symmetric if it looks the same to the left or right of the centre point. Kurtosis is a measure of whether the data is heavy-tailed or light-tailed in relative to a normal distribution. The table below (table 5.7) shows the skewness and Kurtosis of the dataset.

Table 5.7 Skewness and Kurtosis

	Skewness	Kurtosis
PE	-0.294	1.995
EE	-0.716	2.844
SI	-0.387	2.746
SE	-0.901	3.725
PS	-0.063	2.692
AX	-0.055	2.323
T	-0.443	2.657
LR	-0.635	2.474
HM	-0.172	2.059
PV	0.233	2.394
BI	-0.197	-1.956

Except for the PV = Price Value, all the variables have negative skewness, that means that there is a long tail in the negative direction and on the other hand the positive skewness means that there is a long tail to the positive direction however, all the skewness's are within the limit of [-1;1].

All the variables have the kurtosis in the limit of 3 except the Self-Efficacy = 3.73 so these are called platykurtic e.g. are flatter. The Self-Efficacy which has the kurtosis is more significant than 3 which is so-called leptokurtic, e.g. is thinner.

5.3.6 Parallel Analysis Scree Plots

The next step is to determine the optimal number of factors. To do this the researcher uses the "parallel test" which is a usual test that helps us to identify the optimal number of factors. The parallel analysis suggests that the number of factors = 9. The study will look at two options, with 9 and 11 factors. The graph below suggest that the model should only have 9 constructs therefore, the researcher will be testing the originally proposed models statistics against the ideal 9 constructs model as suggested by the numbers.

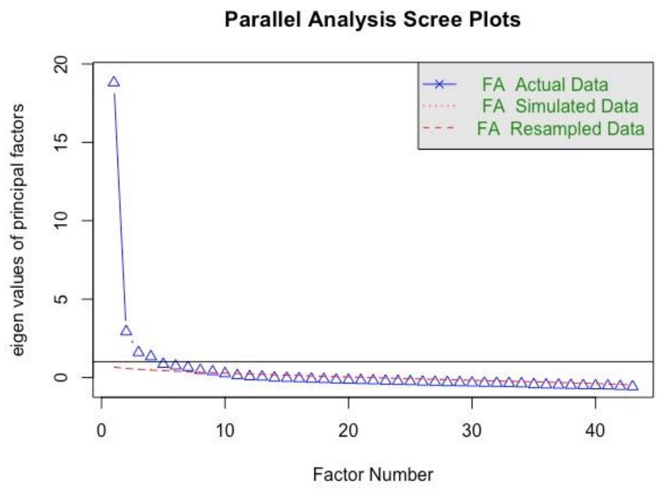


Figure 5.3 Parallel Analysis Scree Plots

In this case, based on the parallel analysis Scree Plots, the dataset suggests that the model should have 9 factors rather than 11 as initially proposed in the previous chapter, therefore, the study will be testing 2 separate models (Option 1 with 11 factors and option 2 with 9 factors).

5.3.7 Factor Analysis (FA) - Construct validity

Factor Analysis is a useful tool for investigating variable relationships for complex concepts. It allows researchers to investigate concepts that are not easily measured directly by collapsing a large number of variables into a few interpretable underlying factors. These techniques are used to address the problem of analysing the structure of the correlations amongst a large number of measurement items (also known as variables) by defining a large set of common underlying dimensions, known as factors. FA takes a large set of variables and summarises or reduces them using a smaller set of variables or components (factors) (Hair et al., 2006). The main purposes of the FA therefore include: (a) understanding the structure of a set of variables, (b) constructing a questionnaire to measure any underlying variables, and (c) reducing a data set to a more manageable level (Field, 2006, p.619).

Equation 5.2 Confirmatory factor Analysis formula

Confirmatory Factor Analysis $\tilde{\Sigma} = \Lambda \ \Phi \ \Lambda^{T} + \ \Psi$

$\tilde{\Sigma}$ = covariance matrix

Λ = factor loading matrix

Cov (F) = Φ

Cov (ε) = Ψ

Cov (X) = Σ

X = centred observed variables

ε = specific factors

F= common factors

Table 5.8 shows the loadings matrix for the original model with 11 factors

Table 5.8 Loadings matrix with 11 factors

	MR5	MR3	MR4	MR1	MR7	MR6	MR2	MR8	MR9	MR11	MR10
PE1	0.09	0.11	-0.03	**0.63**	0.05	0.04	-0.09	0.13	-0.04	0.05	-0.02

PE2	0.01	0.14	-0.01	**0.40**	0.11	-0.04	-0.03	0.09	0.20	0.09	0.22
PE3	0.02	0.05	0.03	**0.87**	-0.01	0.05	-0.04	-0.03	0.04	-0.03	-0.02
PE4	0.08	0.05	0.11	**0.71**	0.03	0.03	0.08	0.05	0.00	0.05	0.03
EE1	0.03	**0.77**	0.06	0.05	0.08	0.11	-0.02	-0.04	-0.09	0.05	-0.07
EE2	0.08	**0.67**	-0.01	-0.01	0.08	0.10	-0.05	0.07	0.05	0.01	0.04
EE3	0.04	**0.89**	0.03	0.05	0.01	0.00	0.00	-0.01	-0.03	0.01	0.02
EE4	-0.03	**0.83**	-0.02	0.03	-0.03	-0.02	-0.05	0.07	0.11	-0.04	0.00
SI1	0.12	0.29	0.17	0.17	0.08	-0.08	0.00	**0.36**	-0.08	-0.03	0.13
SI2	0.02	0.13	0.10	0.00	0.05	-0.02	0.04	**0.75**	-0.04	0.03	0.06
SI3	0.01	0.04	0.09	0.12	0.02	0.04	-0.08	**0.72**	0.03	-0.10	0.02
SI4	-0.02	-0.05	0.01	0.18	0.21	0.03	0.06	**0.33**	0.03	-0.23	-0.04
SE1	-0.02	0.16	-0.10	-0.05	**0.41**	0.04	-0.17	0.22	0.22	0.10	-0.18
SE2	0.01	0.04	0.06	0.06	**0.84**	0.00	-0.07	-0.05	-0.03	-0.02	-0.03
SE3	0.02	-0.01	-0.01	-0.04	**0.90**	0.02	0.09	0.02	0.00	-0.04	0.06
SE4	0.06	0.09	0.12	0.03	**0.53**	0.01	-0.05	0.06	0.07	0.02	-0.06
PS1	-0.09	0.03	0.06	-0.01	-0.05	-0.10	-0.04	-0.05	0.01	**0.78**	0.01
PS2	0.03	-0.06	0.01	0.11	-0.03	0.12	-0.12	-0.06	-0.12	**0.55**	0.05
PS3	0.09	0.06	0.07	0.21	0.19	0.10	0.02	0.03	0.26	0.12	0.30
PS4	-0.05	0.14	-0.01	0.26	0.08	0.05	0.09	0.08	0.43	0.13	0.20
PS5	0.12	0.31	-0.04	-0.03	0.06	0.01	0.12	0.10	0.38	0.24	0.06
PS6	0.00	-0.01	-0.03	0.04	0.04	0.15	-0.21	0.09	0.06	0.32	0.39
AX1	-0.08	-0.11	-0.01	0.00	0.01	-0.12	**0.23**	-0.09	-0.04	-0.16	-0.48
AX2	-0.07	0.05	0.01	-0.01	-0.02	-0.13	**0.44**	-0.09	0.01	-0.06	-0.52
AX3	-0.03	-0.05	0.02	-0.11	0.09	-0.02	**0.67**	-0.09	-0.09	-0.04	-0.14
AX4	0.04	-0.01	-0.05	-0.07	-0.07	0.05	**0.75**	0.00	0.00	-0.06	-0.09
AX5	-0.04	-0.19	-0.01	0.11	-0.01	-0.02	**0.66**	0.07	-0.02	-0.15	0.11
T1	0.04	-0.03	0.32	0.14	0.10	0.02	-0.11	-0.03	**0.46**	-0.04	-0.18
T2	0.08	0.02	0.19	0.09	0.08	0.06	-0.13	0.03	**0.59**	0.00	0.01
T3	0.11	0.14	0.21	0.04	0.00	0.08	-0.07	-0.03	**0.56**	-0.04	0.07
T4	0.07	0.06	0.45	-0.10	-0.06	0.13	0.07	-0.06	**0.19**	-0.02	0.21
LR1	-0.01	0.04	**0.83**	0.03	0.10	0.02	-0.03	-0.03	0.00	0.00	-0.01
LR2	0.04	0.00	**0.87**	0.03	0.01	0.00	0.00	0.06	-0.01	0.07	-0.03
LR3	0.05	-0.01	**0.67**	0.01	-0.06	0.11	0.02	0.14	0.11	-0.04	0.02
HM1	**0.96**	0.03	-0.01	-0.03	0.02	0.00	0.03	0.02	-0.03	-0.02	-0.01

HM2	**0.91**	-0.03	0.03	0.11	0.00	0.00	0.03	-0.02	0.00	0.02	0.00
HM3	**0.96**	0.02	0.01	-0.04	0.00	-0.03	-0.04	-0.04	0.02	-0.04	0.01
PV1	-0.04	0.07	0.06	-0.02	-0.08	**0.80**	0.10	-0.01	0.01	-0.03	0.05
PV2	-0.01	0.03	0.01	0.06	0.05	**0.92**	-0.04	-0.06	-0.01	-0.04	-0.01
PV3	0.09	-0.03	0.05	-0.02	0.16	**0.57**	-0.02	0.22	0.01	0.08	0.03
BI1	0.20	0.01	-0.03	0.19	-0.02	0.33	-0.04	0.29	0.12	0.20	-0.07
BI2	0.19	-0.01	-0.04	0.29	0.13	0.14	-0.06	0.29	0.17	0.15	-0.07
BI3	0.29	-0.06	0.00	0.10	-0.03	0.21	-0.11	0.36	0.17	0.12	-0.05

Table 5.9 shows the loadings matrix for the models with 9 factors. In this model, perceived safety and Trust have been removed.

Table 5.9 Loadings matrix with 9 factors

	MR2	MR3	MR5	MR4	MR7	MR1	MR6	MR9	MR8
PE1	-0.10	0.12	0.12	0.00	0.07	**0.63**	0.06	-0.03	0.11
PE2	-0.19	0.14	0.03	0.00	0.08	**0.32**	0.00	0.28	0.14
PE3	0.03	0.04	0.07	0.06	0.01	**0.73**	0.10	0.07	0.02
PE4	0.05	0.05	0.11	0.12	0.00	**0.64**	0.08	0.06	0.09
EE1	0.00	**0.80**	0.02	0.05	0.07	0.05	0.10	-0.10	-0.06
EE2	-0.06	**0.69**	0.08	-0.01	0.08	-0.03	0.09	0.06	0.06
EE3	0.01	**0.91**	0.04	0.03	0.00	0.01	0.01	-0.01	0.02
EE4	0.01	**0.85**	-0.02	-0.01	0.00	0.00	-0.03	0.11	0.06
SI1	-0.06	0.31	0.13	0.18	0.08	0.15	-0.06	-0.04	**0.38**
SI2	-0.05	0.19	0.01	0.12	0.08	0.12	-0.04	-0.01	**0.63**
SI3	-0.06	0.08	0.03	0.14	0.10	0.20	0.01	0.02	**0.59**
SI4	0.22	-0.06	0.02	0.04	0.29	0.16	0.03	0.01	**0.32**
SE1	-0.13	0.22	-0.04	-0.07	**0.46**	0.09	-0.03	0.17	0.04
SE2	-0.05	0.04	0.01	0.04	**0.85**	0.03	0.02	-0.03	-0.04
SE3	0.07	0.00	0.02	-0.04	**0.84**	-0.06	0.05	0.04	0.07
SE4	-0.03	0.11	0.05	0.12	**0.55**	0.05	0.00	0.07	0.02
PS1	-0.53	0.13	-0.18	0.01	-0.19	0.16	-0.13	0.11	-0.17
PS2	-0.51	0.01	-0.03	-0.03	-0.15	0.23	0.09	-0.03	-0.14
PS3	-0.21	0.05	0.10	0.06	0.13	0.14	0.14	0.34	0.11

PS4	-0.08	0.15	-0.04	0.00	0.05	0.22	0.08	0.52	0.11
PS5	-0.05	0.36	0.09	-0.05	0.02	0.04	-0.01	0.43	0.03
PS6	-0.64	0.00	-0.02	-0.06	-0.04	0.03	0.17	0.16	0.12
AX1	**0.61**	-0.09	-0.08	0.01	0.08	0.08	-0.16	-0.14	-0.20
AX2	**0.77**	0.09	-0.09	0.01	0.00	0.10	-0.17	-0.06	-0.21
AX3	**0.75**	-0.04	-0.05	-0.04	0.01	-0.10	0.02	-0.05	-0.03
AX4	**0.80**	0.00	0.02	-0.10	-0.15	-0.05	0.09	0.06	0.06
AX5	**0.65**	-0.21	-0.02	-0.05	-0.09	0.03	0.06	0.07	0.22
T1	0.06	-0.02	0.05	0.38	0.18	0.16	-0.02	0.39	-0.13
T2	-0.09	0.02	0.09	0.24	0.14	0.09	0.02	0.56	-0.04
T3	-0.03	0.13	0.13	0.24	0.05	-0.01	0.07	0.55	-0.04
T4	-0.03	0.04	0.07	0.45	-0.09	-0.18	0.16	0.23	0.03
LR1	-0.02	0.03	-0.02	**0.86**	0.08	0.00	0.02	-0.02	-0.03
LR2	-0.03	0.01	0.02	**0.90**	-0.02	0.04	0.00	-0.02	0.03
LR3	0.04	-0.01	0.05	**0.71**	-0.05	0.00	0.10	0.10	0.12
HM1	0.03	0.03	**0.96**	-0.02	0.01	-0.02	-0.01	-0.03	0.01
HM2	0.01	-0.03	**0.91**	0.02	-0.02	0.11	0.00	0.01	-0.02
HM3	-0.03	0.01	**0.97**	0.01	0.00	-0.05	-0.03	0.01	-0.04
PV1	0.07	0.08	-0.04	0.06	-0.08	-0.02	**0.80**	0.02	0.00
PV2	-0.04	0.03	0.01	0.02	0.08	0.07	**0.90**	-0.02	-0.09
PV3	-0.12	0.01	0.08	0.06	0.17	0.07	**0.54**	0.02	0.14
BI1	-0.15	0.07	0.18	0.00	0.00	0.33	0.28	0.12	0.13
BI2	-0.13	0.04	0.19	-0.01	0.15	0.39	0.11	0.17	0.15
BI3	-0.18	-0.01	0.28	0.03	0.02	0.24	0.15	0.15	0.20

5.3.8 Structure Equation Modelling (SEM)

Structural Equation Modelling (SEM) is a collective of statistical models that seeks to clarify and explain relationships amongst multiple latent variables (constructs). In SEM, researchers can examine interrelated relationships amongst multiple dependent and independent constructs simultaneously (Hair et al., 2006). Consequently, SEM analytical techniques have been used in many disciplines and have become an important method for analysis in academic research (Byrne, 2001; Kline, 2005; Hair et al., 2006). In addition, SEM is a multivariate statistical approach that allows researchers to examine both the measurement and structural components of a model by testing the relationships amongst multiple independent and dependent constructs simultaneously (Gefen et al., 2000; Tabachnick and Fidell, 2001). Thus, structural equation modelling techniques were most suitable for this research study involving multiple independent-dependent relationships that were hypothesised in the proposed research model as described in Chapter 3.

Table 5.10 Goodness of Fit Statistics in SEM

Index	Abbreviation	Type of fit measure	Recommended criteria	References
chi square	χ^2	Model fit	χ^2, df, p >0.05	Joreskog and Sorbom (1988); Hair et al. (1998); Bryne (2001); Hair et al. (2006)
Normed chi square	χ^2/df	Absolute fit and parsimony of model	1.0< χ^2/df <3.0	
Goodness-of-fit index	GFI	Absolute fit	>0.90	
Root mean square error of approximation	RMSEA	Absolute fit	<0.05 good fit <0.08 acceptable fit	
Normed fit index	NFI	Incremental fit	>0.90	
Comparative fit index	CFI	Incremental fit	>0.90	
Adjusted goodness-of-fit index	AGFI	Parsimonious fit	>0.90	

R programming, version 3.5.2, was used in this research study to explore statistical relationships between the test items of each factor and amongst the factors of independent variables (i.e. PE, EE, and others) and the dependent variable (i.e., Behavioural Intention (BI)). The reasons for selecting the SEM for data analysis were:

firstly, it offered a systematic mechanism to validate relationships among constructs and indicators and to test relationships between constructs in single model (Hoyle, 1995, Hair et al., 2006). Secondly, it offered powerful and rigorous statistical techniques to deal with complex models (Bryne, 2001; Tabachnick and Fidell, 2001; Hair et al, 2006). In SEM, relationships among constructs and indicators are validated by using Confirmatory Factor Analysis (CFA), also known as measurement model, and relationships between constructs are tested using the structural model (Bentler, 1995; Hoyle, 1995, Hair et al., 2006), which are described below.

At first, the researcher does the model with all the variables and 11 factors as follows:

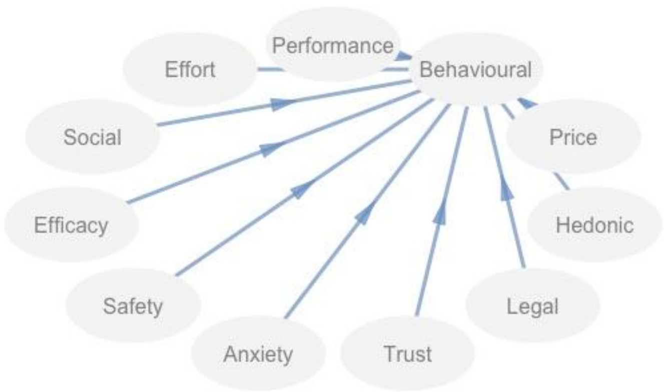


Figure 5.4 Proposed model

Here is the basic statistics of the 11-factor model (Table 5.11)

Table 5.11 Eleven Factor Model

Eleven Factor Model

	N	Values
Statistics	Comparative Fit Index (CFI)	0.852
	Tucker-Lewis Index (TLI)	0.834
	RMSEA	0.087
	SRMR	0.078
	Chi-Square ($\chi 2$)/Degree of Freedom (DF)	2.011
	Adjusted Goodness-of-Fit Index (AGFI)	0.873

As SRMR= 0.078 < 0.08 is a good fit, the other characteristics are not that good as Comparative Fit Index (CFI) 0.852 < 0.9 and RMSEA 0.087 > 0.08.

On the other hand, the researcher uses the 9 factors model, with the 0.6 cut-off and the characteristics are better for this model and the study met the basic parameters of a good-fit model (Table 4.12).

Table 5.12 Nine Factor Model

Nine Factor Model

	N	Values
Statistics	Comparative Fit Index (CFI)	0.942
	Tucker-Lewis Index (TLI)	0.927
	RMSEA	0.076
	SRMR	0.043
	Chi-Square ($\chi 2$)/Degree of Freedom (DF)	2.051
	Adjusted Goodness-of-Fit Index (AGFI)	0.832

Table 5.13 An eleven factor model basic characteristics-Unidimensionality

Factor	Mode	MVs	C.alpha	DG.rho	eig.1st	eig.2nd
1	A	4	0.917781	0.942314	3.214529	0.413805
2	A	4	0.938313	0.95587	3.37668	0.28836
3	A	4	0.839348	0.895636	2.750393	0.74777
4	A	4	0.863464	0.907632	2.845488	0.530677
5	A	6	0.809819	0.864219	3.127027	1.257923
6	A	5	0.890437	0.919996	3.489278	0.704879
7	A	3	0.906319	0.941413	2.528323	0.324276
8	A	4	0.876351	0.916899	2.944861	0.621244
9	A	3	0.959722	0.973852	2.776369	0.122822
10	A	3	0.868908	0.920014	2.38015	0.431685
11	A	3	0.924047	0.951816	2.604471	0.218515

In table 5.13 the column of Cronbach Alpha, as all the values are more significant than 0.7 the researcher is happy as this is good. Dillon-Goldstein rho should be greater than 0.8, as this is OK, it is good as well.

The 1st eigenvalue should be big and greater than 1 and the second should be small and smaller than 1, the researcher sees that this is not the case of the "Perceived Safety", in the next second model.

The researcher plots the loading for each variable

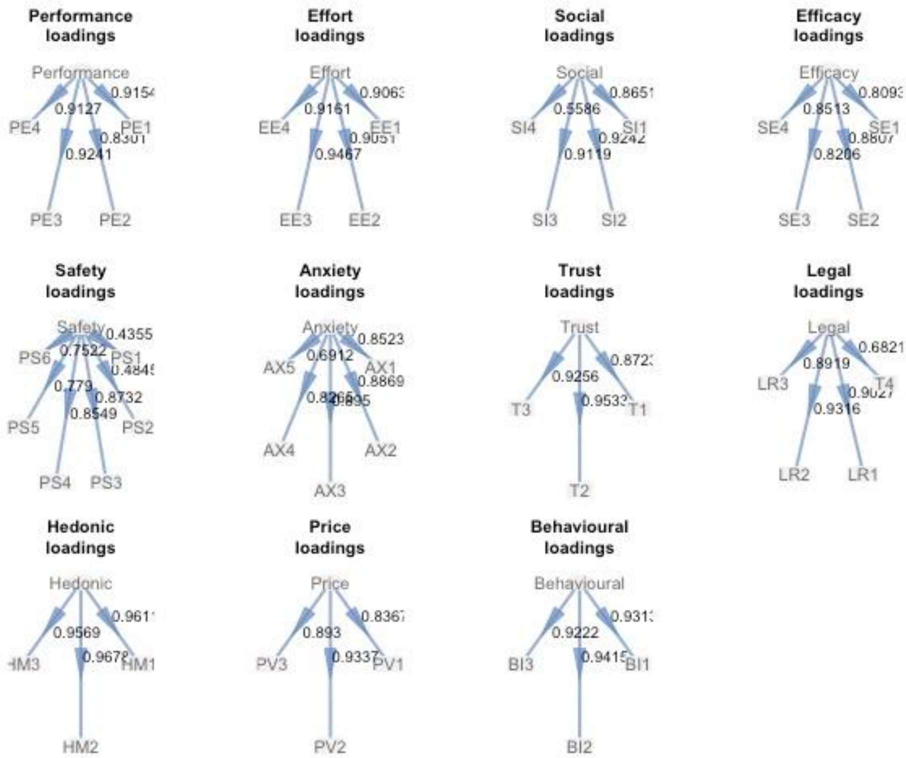


Figure 5.5 Weight Loadings for the Model

Here is Figure 5.5 presents the latent variables and each variable's weight loadings and communality = reliabilities as the study looks at the commonality. They should be greater than 0.49, the variables for which this is not are the ones which won't be in the model probably as PS.

Figure 5.6 illustrates the Chart of the loading-bar type

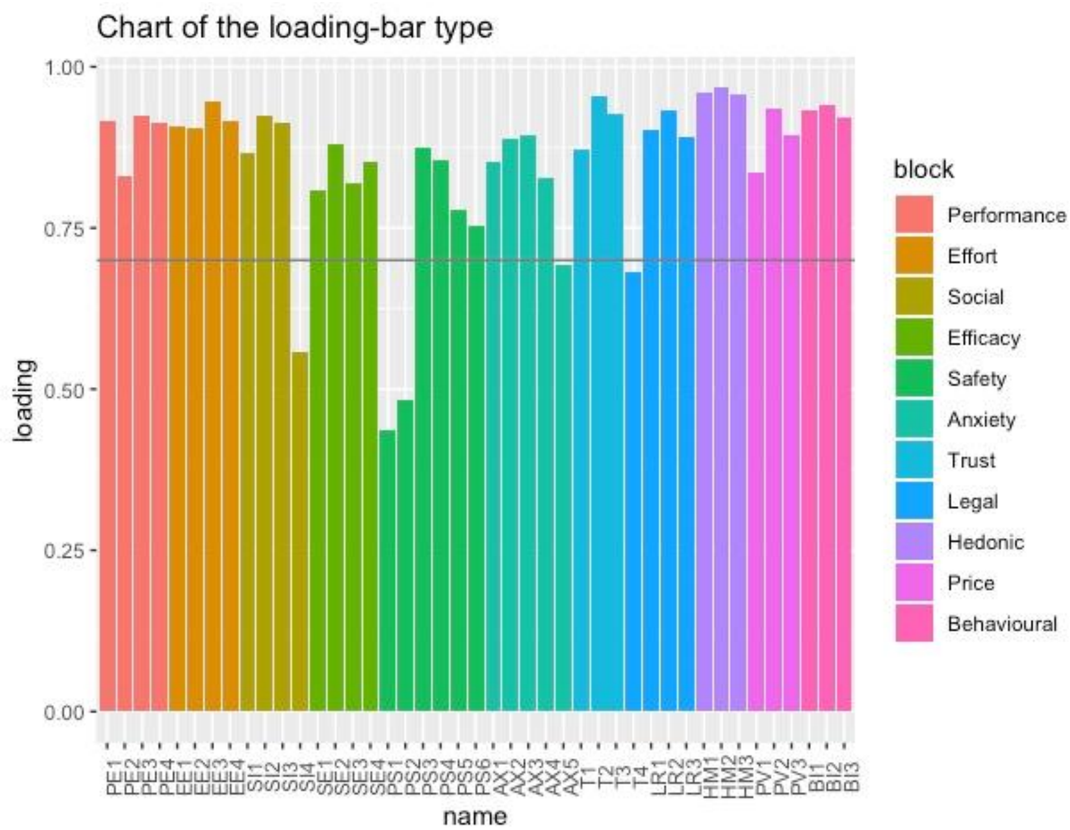
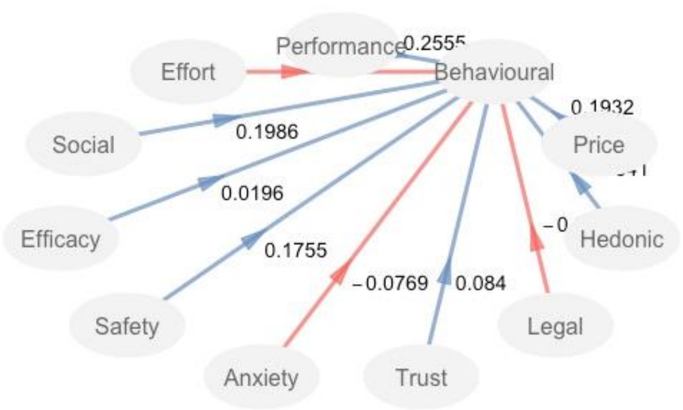


Figure 5.6 Chart of the loading-bar type

Figure 5.7 shows the plot of the model and path coefficient, the blue ones are positive and on the other hand the red ones are negative



Constructs	Regression Weights (β)
Performance (PE)	0.256
Effort (EE)	-0.038
Social (SI)	0.199
Efficacy (SE)	0.020
Safety (PS)	0.176
Anxiety (AX)	-0.077
Trust (T)	0.084
Legal (LR)	-0.043
Hedonic (HM)	0.184
Price (PV)	0.193

Figure 5.7 Plot for the eleven-factor model and path coefficient

Table 5.14 The estimates for the inner model

	Behavioural.Estimate	Behavioural.Std..Error	Behavioural.t.value	Behavioural.Pr
Intercept	0.000	0.021	0.000	1.000
Performance	0.256	0.040	6.455	0.000
Effort	0.038	0.032	1.171	0.242
Social	0.199	0.034	5.812	0.000
Efficacy	0.020	0.029	0.667	0.505
Safety	0.176	0.042	4.135	0.000
Anxiety	-0.077	0.031	-2.514	0.012
Trust	0.084	0.037	2.265	0.024
Legal	0.043	0.031	1.392	0.165
Hedonic	0.184	0.027	6.894	0.000
Price	0.193	0.028	6.894	0.000

Inner summary of the eleven factors model

Table 4.15 Eleven factors model summary statistics

	Type	R2	Block_Communality	Mean_Redundancy	AVE
1	Exogenous	0	0,803500249	0	0,803500249
2	Exogenous	0,000	0,844	0,000	0,844
3	Exogenous	0,000	0,687	0,000	0,687
4	Exogenous	0,000	0,707	0,000	0,707
5	Exogenous	0,000	0,515	0,000	0,515
6	Exogenous	0,000	0,695	0,000	0,695
7	Exogenous	0,000	0,842	0,000	0,842
8	Exogenous	0,000	0,736	0,000	0,736
9	Exogenous	0,000	0,925	0,000	0,925
10	Exogenous	0,000	0,790	0,000	0,790

11	Endogenous	0,803	0,868	0,697	0,868

All the AVEs, as the recommended values are greater than 0.5, the factors are good, except the Perceived Safety.

Table 5.16 Results of the original structural model 1

Construct	**Code Name**	**Hypotheses**	**Relationship (Positive)**	**Standardized regression weights (β)**	**Supported**
Performance Expectancy	PE	H1	PE → BI	**0.256**	**YES*******
Effort Expectancy	EE	H2	EE → BI	**0.038**	**YES**
Social Influence	SI	H3	SI → BI	**0.199**	**YES*******
Self-Efficacy	SE	H4	SE → BI	**0.020**	**YES**
Perceived Safety	PS	H5	PS → BI	**0.176**	**YES*******
Anxiety	AX	H6	AX → BI	**-0.077**	**YES ****
Trust	T	H7	T → BI	**0.084**	**YES**
Legal Regulation	LR	H8	LR → BI	**0.043**	**YES ****
Hedonic Motivation	HM	H9	HM → BI	**0.184**	**YES*******
Price Value	PV	H10	PV → BI	**0.193**	**YES*******

***** Significant at 0.001 level (two tailed), **Significant at 0.01 level (two tailed)**

Moreover, the researcher goes back to the nine factors model

Figure 5.8 Plot for nine factors model

As a first thing to do with the second model, the researcher checks the unidimensionality

Nine Factors model Unidimensionality

Table 5.17 Nine Factors model Unidimensionality

	Mode	MVs	C.alpha	DG.rho	eig.1st	eig.2nd
1	A	3	0.93	0.95	2.62	0.23
2	A	4	0.94	0.96	3.38	0.29
3	A	1	1.00	1.00	1.00	0.00
4	A	2	0.86	0.94	1.76	0.24
5	A	4	0.87	0.91	2.89	0.55
6	A	3	0.91	0.95	2.56	0.31
7	A	3	0.96	0.97	2.78	0.12
8	A	2	0.86	0.94	1.76	0.24
9	A	3	0.92	0.95	2.60	0.22

Here the column of Cronbach Alpha, as all the values are greater than 0.7, the researcher is happy as the minimum is 0.86, so this is pretty good. Dillon-Goldstein rho should be higher than 0.8, as the minimum is 0.91 this is satisfactory as well

Moreover, the 1st eigenvalue should be significant and higher than 1 and the second should be small and smaller than one efficacy is just one variable that is why there are such results, but it is satisfactory.

The next step is to visualize the loadings

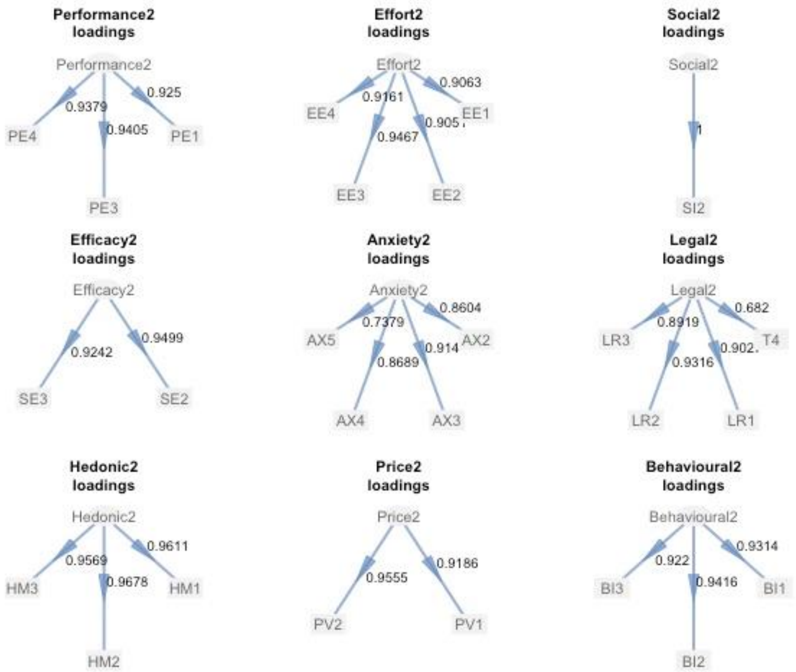


Figure 5.9 Loading for the nine factors model

The next table shows the latent variables, and each variable's weight loadings, where communality = reliabilities. As the researcher looks at the communality, they should be higher than 0.49. In this model, the minimal is 0.54 for AX5 and the second lowest is 0.74 for AX2, so this is very good.

Table 5.18 Outer Model2 characteristics

	name	block	weight	loading	communality	redundancy
1	PE1	Performance2	0.37	0.93	0.86	0.00
2	PE3	Performance2	0.35	0.94	0.88	0.00
3	PE4	Performance2	0.35	0.94	0.88	0.00
4	EE1	Effort2	0.26	0.91	0.82	0.00
5	EE2	Effort2	0.29	0.91	0.82	0.00
6	EE3	Effort2	0.27	0.95	0.90	0.00
7	EE4	Effort2	0.26	0.92	0.84	0.00
8	SI2	Social2	1.00	1.00	1.00	0.00
9	SE2	Efficacy2	0.59	0.95	0.90	0.00
10	SE3	Efficacy2	0.48	0.92	0.85	0.00
11	AX2	Anxiety2	0.34	0.86	0.74	0.00
12	AX3	Anxiety2	0.36	0.91	0.84	0.00
13	AX4	Anxiety2	0.27	0.87	0.75	0.00
14	AX5	Anxiety2	0.19	0.74	0.54	0.00
15	LR1	Legal2	0.34	0.92	0.85	0.00
16	LR2	Legal2	0.37	0.95	0.90	0.00
17	LR3	Legal2	0.38	0.90	0.81	0.00
18	HM1	Hedonic2	0.33	0.96	0.92	0.00
19	HM2	Hedonic2	0.38	0.97	0.94	0.00
20	HM3	Hedonic2	0.33	0.96	0.92	0.00
21	PV1	Price2	0.45	0.92	0.84	0.00
22	PV2	Price2	0.61	0.96	0.91	0.00
23	BI1	Behavioural2	0.36	0.93	0.87	0.67
24	BI2	Behavioural2	0.38	0.94	0.89	0.69
25	BI3	Behavioural2	0.34	0.92	0.85	0.66

In figure 5.10 of the loadings-bar type

Here is again a nice visualization of the loadings, with the 0.7 cut-off line

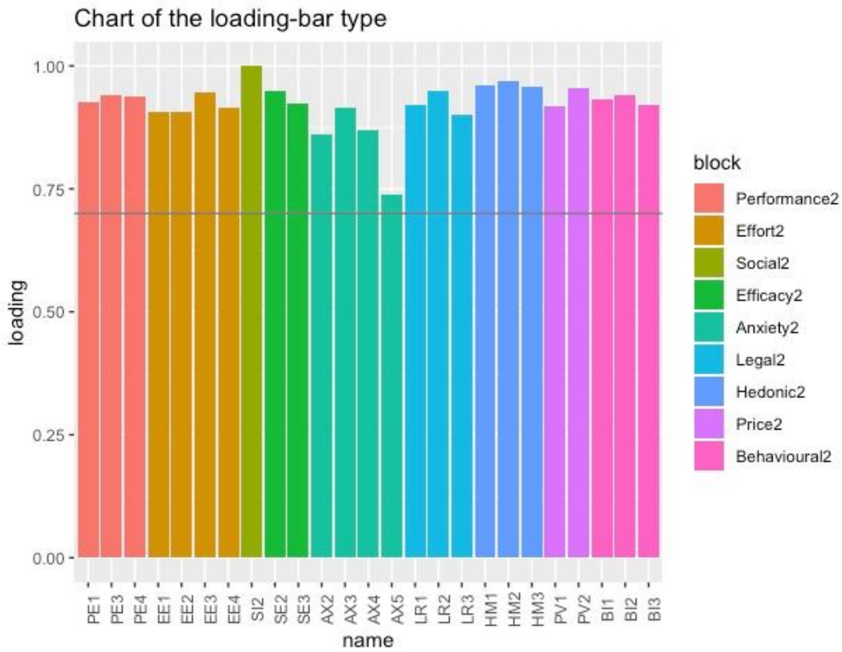


Figure 5.10 Chart of the loading-bar type

It can be seen in figure 5.10 that all the loadings are greater than the 0.7 cut-off as such a variable is chosen.

Figure 5.11 shows the model and path coefficients, where the blue ones are positive and on the other hand the red one are negative.

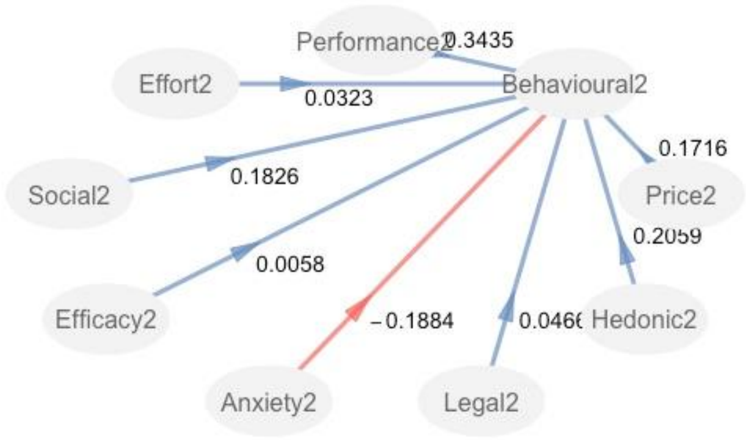


Figure 5.11 Plot for the nine-factor model and path coefficient

Table 5.19 Model2 Estimates

	Behavioural2.Estimate	Behavioural2.Std..Error	Behavioural2.t.value	Behavioural2.Pr...t..
Intercept	0.0000	0.0222	0.0000	1.0000
Performance2	0.3435	0.0353	9.7448	0.0000
Effort2	0.0323	0.0331	0.9767	0.3292
Social2	0.1826	0.0298	6.1348	0.0000
Efficacy2	0.0058	0.0271	0.2152	0.8297
Anxiety2	-0.1884	0.0262	-7.1872	0.0000
Legal2	0.0466	0.0286	1.6308	0.1036
Hedonic2	0.2059	0.0283	7.2784	0.0000
Price2	0.1716	0.0268	6.3964	0.0000

Where the most important are the first and the last column, in the first one, there are the estimates.

Table 5.20 gives the effects

Effects Model2

Table 5.20 Effects Model2

relationships	direct	indirect	total
Performance2 -> Effort2	0.000	0.000	0.000
Performance2 -> Social2	0.000	0.000	0.000
Performance2 -> Efficacy2	0.000	0.000	0.000
Performance2 -> Anxiety2	0.000	0.000	0.000
Performance2 -> Legal2	0.000	0.000	0.000
Performance2 -> Hedonic2	0.000	0.000	0.000
Performance2 -> Price2	0.000	0.000	0.000
Performance2 -> Behavioural2	0.344	0.000	0.344
Effort2 -> Social2	0.000	0.000	0.000
Effort2 -> Efficacy2	0.000	0.000	0.000
Effort2 -> Anxiety2	0.000	0.000	0.000
Effort2 -> Legal2	0.000	0.000	0.000
Effort2 -> Hedonic2	0.000	0.000	0.000
Effort2 -> Price2	0.000	0.000	0.000
Effort2 -> Behavioural2	0.032	0.000	0.032
Social2 -> Efficacy2	0.000	0.000	0.000
Social2 -> Anxiety2	0.000	0.000	0.000
Social2 -> Legal2	0.000	0.000	0.000
Social2 -> Hedonic2	0.000	0.000	0.000
Social2 -> Price2	0.000	0.000	0.000
Social2 -> Behavioural2	0.183	0.000	0.183
Efficacy2 -> Anxiety2	0.000	0.000	0.000
Efficacy2 -> Legal2	0.000	0.000	0.000
Efficacy2 -> Hedonic2	0.000	0.000	0.000
Efficacy2 -> Price2	0.000	0.000	0.000
Efficacy2 -> Behavioural2	0.006	0.000	0.006
Anxiety2 -> Legal2	0.000	0.000	0.000
Anxiety2 -> Hedonic2	0.000	0.000	0.000
Anxiety2 -> Price2	0.000	0.000	0.000

Anxiety2 -> Behavioural2	-0.188	0.000	-0.188
Legal2 -> Hedonic2	0.000	0.000	0.000
Legal2 -> Price2	0.000	0.000	0.000
Legal2 -> Behavioural2	0.047	0.000	0.047
Hedonic2 -> Price2	0.000	0.000	0.000
Hedonic2 -> Behavioural2	0.206	0.000	0.206
Price2 -> Behavioural2	0.172	0.000	0.172

As you look only at the non-zero ones you can see that these ones are the path loadings.

Here are the AVEs, as all the values are greater than 0.7, these are above the recommended value of 0.5 so the researcher is quite happy about this

Table 5.21 Inner Model2 Summary

	Type	R2	Block_Communality	Mean_Redundancy	AVE
1	Exogenous	0.000	0.873	0.000	0.873
2	Exogenous	0.000	0.844	0.000	0.844
3	Exogenous	0.000	1.000	0.000	1.000
4	Exogenous	0.000	0.878	0.000	0.878
5	Exogenous	0.000	0.719	0.000	0.719
6	Exogenous	0.000	0.854	0.000	0.854
7	Exogenous	0.000	0.925	0.000	0.925
8	Exogenous	0.000	0.878	0.000	0.878
9	Endogenous	0.774	0.868	0.672	0.868

The researcher also had to check the cross loadings see Table 5.22

Table 5.22 Cross loading for model 2

	name	block	Performance2	Effort2	Social2	Efficacy2	Anxiety2	Legal2	Hedonic2	Price2	Behavioural2
1	PE1	Performance2	0.925	0.629	0.594	0.417	-0.483	0.472	0.548	0.443	0.774
2	PE3	Performance2	0.941	0.559	0.536	0.383	-0.397	0.496	0.523	0.472	0.716
3	PE4	Performance2	0.938	0.571	0.562	0.407	-0.365	0.545	0.558	0.453	0.719
4	EE1	Effort2	0.576	0.906	0.480	0.500	-0.398	0.446	0.408	0.418	0.557
5	EE2	Effort2	0.590	0.905	0.541	0.491	-0.474	0.459	0.453	0.436	0.621
6	EE3	Effort2	0.591	0.947	0.535	0.481	-0.427	0.453	0.426	0.385	0.582
7	EE4	Effort2	0.551	0.916	0.502	0.434	-0.425	0.416	0.357	0.335	0.553
8	SI2	Social2	0.604	0.561	1.000	0.423	-0.352	0.449	0.441	0.348	0.649
9	SE2	Efficacy2	0.454	0.536	0.409	0.950	-0.246	0.414	0.366	0.263	0.434
10	SE3	Efficacy2	0.344	0.427	0.382	0.924	-0.109	0.328	0.319	0.227	0.355
11	AX2	Anxiety2	-0.418	-0.383	-0.378	-0.164	0.860	-0.262	-0.301	-0.406	-0.532
12	AX3	Anxiety2	-0.462	-0.444	-0.341	-0.155	0.914	-0.286	-0.280	-0.321	-0.563
13	AX4	Anxiety2	-0.342	-0.382	-0.256	-0.200	0.869	-0.235	-0.181	-0.228	-0.413
14	AX5	Anxiety2	-0.230	-0.395	-0.160	-0.160	0.738	-0.163	-0.150	-0.181	-0.299
15	LR1	Legal2	0.467	0.459	0.381	0.420	-0.261	0.919	0.388	0.396	0.481

16	LR2	Legal2	0.515	0.457	0.429	0.375	-0.277	0.951	0.436	0.400	0.522
17	LR3	Legal2	0.510	0.427	0.430	0.320	-0.258	0.902	0.437	0.444	0.536
18	HM1	Hedonic2	0.536	0.427	0.439	0.359	-0.236	0.409	0.961	0.332	0.584
19	HM2	Hedonic2	0.620	0.447	0.450	0.365	-0.287	0.472	0.968	0.374	0.663
20	HM3	Hedonic2	0.514	0.421	0.382	0.337	-0.288	0.431	0.957	0.325	0.590
21	PV1	Price2	0.372	0.333	0.277	0.156	-0.244	0.380	0.270	0.919	0.456
22	PV2	Price2	0.523	0.457	0.364	0.315	-0.394	0.452	0.386	0.955	0.610
23	BI1	Behavioural2	0.733	0.589	0.600	0.354	-0.514	0.504	0.570	0.609	0.931
24	BI2	Behavioural2	0.783	0.638	0.627	0.485	-0.517	0.544	0.610	0.515	0.942
25	BI3	Behavioural2	0.686	0.532	0.585	0.340	-0.518	0.505	0.605	0.494	0.922

The cross-loading look good as well as the values for each variable are the highest in the corresponding column and not in the other factor!

Goodness of fit is 0.809 where the values > 0.7 are considered as very good

The R squared of this second model is 0.77 as well what is important is mean redundancy which is 0.67 for the Behavioral

Table 5.23 Results of the revised structural model 2

Construct	Code Name	Hypotheses	Relationship (Positive)	Standardized regression weights (β)	Supported
Performance Expectancy	PE	H1	PE → BI	**0.344**	**YES*** **
Effort Expectancy	EE	H2	EE → BI	**0.032**	**YES**
Social Influence	SI	H3	SI → BI	**0.183**	**YES*** **
Self-Efficacy	SE	H4	SE → BI	**0.006**	**YES**
Anxiety	AX	H6	AX → BI	**-0.188**	**YES*** **
Legal Regulation	LR	H8	LR → BI	**0.047**	**YES**
Hedonic Motivation	HM	H9	HM → BI	**0.206**	**YES*** **
Price Value	PV	H10	PV → BI	**0.172**	**YES*** **

***** Significant at 0.001 level (two tailed), **Significant at 0.01 level (two tailed)**

As Perceived Safety (H5) and Trust (H7) were not taken in the account in the model, the researcher cannot decide what kind of relationship they would have on the Behavioural Intention

H1: Performance Expectancy will be positively related to behavioural intention of using autonomous vehicles**.**

H2: Effort Expectancy will be positively related to behavioural intention of using autonomous vehicles**.**

H3: Social Influence will be positively related to behavioural intention of using autonomous vehicles**.**

H4: Self-Efficacy will be positively related to behavioural intention of using autonomous vehicles**.**

H5: Perceived Safety will be positively related to behavioural intention of using autonomous vehicles**.**

H6: Anxiety will be negatively related to behavioural intention of using autonomous vehicles**.**

H7: Trust will be positively related to behavioural intention of using autonomous vehicles**.**

H8: Legal Regulation will be positively related to behavioural intention of using autonomous vehicles**.**

H9: Hedonic Motivation will be positively related to behavioural intention of using autonomous vehicles**.**

H10: Price Value will have a significant influence on behavioural intention of using autonomous vehicles.

5.3.9 Final Model

Figure 5.13 represent the final validated model

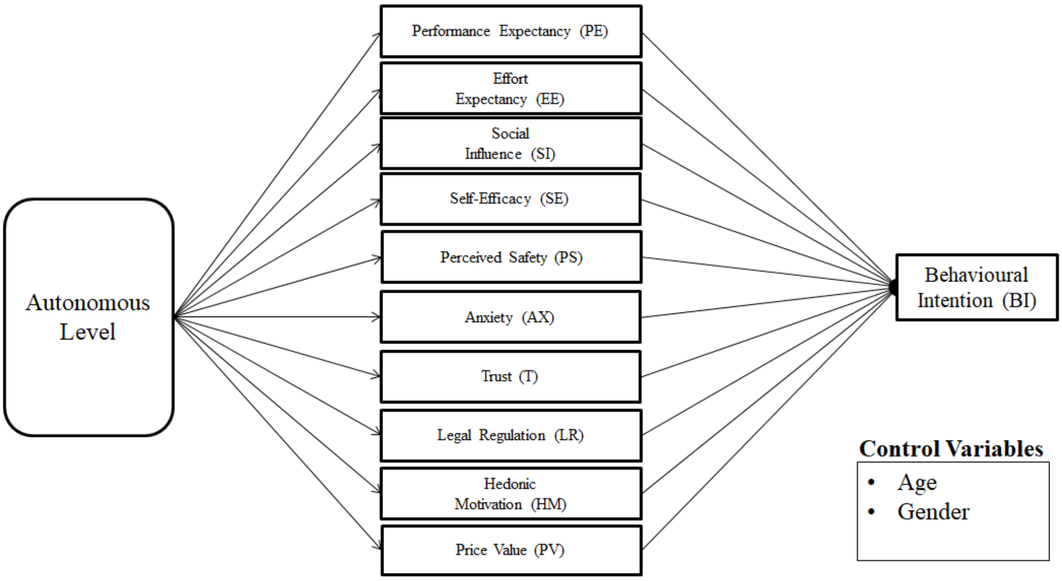


Figure 5.12 Research model for measuring consumers' behavioural intention to adopt Autonomous Vehicles: Autonomous Vehicle Technology Acceptance Model (AVTAM)

5.4 Summary

This chapter presented the results of this research study. Several statistical procedures were applied to screen the data to deal with missing values, outliers, and normality issues. This screening was important before performing structural equation modelling (SEM) because SEM is very sensitive to such issues. Mahalanobis distance (D^2) using R Programming version 3.5.2 was measured to identify outliers. Results revealed that there were very few outliers. It was however decided to remove all the cases. Skewness and kurtosis were used to investigate normality of the data. Results suggested that data were normally distributed.

Structural Equation Modelling (SEM) using R Programming version 3.5.2 was chosen to test the measurement and structural model in this study. Two models were analysed.

The SEM analysis was performed in two stages. In the first stage, Confirmatory Factor Analysis (CFA) was employed to assess the fit of measurement model. Assessment of results indicated the measurement model needed to be rectified. The standardised regression weights for all measurement items were above the recommend level (> 0.7). Few observable variables were dropped. After dropping these problematic items, CFA performed again for the measurement model. The results of the model revealed that goodness of fit indices was improved, and the revised model demonstrated a better fit to the data. Each latent construct was then assessed for the reliability and validity. The assessment of these constructs indicated that all constructs were reliable. Furthermore, the convergent, discriminant and nomological validity for each construct were also confirmed.

Thereafter, structural model was assessed to test the hypothesised relationships between latent constructs. Ten hypotheses (i.e. H1, H2, H3, H4, H5,H6, H7, H8, H9 and H10) represented as causal paths were used to test the relationships between these latent constructs. Both the goodness of the fit indices and parameter estimates coefficients were examined to check whether the hypothesised structural model fitted the data and to test the hypotheses. The fit indices indicated that the hypothesised structural model provided the good fit to the data. The next chapter presents the information visualisation tool proposed as a result of the model developed in this study.

Chapter 6 Phase – III: Information Visualisation

6.1 Introduction

Visualisation is an exciting and expansive area of research, combining the areas of computer graphics, problem solving and software engineering. There is both an art and a science behind good visualisation. In this chapter, the objective is to introduce a new information visualisation method and interactive tool to further explain the data collected from the survey by providing a different perspective to the story.

Technology is an ever changing and always evolving thing. There are new technologies coming out every year and there is always something on the brink of becoming mainstreamed. Currently there is no existing tool to be able to assist technology companies and management/marketing firms in predicting consumer behavioural intentions with regards to their new technology before it can be sold on the market. The aim here is to mainly develop a web application based on the extended unified theory of acceptance and use of technology that will be able to assist clients (private or public technology companies) in predicting adoption or rejection of any technologies and be able to investigate how to promote usage and also examine the barriers obstructing usage and intention to use a specific product. **Three.js - JavaScript 3D libraries** have been selected for the development of 2D and 3D radar charts, and **Tableau Visual Analytics software** version 2019.1 has been selected for the heat map generation.

6.2 Visualisation

Visualization has been a corner stone of computing from its earliest days (Brodlie et al., 2004b) and provides a mechanism for users to gain insight into data they are investigating.

A definition of visualisation (alternatively spelt visualization): Visualisation is

"The ability to present information visually that is rapidly assimilated by human observers and transformed into understanding or insight." (Bethel et al., 2003).

This definition is reinforced by the following quotations as to the purpose of visualisation.

"*The purpose of computing is insight not numbers*" (Hamming, 1962)

For visualisation the researcher can go as far to say that "*the purpose of visualisation is insight not pictures"* Ben Shneiderman quoted in Scientific American (Beardsley, 1999).

The purpose of visualisation therefore is insight. The mechanism to achieve that insight is pictures. Those pictures are built from data, often numbers. Therefore, a high-level definition of visualisation can be stated as thus: Visualisation is a high-level interpretation mechanism for data.

There are many types of visualisation with the most prevalent being scientific visualisation which is concerned with the visualisation of data from scientific experiments and simulation. This data is usually numeric in nature. The second main area of visualisation is information visualisation, the data visualised in information visualisation includes text, images as well as numerical data. The majority of visualisations are generated through the use of the visualisation pipeline the conceptual model of which was proposed by Haber and McNabb (Haber and McNabb, 1990) and is shown in Figure 5.1

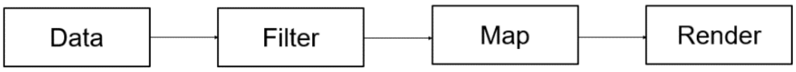


Figure 6.1 Conceptual Model of Visualisation Pipeline

The pipeline model is not always explicitly exposed in visualisations, however each of the stages: data where the user data is loaded; filter where the data is manipulated; map where a representation of the data is generated and render where the final output is produced, are all used. The pipeline model for visualisation is used as a basis for the design of many visualisation systems. The systems are discussed later in this chapter.

Ware (2000) highlights five advantages of visualisation, these are listed below:

- Ability to comprehend huge amounts of data
- The perception of emergent properties
- Shows errors in the data easily

- Understanding large scale and small-scale features.
- Facilitation of hypothesis formation

Exploring and understanding the complexity of the individuals, groups and whole populations’ experiences is the key objective of this phase.

6.3 System Design

This section describes the UML model of the system under analysis the so-called Web application for predicting technology usage behavioural intention. **StarUML software** was used for the development of the use case diagram below.

6.3.1 Use case Diagram (Functional Model)

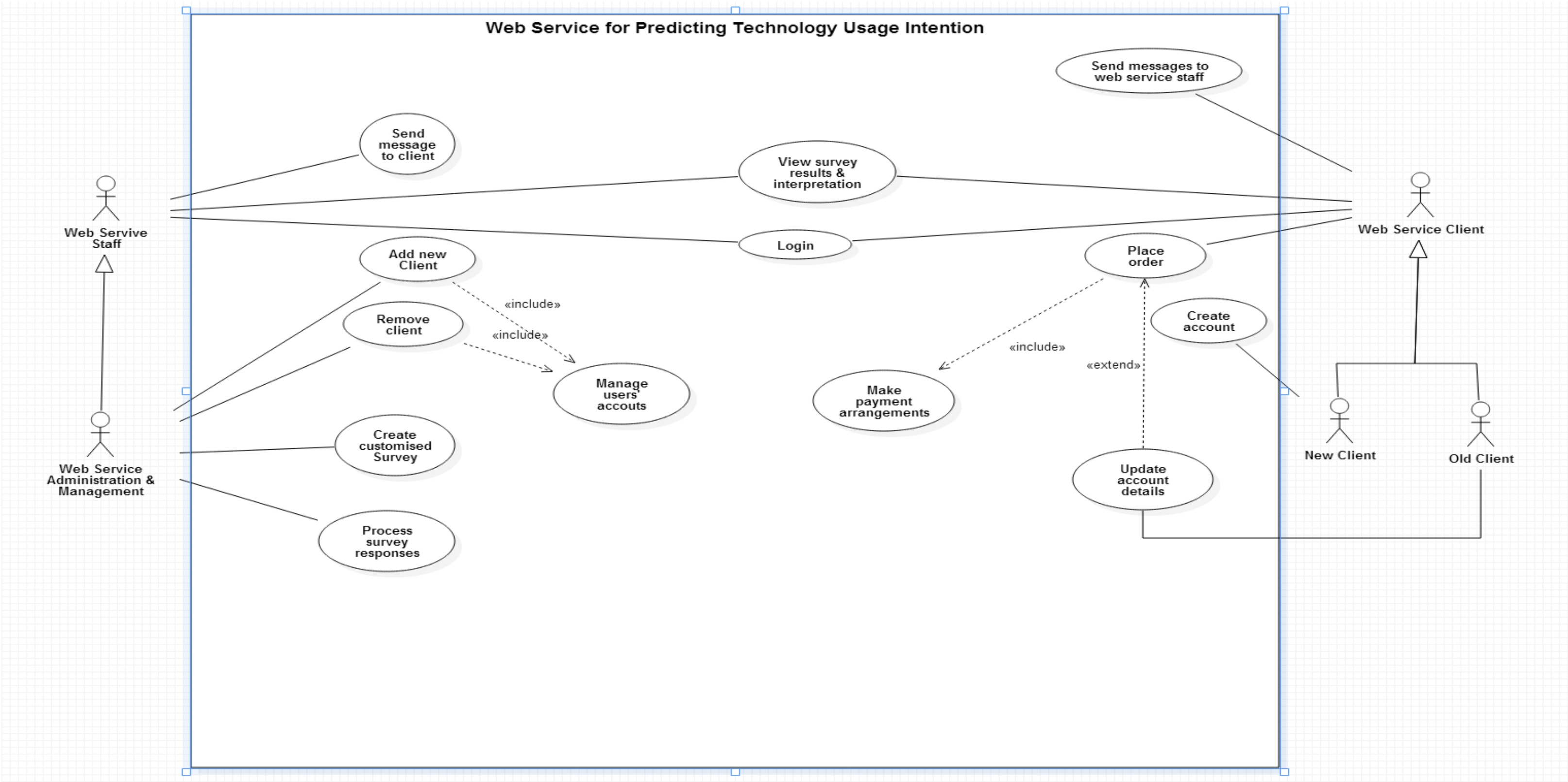


Figure 6.2 Web Service for Predicting Technology Usage Intention Use Case Diagram

Figure 6.2 illustrate the use case diagram of the Web application tool. This application will have two different types of users:

1. Staff members (with different levels of access to the software)
2. Costumer (technology companies, marketing or management team or other representing bodies)

Company staff members can be working on the server side of the application; all staff will have had a different level of access to the system. The Web service administration and management will inherit properties of the Web service staff members.
They will be able to do the following:

- Login to the system
- Create new client account
- Delete client account
- Develop customised questionnaire
- Collect survey response
- Manage clients' accounts
- Manage payment
- Contact clients
- View survey results

Client will be able to do the following:

- Create an account through the web service
- Place an order
- Provide details of their product
- Login to the system to check the progress of the study
- Provide details about the population they are interested in to conduct the study
- Make payment arrangements
- Update account details
- Contact the web service staff customer service team

6.3.1 Notation for information visualisation

Figure 6.3 below represents the notation used to calculate the coordinates for our 2D/3D data visualisation technique developed.

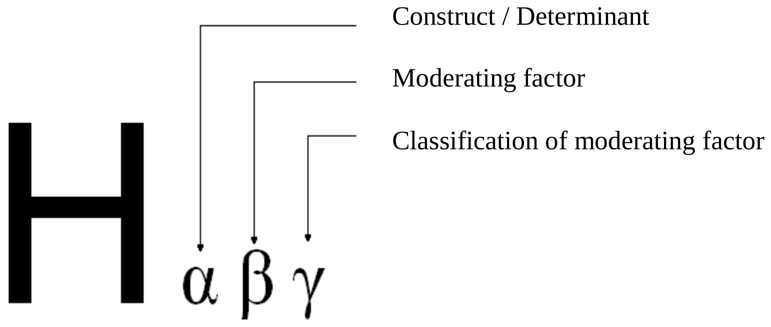


Figure 6.3 Background Notations for Information Visualisation

Table 6.1 Range of options for α

Range of options for α		
1	PE	Performance Expectancy
2	EE	Effort Expectancy
3	SI	Social Influence
4	SE	Self-Efficacy
5	PS	Perceived Safety
6	AX	Anxiety
7	T	Trust
8	LR	Legal Regulation
9	HM	Hedonic Motivation
10	PV	Price Value
11	BI	Behavioural Intention

Table 6.2 Range of options for β

Range of options for β	
1	Age
2	Driving Experience
3	Gender
4	Level of Autonomy
5	Level of Education

Table 6.3 List of possibilities for background notations

β		γ	Range of options for γ depending on β: Classification
1	Age	1	[18-24]
		2	[25-34]
		3	[35-44]
		4	[45-54]
		5	[55-64]
		6	[65 & Over]
2	Driving Experience	1	No driving experience
		2	Novice
		3	Intermediate
		4	Experienced
		5	Expert
3	Gender	1	Male
		2	Female
4	Level of Autonomy	1	Level 0
		2	Level 1
		3	Level 2
		4	Level 3
		5	Level 4
5	Level of Education	1	No formal qualifications
		2	GCSE or equivalent
		3	A level or equivalent
		4	Bachelor's degree or equivalent
		5	Master's degree or equivalent
		6	PhD
		7	Other

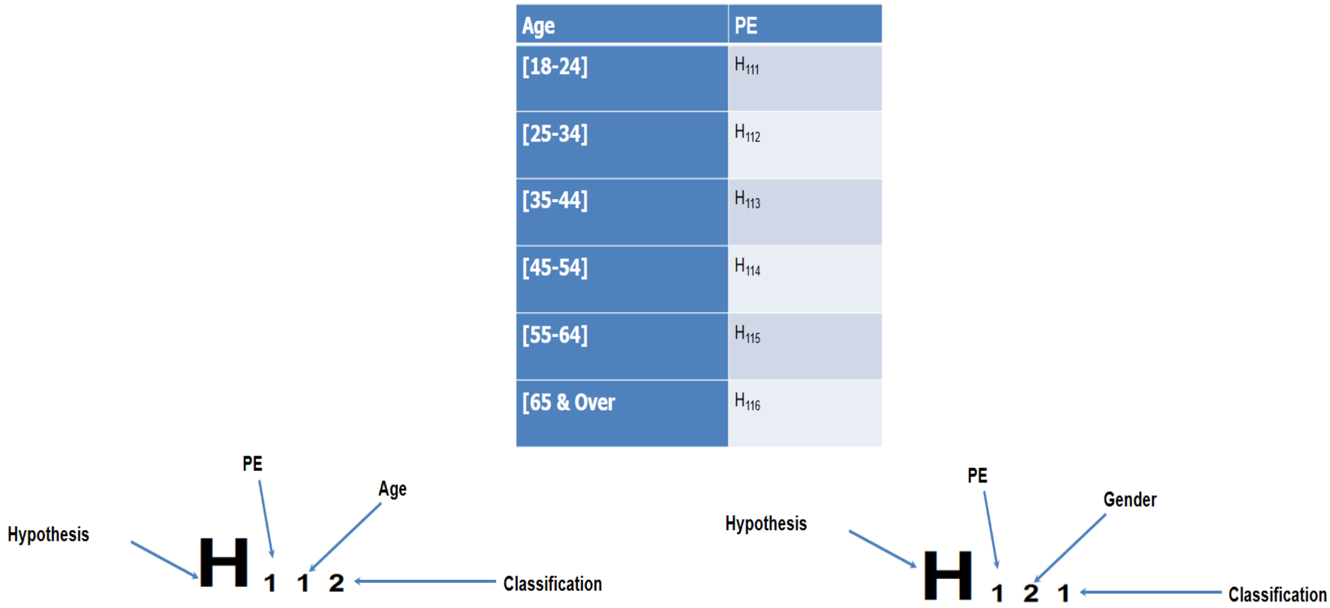


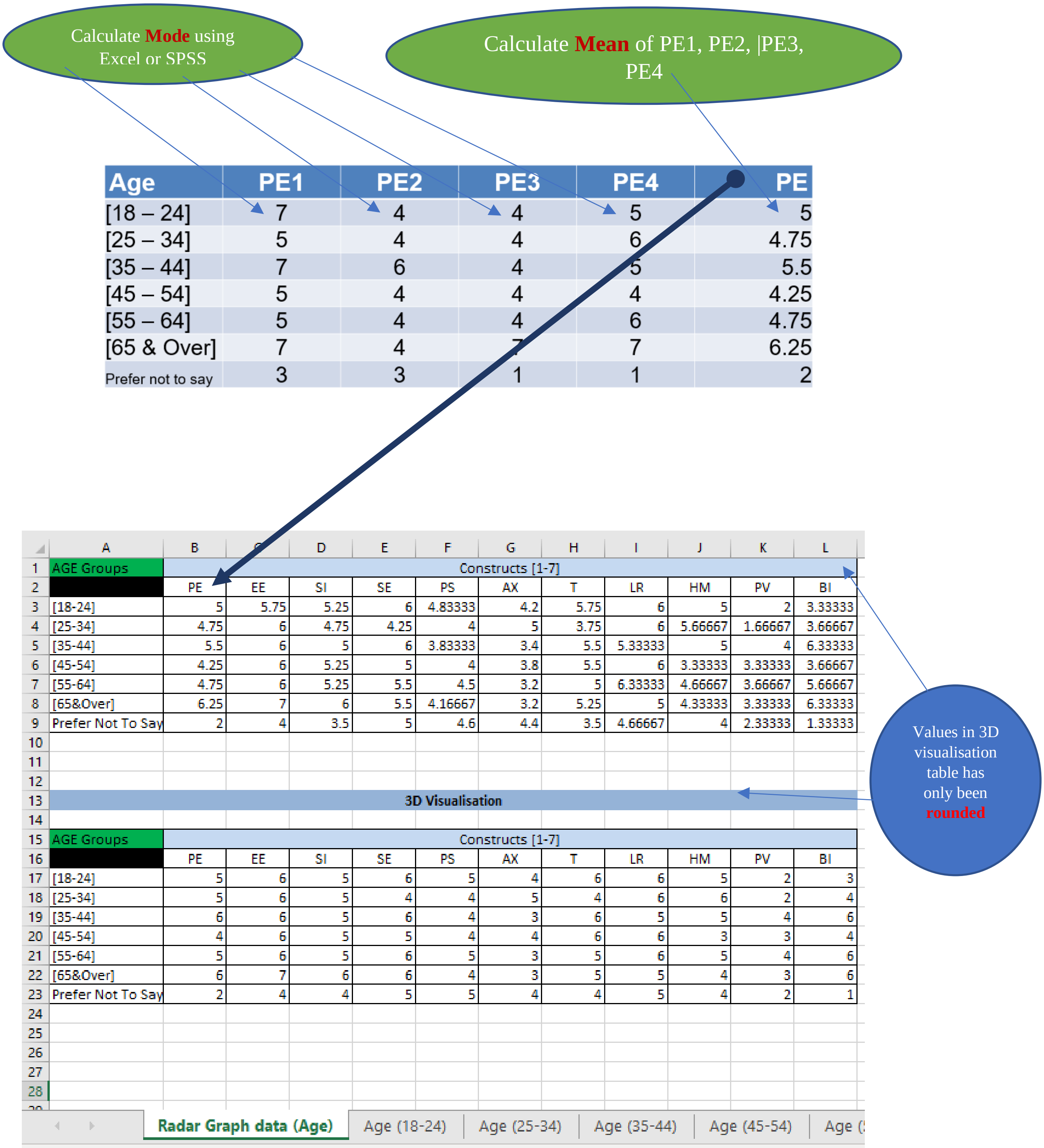
Figure 6.4 Example of Notation for PE

Age	PE1	PE2	PE3	PE4	PE
[18 – 24]	a_1	a_2	a_3	a_4	H_{111}
[25 – 34]	b_1	b_2	b_3	b_4	H_{112}
[35 – 44]	c_1	c_2	c_3	c_4	H_{113}
[45 – 54]	d_1	d_2	d_3	d_4	H_{114}
[55 – 64]	e_1	e_2	e_3	e_4	H_{115}
[65 & Over]	f_1	f_2	f_3	f_4	H_{116}

Figure 6.5 Examples of Background Notations for PE

6.3.2 Example illustration calculation of Performance Expectancy (PE) for Age as a moderating factor (Data Reduction technique)

1. The data set is initially separated in different categories
   a. Age groups
   b. Gender
   c. Level of autonomy
   d. Level of experience
   e. Level of education
2. The **Average** values for each observation are then calculated PE = (PE1+PE2+PE3+PE4)/4. This exercise is replicated for all observations to create a 5th column (PE) [the calculated value]
3. In order to reduce the data to a single value, the other measurement of central tendency techniques (**Mode**) have been selected. This technique then identifies the most repeated value amongst all observations for PE and the value is selected as representing the group response as illustrated in Figure ?? below.
4. The selected value is then **rounded** to the next closer integer.
5. This exercise is repeated for all construct and for all categories.



Age	PE1	PE2	PE3	PE4	PE
[18 – 24]	7	4	4	5	5
[25 – 34]	5	4	4	6	4.75
[35 – 44]	7	6	4	5	5.5
[45 – 54]	5	4	4	4	4.25
[55 – 64]	5	4	4	6	4.75
[65 & Over]	7	4	7	7	6.25
Prefer not to say	3	3	1	1	2

	A	B	C	D	E	F	G	H	I	J	K	L
1	AGE Groups	Constructs [1-7]										
2		PE	EE	SI	SE	PS	AX	T	LR	HM	PV	BI
3	[18-24]	5	5.75	5.25	6	4.83333	4.2	5.75	6	5	2	3.33333
4	[25-34]	4.75	6	4.75	4.25	4	5	3.75	6	5.66667	1.66667	3.66667
5	[35-44]	5.5	6	5	6	3.83333	3.4	5.5	5.33333	5	4	6.33333
6	[45-54]	4.25	6	5.25	5	4	3.8	5.5	6	3.33333	3.33333	3.66667
7	[55-64]	4.75	6	5.25	5.5	4.5	3.2	5	6.33333	4.66667	3.66667	5.66667
8	[65&Over]	6.25	7	6	5.5	4.16667	3.2	5.25	5	4.33333	3.33333	6.33333
9	Prefer Not To Say	2	4	3.5	5	4.6	4.4	3.5	4.66667	4	2.33333	1.33333
13	3D Visualisation											
15	AGE Groups	Constructs [1-7]										
16		PE	EE	SI	SE	PS	AX	T	LR	HM	PV	BI
17	[18-24]	5	6	5	6	5	4	6	6	5	2	3
18	[25-34]	5	6	5	4	4	5	4	6	6	2	4
19	[35-44]	6	6	5	6	4	3	6	5	5	4	6
20	[45-54]	4	6	5	5	4	4	6	6	3	3	4
21	[55-64]	5	6	5	6	5	3	5	6	5	4	6
22	[65&Over]	6	7	6	6	4	3	5	5	4	3	6
23	Prefer Not To Say	2	4	4	5	5	4	4	5	4	2	1

Radar Graph data (Age) | Age (18-24) | Age (25-34) | Age (35-44) | Age (45-54) | Age (

Figure 6.6 Example of 3D coordinates calculation

2D Visualisation

Performance Expectancy (PE)	
AGE Groups	PE
[18-24]	5
[25-34]	5
[35-44]	6
[45-54]	4
[55-64]	5
[65&Over]	6
Prefer Not To S	2

Effort Expectancy (EE)	
AGE Groups	EE
[18-24]	6
[25-34]	6
[35-44]	6
[45-54]	6
[55-64]	6
[65&Over]	7
Prefer Not To S	4

Social Influence (SI)	
AGE Groups	SI
[18-24]	5
[25-34]	5
[35-44]	5
[45-54]	5
[55-64]	5
[65&Over]	6
Prefer Not To S	4

Self- Efficacity (SE)	
AGE Groups	SE
[18-24]	6
[25-34]	4
[35-44]	6
[45-54]	5
[55-64]	6
[65&Over]	6
Prefer Not To S	5

Perceived Safety (PS)	
AGE Groups	PS
[18-24]	5
[25-34]	4
[35-44]	4
[45-54]	4
[55-64]	5
[65&Over]	4
Prefer Not To S	5

Anxiety (AX)	
AGE Groups	AX
[18-24]	4
[25-34]	5
[35-44]	3
[45-54]	4
[55-64]	3
[65&Over]	3
Prefer Not To S	4

Trust (T)	
AGE Groups	T
[18-24]	6
[25-34]	4
[35-44]	6
[45-54]	6
[55-64]	5
[65&Over]	5
Prefer Not To S	4

Legal Regulation (LR)	
AGE Groups	LR
[18-24]	6
[25-34]	6
[35-44]	5
[45-54]	6
[55-64]	6
[65&Over]	5
Prefer Not To S	5

Hedonic Motivation (HM)	
AGE Groups	HM
[18-24]	5
[25-34]	6
[35-44]	5
[45-54]	3
[55-64]	5
[65&Over]	4
Prefer Not To S	4

Price Value (PV)	
AGE Groups	PV
[18-24]	2
[25-34]	2
[35-44]	4
[45-54]	3
[55-64]	4
[65&Over]	3
Prefer Not To S	2

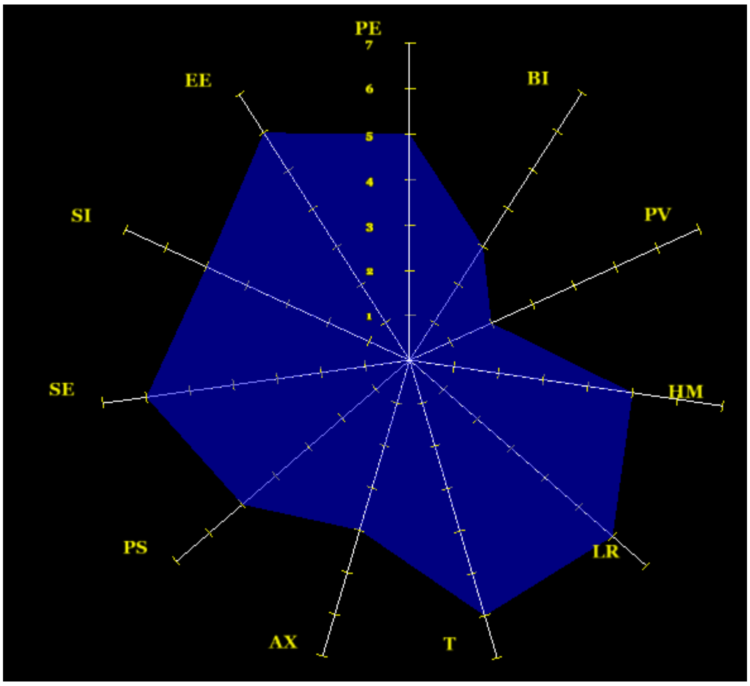
Behavioural Intention (BI)	
AGE Groups	BI
[18-24]	3
[25-34]	4
[35-44]	6
[45-54]	4
[55-64]	6
[65&Over]	6
Prefer Not To S	1

(35-44) | Age (45-54) | Age (55-64) | Age (65& Over) | Prefer Not Say | Label

Figure 6.7 Example of 2D coordinates calculation

6.4 Visualisation and interpretation

The tool developed for the visualisation is very interactive and is capable of generating 31 charts. The researcher is using a radar chart for the representation of the factors influencing different groups of future users. These categories are organised based upon the types of moderating factors (age, gender, level of education and level of autonomy selected or level of previous driving experience) The arms of the charts are split into 7 equal intervals representing a 7 point Likert scale (1 = Strongly disagree, 2 = slightly disagree, 3 = disagree, 4 = neutral, 5 = slightly agree, 6 = agree, 7 = strongly agree).



Range of options for α	
PE	Performance Expectancy
EE	Effort Expectancy
SI	Social Influence
SE	Self-Efficacy
PS	Perceived Safety
AX	Anxiety
T	Trust
LR	Legal Regulation
HM	Hedonic Motivation
PV	Price Value
BI	Behavioural Intention

Figure 6.8 Radar chart for [18 - 24] Age group

Interpretation:

This figure 6.8 clearly shows that the majority of the [18 – 24] age group do not have the intention to adopt AV. This group is very worried about the cost of such a technology. They score very high on most factors except Anxiety. Indeed, the effort necessary to control the technology, the trust on car manufacturers, the self-efficacy and the laws put in place to regulate the service will play a major role for younger users. They mostly scored [6 = Agree].

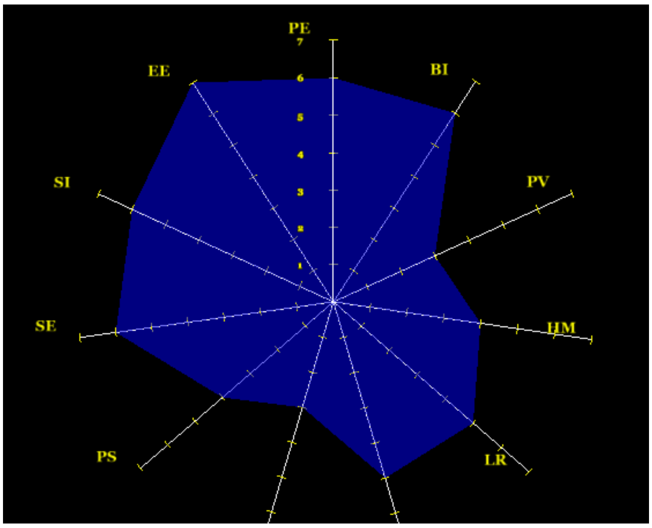


Figure 6.9 Radar chart for [65 & Over] Age group

Range of options for α	
PE	Performance Expectancy
EE	Effort Expectancy
SI	Social Influence
SE	Self-Efficacy
PS	Perceived Safety
AX	Anxiety
T	Trust
LR	Legal Regulation
HM	Hedonic Motivation
PV	Price Value
BI	Behavioural Intention

Interpretation:

Figure 6.9 clearly shows that the majority of [65 & Over] age group are very interested in adopting AV [BI]. This group is also very worried about the cost of such a technology. Effort necessary [EE] to control the technology appears to be more important than all other factors. This group will be influenced by friends, family, and experts' commentators on the technology [SI]. The performance of the technology will also play an important role.

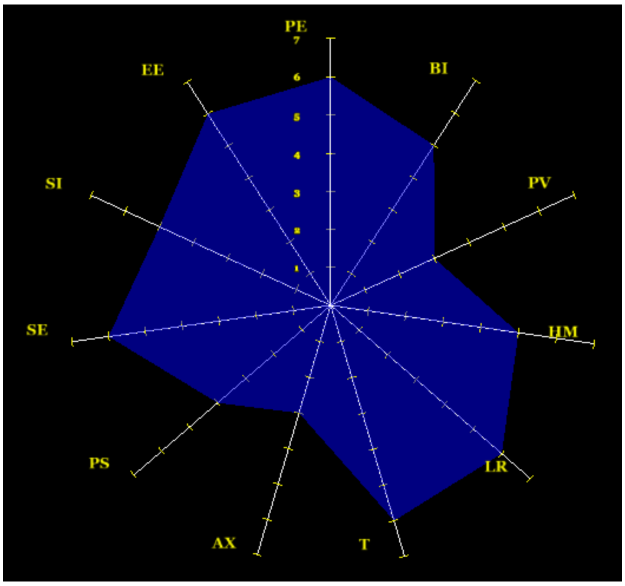


Figure 6.10 Radar chart for gender [Male]

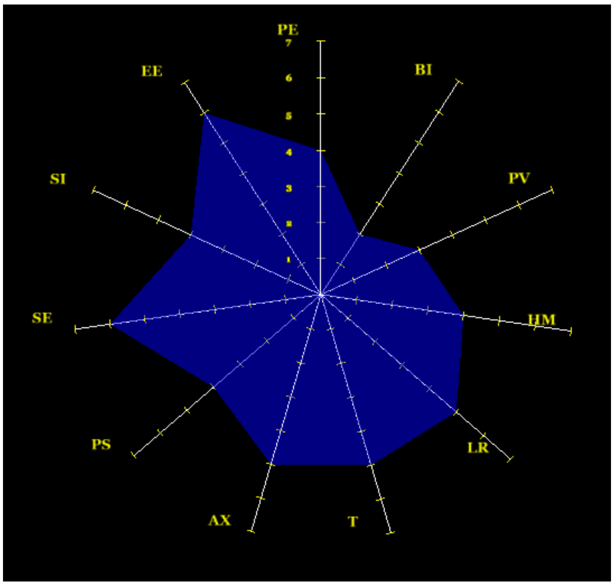


Figure 6.11 Radar chart for Gender [Female]

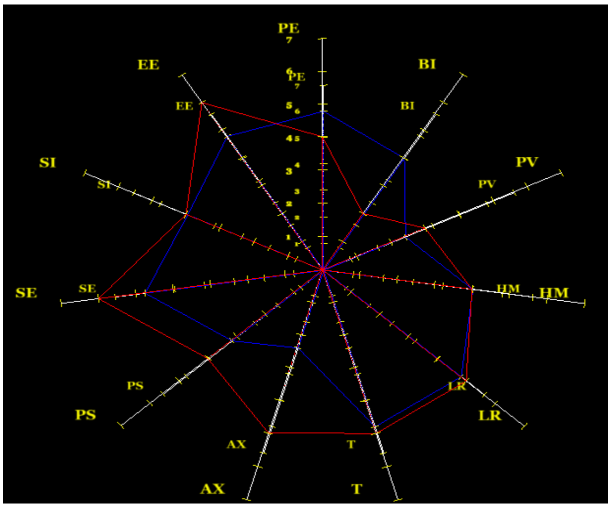


Figure 6.12 3D representation of All Genders chart

Interpretation:

Figure 6.10 represents male responses; Figure 6.11 represents female response; Figure 6.12 represents the juxtaposition of both male and female response. It appears that men tend to be more attracted to the AV than female users. For both groups, the effort necessary to learn how to operate these vehicles will play a very important role.

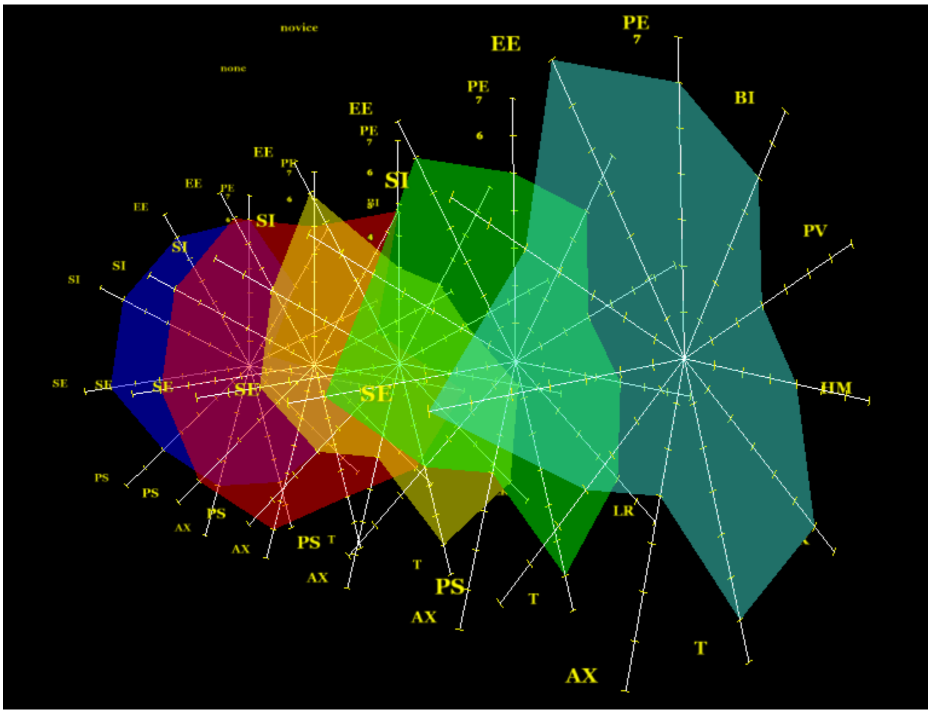


Figure 6.13 3D representation of all Level of driving experience

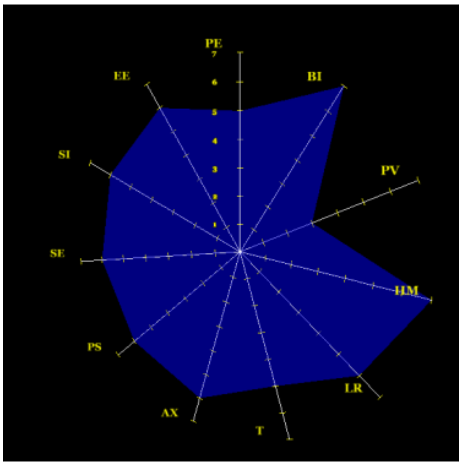


Figure 6.14 Radar chart for novice drivers

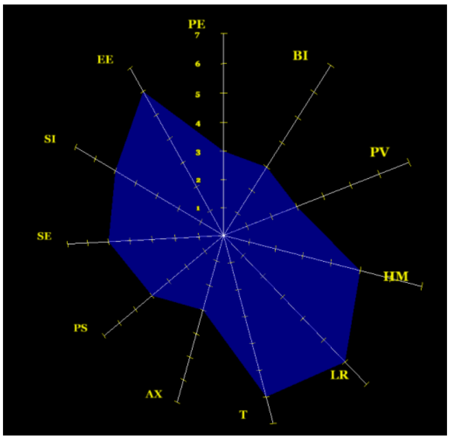


Figure 6.15 Radar chart for intermediate drivers

Figure 6.13 shows the 3D representation of responses of participants separated by driving experience. In Figure 6.14, it is clear that most novice drivers are very interested in adopting AV while intermediate drivers as shown in Figure 6.15 not to be very interested in the technology.

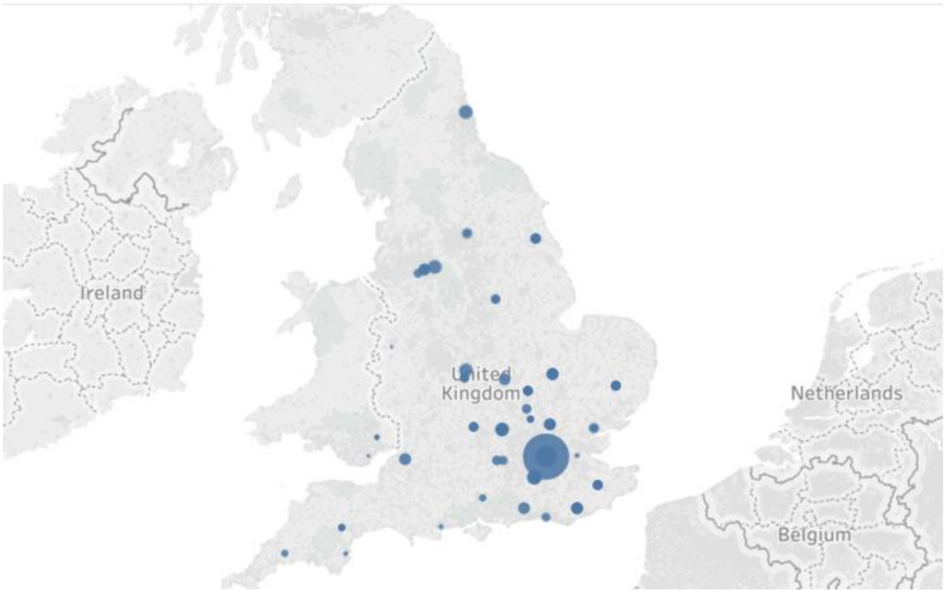


Figure 6.16 Heat Map of the Survey participants

In Figure 6.16, the tableau data analytics software was used to visualise the location of people who took part in this survey. The map clearly shows that although most participants were located in London many respondents came from various regions of the UK.

6.5 Summary

Visualisation, both as an art and a science, has an important role to play in the analysis of large data sets. Numerous techniques for visualisation are available and these are embodied in visualisation systems, either bespoke or for general purpose, closed source or open source, providing a suitable environment to allow asynchronous and synchronous collaborative visualisation using federated resources to scale in the analysis of very large data sets. In this chapter, as part of Phase III, the researcher has developed a tool for information visualisation. This tool has the capabilities to provide further explanation to the data collected; therefore, providing another of layer of description and clarification of the participants' responses currently not available with the existing commercial software. This novel data visualisation technique represents the study's final contribution. The future impact of visualisation has the potential to be the greatest as it is increasingly used for the analysis of scientific data. The next chapter presents detailed discussion of the findings of this study.

Chapter 7 Discussion

The previous chapter presented the findings obtained from the data visualisation tool developed to further examine and explain the various groups' behavioural intention towards AV. The purpose of this chapter is to discuss and reflect upon the findings from a theoretical perspective using those provided in Chapter 2. It also discusses the empirical issues that have been reported from the surveys' findings in Chapter 4 and Chapter 5 as well as the Information visualisation software developed. It also discusses the empirical issues that have been reported from survey findings in the previous chapter.

This chapter is structured as follows: It starts with overview of the main objectives of this research in Section 7.1. It then presents a discussion on the response rate and non-response bias in Section 7.2. The research instrument validation is discussed in 7.3. The research model and supported hypotheses are illustrated in Section 7.4. In Section 7.5 the key constructs of the model are discussed, and then the descriptive statistical findings and the hypothesized relationships are further explained. The last section of the chapter presents the summary and conclusion.

7.1 Overview of this Research

The purpose of this research study was to determine factors affecting User Behavioural Intention to accept autonomous vehicles. This thesis developed and empirically tested a hypothesised model for understanding the factors that influence users' intention to adopt autonomous vehicles in a better way. By extending the Unified Theory of Acceptance and Use of technology - UTAUT2 (see model proposed and tested in phase I and phase II) in the context of an emerging technology such as autonomous vehicles, this study incorporated factors from other well-known theories and models applied in IS research stream. In this background, the main objectives of the research included identifying factors; testing the hypothesised model for validating it by exploring relationships between studied factors and developing an information visualisation tool to illustrate different group behaviours.

As described in Chapter 4, the research model in the present study proposed that user acceptance of an autonomous vehicle systems is affected by Performance Expectancy (PE), Effort Expectancy (EE), Social Influence (SI), Self-Efficacy (SE), Perceived Safety (PS) Anxiety (AX), Trust (T), Legal Regulation (LR), Hedonic Motivation (HM) and Price Value (PV) Age and Gender were proposed to mediate the effects of the external factors. The relative importance of each of these factors in the prediction of the BI to use an autonomous vehicle system was also evaluated.

In order to achieve the above-mentioned research objectives, a detailed and organized literature review was conducted, which is already reported in Chapter 2. Different theories were compared, and empirical research studies were reviewed. The literature suggested that the Unified Theory of Acceptance and Use of Technology were the most appropriate models for the present research due to its simplicity, parsimony and specific focus on Information Systems. Hence, the UTAUT2 was selected as a base model. However, it was identified that the UTAUT2's core constructs i.e. Habit and Facilitating conditions were not sufficient or relevant enough to explain a future emerging technology such as AV's acceptance or behavioural intention to adopt. Therefore, a need for additional variables was also identified. In addition, suitable factors which included an internal factor i.e. Trust, Anxiety and some external factors i.e. technological Self-Efficacy, Perceived Safety and Legal Regulation were identified from interviews conducted with experts in the field of psychology, sociology and computer science together with other constructs identified in the literature. These were incorporated into the model.

This study employed a mixed method approach using two cross-sectional field surveys and interviews for collecting primary data. Two questionnaires were developed from the published literature by adapting exiting measurement scales reported by previous research studies. Prior to using the questionnaire in the main survey, one pre-test and a pilot study were conducted. The purpose of the pre-test and pilot study was to detect any errors and ambiguities in the measurement instrument in order to avoid confusions and misinterpretations (already mentioned in detail in previous Chapters [4-5]). The scales were revised and modified where necessary.

A final sample of 482 responses was used for data analysis. The data collected was then analysed using two statistical software tools i.e. SPSS and R programming. The SPSS version 21.0 was used for the descriptive analysis, while the R programming version 3.5.2 was used for Structural Equation Modelling (SEM) analysis i.e. Confirmatory Factor Analysis (CFA), testing model fit to the data and hypotheses testing. The descriptive analysis of the survey presented a demographic profile of the sample and item analysis. The Exploratory Factor Analysis was performed to extract latent factors (constructs), which were then confirmed by confirmatory factor analysis. Finally, the hypothesised relationships between the constructs were examined by structural equation modelling. A two step- stage approach was adopted in SEM. In the first stage, the measurement model using CFA method, was tested to examine and assess the reliability and validity of the constructs used in the model. In the second stage, a hypothesised structural model was assessed using the path analysis technique for testing the hypothesized casual relationships amongst the constructs proposed in the research model. The proposed research model was found to be valuable in explaining Behavioural Intention to adopt AV by potential users and adequately fit the data.

The results of this study largely support the hypothesised relationships proposed in Model 2 (see chapter 5). In particular, the results suggested that Performance Expectancy (PE), Effort Expectancy (EE), Social Influence (SI), Self-Efficacy (SE), Anxiety (AX), Legal Regulation (LR), Hedonic Motivation (HM), Price Value (PV), jointly influences the behavioural intentions towards AV acceptance. Age and Gender were proposed to mediate the effects of external factors. The structural model was evaluated, and a discussion of the findings is presented in more detail in the next section. It is to be noted that the discussion in this chapter is organised around hypotheses testing results and findings in respect to the proposed hypothesised research model. This is followed by the conclusions of this chapter.

7.2 Response Rate and Non-Response Bias

A 24.6% response rate was obtained in this research. Cornford and Smithson (1996) suggested that, within IS research, a response rate of 20% is considered to be acceptable and if the response rate is approximately 10% then that means the questionnaire design was poor (Cornford and Smithson, 1996). According to Fowler (2002), the majority of surveys produced response rates above 20% being considered as satisfactory (Fowler, 2002). Considering the above two recommended levels (Cornford and Smithson, 1996; Fowler, 2002), the survey response of this research is considered to be satisfactory and acceptable.

However, despite the response rate, a non-response bias could arise in the findings. Therefore, it is essential to conduct a non-response bias test in order to demonstrate whether the non-respondents are similar to the respondents (Fowler, 2002; Karahanna *et al,* 1999). Therefore, in this research a *t*-test was undertaken to determine whether the characteristics of the respondents from the original responses are like the non-respondents. The t-test was conducted for demographics (i.e. age and gender). The results suggested that the demographics and all key constructs except the primary influence of the study showed no significant differences between the respondents and non-respondents. There is a significant difference between the original responses and responses from the non-respondents for the primary influence construct. This suggests that those non-respondents who returned the completed questionnaire after reminders were similar to the respondents from the original responses. Hence this provides evidence that within the sample used for this research there are minimal chances that it is likely that data has a non-response bias.

7.3 Instrument Validation

Although we use multiple methods in this study, the research was largely positivistic in nature. To establish and demonstrate rigour in the findings of positivist research, validity should be undertaken both prior to and after final data collection (Straub *et al*, 2004). The validation process suggested for application to the cases is one where research either utilises previously validated instruments or creates new instruments (Straub et al, 2004, pp 412). Although the application of validation is recommended in both the aforementioned situations, it is essential in the latter case where a study employs newly created instruments for data collection (Straub *et al*, 2004, pp 414). Since this study created a new research instrument for examining Autonomous Vehicle behavioural intention to acceptance, the utmost care was taken to validate a newly created instrument. The process of development and validation of the instrument is already described in chapter 5. This section provides an overall picture of the validation process and also briefly discusses if the undertaken validity measures and their outcomes are on par with the recommendations made in IS research.

The recommended validities include content validity; construct validity, reliability, manipulation validity and the common method bias (Straub *et al*, 2004). Figure 7.1 depicts the overall process of creating and validating a new research instrument. The justification for undertaking each stage is provided in Chapter 5 and the purpose is briefly illustrated in Figure 7.1.

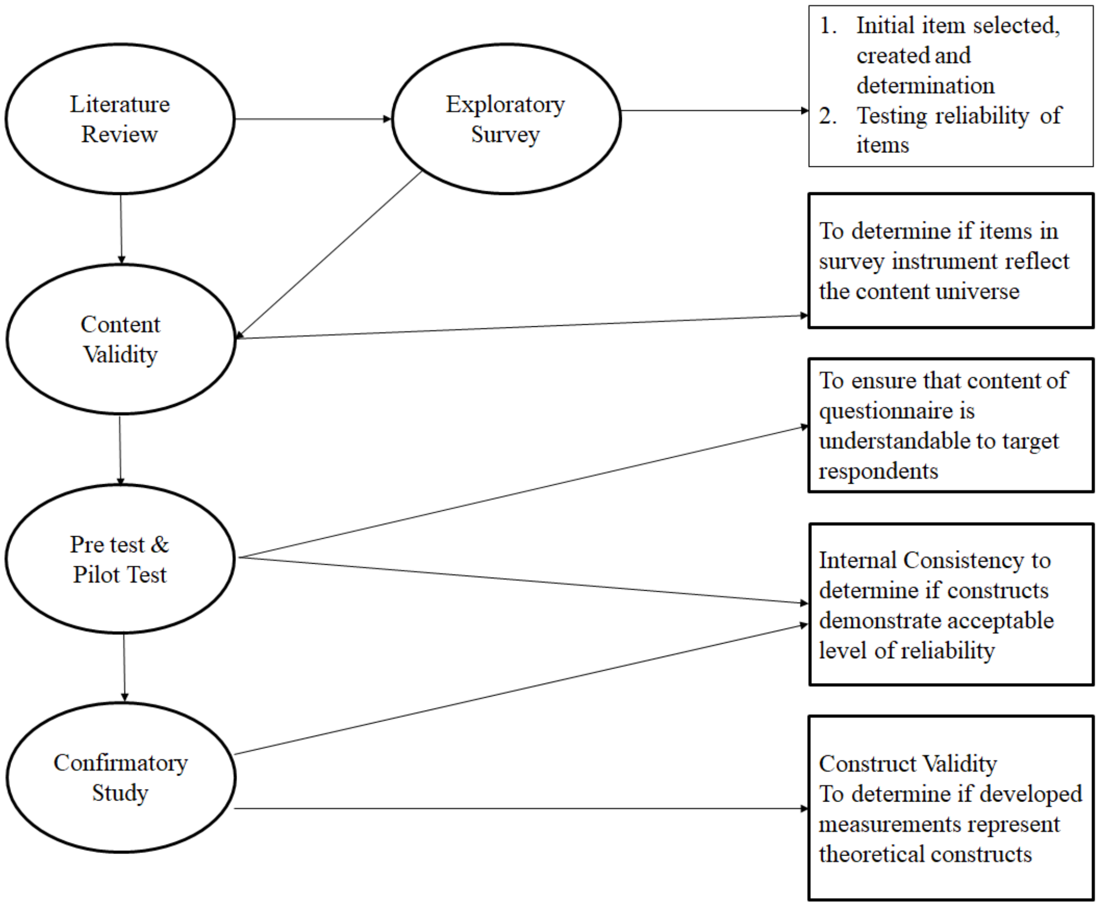


Figure 7.1 Development and Validation Process of Research Instrument

The stages involved in the validation process comprised an exploratory survey, content validation, pre and pilot tests and finally the confirmatory study. Validities that are exercised in this research included content validity, reliability and construct validity.

7.4 Research Model and Hypotheses

Although the explanation and discussion on each hypothesis included in this study are provided in Chapter 5, this section simply summarises that numbers of hypotheses proposed in Chapter 4 ad states whether they are supported by the data or not. Table 7.1 illustrates that a total of 10 research hypotheses were tested to examine if the independent variables significantly explained the dependent variables.

Table 7.1
Summary of Research Hypotheses

HN	Research Hypotheses	Results
H1	Performance Expectancy will be positively related to behavioural intention of using autonomous vehicles.	Supported
H2	Effort Expectancy will be positively related to behavioural intention of using autonomous vehicles.	Supported
H3	Social Influence will be positively related to behavioural intention of using autonomous vehicles.	Supported
H4	Self-Efficacy will be positively related to behavioural intention of using autonomous vehicles.	Supported
H5	Perceived Safety will be positively related to behavioural intention of using autonomous vehicles.	Supported
H6	Anxiety will be negatively related to behavioural intention of using autonomous vehicles.	Supported
H7	Trust will be positively related to behavioural intention of using autonomous vehicles.	Supported
H8	Legal Regulation will be positively related to behavioural intention of using autonomous vehicles.	Supported
H9	Hedonic Motivation will be positively related to behavioural intention of using autonomous vehicles.	Supported
H10	Price Value will have a significant influence on behavioural intention of using autonomous vehicles.	Supported

The summary of the research hypotheses test; also a reflection of the hypotheses relating to proposed conceptual model the performance of the said proposed model. It is possible to compare the predictability of the Autonomous Vehicle Technology Acceptance Model with Oh *et al's* (2003) study.

Table 7.2
Comparison of Intention and Behaviour in Terms of Adjusted R^2

Study	**Theory**	**Adjusted R^2**	
		Behavioural Intention	**Actual Behaviour**
Davis et al (1989)	TAM	---	0.45
Davis et al (1989)	TRA	---	0.32
Davies (1989)	TAM	---	0.51
Taylor and Todd (1995)	DTP	0.57	0.34
Taylor and Todd (1995)	TBP	0.57	0.34
Taylor and Todd (1995)	TAM	0.52	0.34
Karahanna et al (1999)	TRA + TAM	0.38	---
Agarwal & Karahanna (2000)	TAM & Cognitive Absorption	0.50	---
Gefen & Straub (2000)	TAM	0.20	---
Brown et (2002)	TAM	0.52	---
Koufaris (2002)	TAM + Flow Theory	0.54	---
Current study	AVTAM	0.77	---
Recommended level (Straub et al, 2004)		0.40 or above	0.40 or above

Table 7.2 illustrates the comparison of previous studies for the adjusted R^2 obtained for both behavioural intention and actual behaviour. The comparison clearly demonstrates that the AVTAM performed as well as the previous studies. With regards to the behavioural intention value of adjusted R^2 varied between 0.20 (Gefen and Straub, 2000) and 0.57 (Taylor and Todd, 1995 (table 7.2), the adjusted $R^{2.}$ For this study is found to be 0.77, which suggests that the model has a very high predictability power.

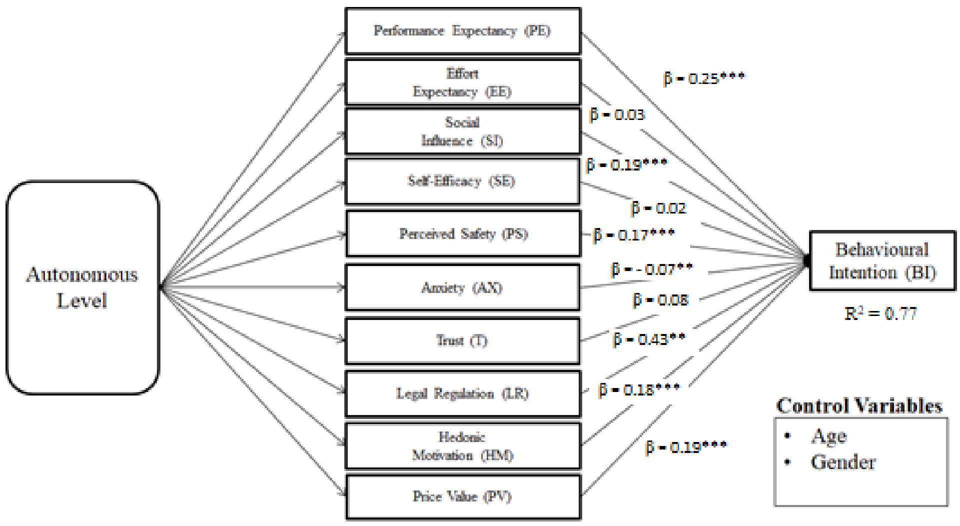


Figure 7.1 Autonomous Vehicle Technology Acceptance Model (AVTAM)

*** p <0.001
** p< 0.01

7.4 Discussing Constructs and Items of the Model

The following sections provide discussions on the constructs and items, and hypotheses tested in this study. It also provides discussions on the ratings of construct items obtained through descriptive statistics and the Structure Equation Modelling.

Performance Expectancy (PE)

PE construct was measured by four items on a seven-point Likert scale. The overall mean score of all items of this construct was 4.39 which suggested that most participants believe that the AV performance will play a major role upon their intention to use this technology. Most participants agreed or strongly agreed when asked whether they will find AV useful for their daily activities. In addition, Cronbach's Alpha coefficient for this construct was 0.91 above the recommended value for the optimal consistency is 0.7. This finding suggests strong internal consistency of the measurement items of PE construct. PE1 stating 'I would find self-driving cars useful in my daily life.' PE2 stated 'If I use self-driving cars, I will reach my destination safely.' PE3 stating 'Using self-driving cars would enable me to accomplish my goals more quickly.' PE4 stating 'Using self-driving cars would increase my productivity.' Hypothesis for this construct was supported after the test; therefore it is part of the revised model as the estimate was 0.3435 significant with a p-value less than 0.001.

Effort Expectancy (EE)

EE construct was measured by four items on a seven-point Likert scale. The overall mean score of all items of this construct was 5.06 which suggested that most participants believe that learning how to use this technology would be easy. Most participants agreed or strongly agreed when asked whether they will find AV easy to drive. In addition, Cronbach's Alpha coefficient for this construct was 0.93 above the recommended value for the optimal consistency is 0.7. This finding suggests strong internal consistency of the measurement items of EE construct. PE1 stating 'Learning how to use a self-driving car would be easy for me.' EE2 stated 'Interaction with self-driving cars would be clear and understandable.' EE3 stating 'I would find self-driving cars easy to use.' EE4 stating 'It would be easy for me to become skilful at using self-driving cars.' Hypothesis for this construct was supported after the test, although not significant, therefore is part of the revised model.

Social Influence (SI)

SI construct was measured by four items on a seven-point Likert scale. The overall mean score of all items of this construct was 4.64 which suggested that most participants believe that people important to them such as family members, experts' commentators, celebrities and friends will play a major role on their intention to use this technology. Most participants agreed or strongly agreed when asked whether they will be influenced by others, and the media. In addition, Cronbach's Alpha coefficient for this construct was 0.82 above the recommended value for the optimal consistency is 0.7. This finding suggests strong internal consistency of the measurement items of PE construct. SI1 stating 'I would be proud to show the system to people who are close to me.' SI2 stated 'People whose opinions are important to me would like the system too.' SI3 stating 'In general, people who I like would encourage me to use the system.' SI4 stating 'I would take into consideration the advice from people important to me when making plans to use self-driving cars.' Hypothesis for this construct was supported after testing, therefore it is part of the revised model as the estimate was 0.1826 significant with a p-value less than 0.001.

Self-Efficacy (SE)

SE construct was measured by four items on a seven-point Likert scale. The overall mean score of all items of this construct was 4.84 which suggested that most participants believe in their ability to use the system should they have more time to better understand it or had the necessary support with it. This will also influence their intention to use this technology. Most participants agreed or strongly agreed to questions related to the construct. In addition, Cronbach's Alpha coefficient for this construct was 0.86 above the recommended value for the optimal consistency is 0.7. This finding suggests strong internal consistency of the measurement items of PE construct. "I could complete a task or activity using the system..." SE1 stating '...if there was no one around to tell me what to do…' SE2 stated '…if I could call someone for help if I got stuck.' SI3 stating '…if I had a lot of time.' SI4 stating '...if I had just the built-in help facility for assistance.’ Hypothesis for this construct was supported after the test as the estimate was 0.0058; although not significant it is part of the revised model.

Anxiety (AX)

AX construct was measured by five items on a seven-point Likert scale. The overall mean score of all items of this construct was 3.93 which suggested that most participants believe the system will help them to reach their destination as designed. The Anxiety will be a construct of the model, but it will negatively influence the Behavioural Intention, which means that with greater Anxiety the smaller the Behavioural Intention, it corresponds with the correlation. In addition, Cronbach’s Alpha coefficient for this construct was 0.88 above the recommended value for the optimal consistency is 0.7. This finding suggests strong internal consistency of the measurement items of the AX construct. AX1 stating ‘I have concerns about using the system.’ AX2 stating ‘I think I could have an accident because of using the system.’ AX3 stating ‘The system is somewhat frightening to me.’ AX4 stating ‘I fear that I do not reach my destination because of the system.’ AX5 stating ‘I am afraid that I do not understand the system.’ Hypothesis for this construct was NOT supported after the test but is part of the revised model as the estimate was -0.1884 significant with a p-value less than 0.001.

Legal Regulation (LR)

LR construct was measured by three items on a seven-point Likert scale. The overall mean score of all items of this construct was 4.55 which suggested that most participants believe that the legal regulation imposed on AV manufacturer and software companies developing these technologies will play a major role on their intention to use this technology. Most participants agreed or strongly agreed when asked whether robust regulations will be put in place to protect self-driving car users. In addition, Cronbach’s Alpha coefficient for this construct was 0.90 above the recommended value for the optimal consistency which is 0.7. This finding suggests strong internal consistency of the measurement items of LR construct. LR1 stating ‘I believe that robust guidelines will be in place to regulate self-driving car manufacturers.' LR2 stating 'I believe that robust regulations will be put in place to protect self-driving car users.' LR3 stating 'I believe that the public liability insurance will protect users from personal damage.' Hypothesis for this construct was supported after the test as the estimate was 0.0466. Although not significant, it is part of the revised model.

Hedonic Motivation (HM)

PE construct was measured by three items on a seven-point Likert scale. The overall mean score of all items of this construct was 4.84 which suggested that most participants believe that using self-driving cars would be very entertaining, compared to traditional cars. Most participants agreed or strongly agreed when asked whether they will find AV more entertaining, compared to traditional cars. In addition, Cronbach's Alpha coefficient for this construct was 0.96 above the recommended value for the optimal consistency which is 0.7. This finding suggests strong internal consistency of the measurement items of HM construct. HM1 stating 'Using self-driving cars would be fun, compared to traditional cars.' HM2 stating 'Using self-driving cars would be enjoyable, compared to traditional cars.' HM3 stating 'Using self-driving cars would be very entertaining, compared to traditional cars.' Hypothesis for this construct was supported after the test, therefore it is part of the revised model as the estimate was 0.2059 significant with a p-value less than 0.001.

Price Value (PV)

PV construct was measured by three items on a seven-point Likert scale. The overall mean score of all items of this construct was 3.21 which suggested that most participants believe that the AV technologies will be very expensive, and the cost will play a major role in their intention to use this technology. Most participants disagree or strongly disagreed when asked whether self-driving car would be reasonably priced. In addition, Cronbach's Alpha coefficient for this construct was 0.87 above the recommended value for the optimal consistency is 0.7. This finding suggests strong internal consistency of the measurement items of PV construct. PV1 stating 'I believe that self-driving car would be reasonably priced.' PV2 stating 'I believe that self-driving car would be good value for the money.' PV3 stating 'I believe that purchasing a self-driving car would be a sound purchase.' Hypothesis for this construct was supported after the test, therefore is part of the revised model as the estimate was **0.1716** significant with a p-value less than 0.001.

Behavioural intention (BI)

The findings revealed that the mean scores for three measured items for this scale were 4.07, which reflected participants' strong behavioural intentions towards the use of an Autonomous Vehicle. Many participants agreed or strongly agreed, but at the same time, large number of participants also disagreed or strongly disagreed when asked whether they will use AV when it is deployed in the future. In addition, Cronbach's Alpha coefficient for this construct was 0.92 above the recommended value for the optimal consistency which is 0.7 (as shown in Table 5.22a). This finding suggests strong internal consistency of the measurement items of BI construct. BI1 stating 'I intend to use self-driving car when it becomes available' BI2 stating 'I believe that using self-driving cars in the future will be a good idea.' BI3 stating 'I have a plan to use self-driving car in the future.' These opposing responses clearly reflect the two extreme views on the topic suggested. Most participants who do not want to use AV were very worried about the security aspect of the technology, the lack of trust on technology companies, the possibility of hacking and the compromise of security features. See below comments from various participants:

> *"I believe that self-driving cars are a retrograde step. Not only are they a security risk, but they will render people more helpless, and dependent on technology that they do not understand.*
>
> *I enjoy driving. Self-driving vehicles remove the pleasure and skill of driving. I have heard the news reports of failures and in some cases, the resulting collisions involving self-driving vehicles. I have concerns that the vehicle systems could be hacked or otherwise interfered with. I also have reservations about Google's intrusion into people privacy, tracking and effectively spying on people. I believe Google to be a malevolent and sinister organisation."*
>
> *"I would not get in a car that self-drives. I wouldn't trust the system like that at all."*
>
> *"My main concern is the issue of privacy"*

"Self-driving cars would be productive in daily lives but only under following strong road regulations."

"You haven't addressed the area of illegal hacking of a self-driving car"

It clearly appears that the main concerns of most participants are around security, hacking, privacy, trust, liability, cost and regulations.

At the same time several participants were very excited about the technology as it can be reflected in their comments below:

"Self-driving cars raises interesting possibilities for older people to complete journeys that they otherwise might not be able to do."

"Looking forward to it. I am an advanced police driver."

"The self-drive car would be good for the disabled and elderly but for me I prefer to be active and in control of my car and drive in peace without the government interference"

"My use of AV will depend on cost, having legal structures in place, and reliability/safety records of the various vehicle options noted. It will also depend on when these options become available, since I am also considering a hybrid in the next few years (which would likely be my last car)."

Although many cannot wait for the technology to be available, it is also clear that security, privacy, safety and government interferences appear to be their primary concerns.

7.5 Summary and conclusion

This chapter discussed and reflected upon the findings from the theoretical perspective. First, this chapter discussed the obtained response rate and the effects of the non-response bias. The discussion suggests that the response rate obtained within this study is satisfactory and falls within an acceptable range in IS research. Furthermore, the effect of the non-response bias was found to be minimal in this study, which means that the findings of this study are least likely to be affected by non-responses.

Secondly, this chapter compared the outcomes of the instrument development and validation processes with a standard recommended within IS research, in terms of content validity, construct validity and reliability. The comparison led to the conclusion that the research instrument possessed an appropriate level of content validity, reliability and construct validity and satisfied the standard criteria within IS research.

Thirdly, this chapter presented the refined and validated conceptual model of Autonomous Vehicle acceptance. This discussion led to the conclusion that all the constructs were positively related to BI, except Anxiety which was negatively correlated. A comparison of adjusted R square obtained in this study with the previous studies suggested that the performance of the conceptual model that was used to understand the behavioural intention to accept Autonomous Vehicles is as good as its guiding models.

Fourth, this chapter discusses the key factors and constructs of the conceptual model. It was observed that the response rate (i.e. 8.75 per cent) achieved in this study was lower than the initial expectations of the researcher but compared reasonably well with earlier studies on technology acceptance. The demographic information suggested that majority of the respondents were male. In addition, the age of about 62 percent of participants in this survey was between 35 years and 65 years and 75.7 per cent had university degrees. Furthermore, the findings, regarding education, reveal that the level of education of most of the participants was a minimum of a bachelor’s degree which reflects the selected population, university staff and students. The model proposed in this study helped to explain the overall relationships amongst the predictor variables and the outcome variable i.e. behavioural intention to use (BI), the dependent variable. The AVEs, as all the values were greater than 0.7, these are above the recommended value of 0.5 which is very good. The cross-loading looks good as well as the values for each variable are the highest in the corresponding column and not in the other factor! Goodness of fit is 0.809 where the values > 0.7 are considered as very good The R squared of this second model is 0.77 as well what is important is mean redundancy which is 0.67 for the Behavioral Intention.

Finally, the next chapter (Chapter 8) will conclude this dissertation. Chapter 7 will initially provide a summary, as well as conclusions drawn from each chapter. Then discussions on research contribution, limitations and further research directions are provided.

Chapter 8 Conclusion

8.1 Introduction

This chapter provides a conclusion to the results and discussions of the research presented in this thesis. The chapter begins with an overview of this research in Section 8.2. This is followed by the main conclusions drawn from this study in Section 8.3. Then Section 8.4 provides a discussion of the research contributions and implications of this research in terms of the theory. Then Section 8.5 provides the implications to practice. This is followed by the research limitations and direction for future research in Section 8.6. Finally, the summary of the chapter is provided in Section 8.7 with some recommendations.

8.2 Research overview

Chapter 1 defined the research problem and outlined the motivations for conducting this research. Given the large-scale investments in the development of AV technologies by major car manufacturers and software companies as an action to decrease the number of road accidents around the world and make driving more secured and enjoyable. AV is a very controversial subject in UK, particularly due to the disruption it would bring to society. The British government intends to be recognised as a leader in this industry because of the potentials benefits to the environment in terms of reduction of CO^2 emission. Current statistics shows that several car users are likely to reject this technology, therefore resulting in the need to explore the factors that would influence consumers' behaviour towards its acceptance as a requirement. AV is a technology currently been tested in different parts of the world. The technology has been deployed in some UK cities (Coventry and Milton Keynes). The literature analysis indicated that existing research on technology adoption mainly focused on technologies fully deployed, mainly measuring consumers user behaviour. In this scenario, we will be measuring only the behavioural intention to adopt AV as a mode of transport. The analysis of the literature also suggested that an examination of AV adoption, usage and impact from consumers' perspective has just begun to emerge and is yet to be undertaken.

Therefore, this research aimed to identify and determine the consumer level factors that will influence AV adoption and use and, consequently, develop a system to visualise these factors and make them useful to technology and marketing organisations when targeting different groups of consumers. The objectives to achieve the overall aim include: developing a conceptual model; developing and validating a research instrument; then conducting data collection and analysis to validate and refine the conceptual model; and finally outlining implications for theory and practice. Chapter 1 also provided brief information on potential research approaches, outlined the research contribution to theory, practice and policy and finally provided an overview of the dissertation.

To achieve the first objective of the research, chapter 2 reviewed the various technology adoption and diffusion related theories and models including the Diffusion of Innovations, TRA, TPB, DTPB, TAM, UTAUT, UTAUT2 and various other models proposed in the past. Since the adoption and diffusion theories and models provided this research with several underlying constructs or factors. The UTAUT2 was adopted and was the guiding framework for the current research. Chapter 2 also evaluated the key barriers to AV adoption, reviewed current literature on AV adoption and identified the gap in the literature.

Chapter 3 provided an overview of the research approaches utilised within the information systems (IS) field and selected an appropriate research approach for guiding this research. To validate and understand the conceptual model it was found that a mixed method research would be appropriate than only a quantitative one. An overview of the underlying epistemologies was provided to decide whether pragmatism is appropriate as a philosophical foundation for this research. The research was divided into three phases with distinct objectives discussed below.

Chapter 4 described aspects of phase I of the research, focusing on identifying the factors influencing Behavioural Intention (BI) to accept AV. At this stage of the investigation, an exploratory sequential mixed method design was selected. Previous models and theories were analysed, and initial surveys were conducted. The survey was carried out to help the researcher determine people's opinions regarding the introduction of AV and the public acceptance of the technology. The objective of this survey was also to identify other potential factors or determinants neglected by previous models that may play an important role for AV scenario. Whilst discussing the factors, several underlying hypotheses were also proposed that are required to be tested in order to validate and refine the conceptual model. Accomplishment of Chapter 3 led to achieve the first objective of this research, which is “to develop a conceptual model of the determinants of autonomous vehicles acceptance based on the UTAUT as a foundation”.

Chapter 5 describe the key aspects of Phase II of the investigation. This phase is positivistic in nature and its main purpose is to test and validate the model proposed in phase I of the study. This chapter further discusses the development process of the research instrument. The development process was achieved in three stages, which were made up of the exploratory survey, content validity and instrument testing. The exploratory stage included surveying the known existing instruments, choosing appropriate items, creating the required new items and then determining if the selected items were appropriate enough to measure the perceptions of imminent adopters and future non-adopters. This stage also examined the reliability of the initial scale. At this stage it was found that although most items either selected from the existing instruments or newly created ones were important enough to describe the behaviour of future adopters and potential non-adopters, the scale was mostly reliable. This chapter also presented the findings obtained from the data analysis of the conducted survey. The findings were obtained using several steps. The first step was to calculate the survey’s response rate and conduct a response bias test which suggested that there was no significant difference for those demographic characteristics such as age and gender of the respondents and non-respondents. This chapter also presented the reliability test, construct validity. The reliability test confirmed that measures are internally consistent, as all the constructs possessed a Cronbach’s alpha above 0.70. Constructs validity was established utilising Principal Component Analysis (PCA). Structure Equation Modelling tools and techniques were applied at this stage and the regression analysis suggested that Performance Expectation (PE), Social Influence (SI), Perceived Safety (PS), Hedonic Motivation (HM) and Price Value (PV) will play a significant role in consumer’s behavioural intention to adopt AV.

Chapter 6 presents the third and final phase of this study. In this chapter, the researcher develops an information visualisation tool that combines areas of computer graphics, problem solving and software engineering to help better illustrate the main factors influencing behavioural intention to adopt AV. Data visualisation tools are also utilised here to develop a 2D and 3D of the key determinants. These tools can be used to provide a deeper interpretation of participant's behaviour towards to specific technology being evaluated.

Chapter 7 discussed and reflected upon the findings from the theoretical perspectives. This chapter first discussed the obtained response rate and effects of the non-response bias. The discussion suggests that the response rate obtained within this study is satisfactory and falls within a range that is acceptable in the IS research. Then the outcomes of the overall instrument development and validation process were also compared to a recommended standard within IS research with regard to content validity, construct validity and reliability. The comparison led to conclusion that the research instrument used in this study possessed an appropriate level of content validity, reliability and construct validity and satisfied the standard criteria within IS research. Accomplishment of chapter 3, 4, 5, 6 along with chapter 7 led to the achievement of the second part of the research which was "*To test the empirical validity of the proposed research model in a developed economy context i.e. UK*" and the third objectives "*To develop a tool to visualise the importance of numerous factors influencing the behaviour of potential consumers towards autonomous vehicles*". The discussion led to the conclusion that all the constructs proposed significantly explained the BI to adopt AV. Anxiety has a negative Impact on BI. Comparison of the adjusted R^2 obtained in this study compared with previous studies suggests that the performance of the conceptual model that can be used to understand the BI for the adoption is as good as its guiding models. The discussion revealed that the findings supported the assumption made in Chapter 4.

8.3 Key conclusions

The following main conclusions are drawn from this research and are based on underlying research questions proposed in chapter 1 (Section 1.3):

1. Most respondents had previously heard of AV, had a positive initial opinion of the technology, and had high expectations about the benefits of the technology.

2. Most respondents expressed high levels of concern about riding in an Autonomous Vehicle, security issues related to technology and the vehicle not performing as well as actual drivers.

3. Respondents also expressed high levels of concern about vehicles without driver controls; Autonomous Vehicles moving while unoccupied; and self-driving commercial vehicles, busses, and taxis.
4. The majority of respondents expressed a desire to have this technology in their vehicle. However, a majority was also unwilling to pay extra for the technology; those who were willing to pay offered about £1000 or less.

5. Females expressed higher level of concern with AV than did males. Similarly, females were more cautious about their expectations concerning benefits from using self-driving vehicles.

6. All ten types of constructs, namely Performance Expectancy (PE), Effort Expectancy (EE), Social Influence (SI), Self-Efficacy (SE), Perceived Safety (PS), Anxiety (AX), Trust (T), Legal Regulation (LR), Hedonic Motivation (HM), Price Value (PV) significantly explained the BI of consumers for future adoption of AV. Amongst all constructs, Performance Expectancy contributed to the largest variance ($\beta = 0.344$) when explaining BI of autonomous vehicles acceptance. Hedonic Motivation construct contributed to the second largest variance ($\beta = 0.206$) while Effort Expectancy construct ($\beta = 0.032$) contributed to the least amongst the aforementioned types of constructs. Anxiety was negatively related to BI with a variance ($\beta = - 0.188$).

7. From the information visualisation tool developed our examination shows that most participants between the ages of 55 & 64 and those aged 65 and over intend to use autonomous cars. Perceived security will largely influence all of the age group decisions.

8. Cost of the technology is likely to be a very important factor particularly for people aged 65 and over and for traditional working-class people. Most established middle-class participants do not have the intention to use the

technology. The gender as a moderating factor plays a role in the sense that men will be more attracted to the technology than women. Women are more likely to take into consideration advice from family and friends when makings their decisions. The support made available to car users will also be crucial. The fun associated to using the vehicle tends to be very important for people aged 18 to 24 compared to other groups. Another interesting find is that most current expert car users are not interested in using autonomous cars mainly because of the fun associated to driving which they are not yet ready to give up.

8.4. Theoretical contributions and implications

This research study has made two contributions to the body of knowledge. The contributions of this study are explained as follows:

8.4.1 Main contributions

Firstly, technology acceptance literature shows the scarcity of empirical research of the determinants of the individuals' behavioural intention to use AV, especially in UK. This study examined the viability of the UTAUT2 model, which was established in developed economy settings for Information Systems, in explaining a similar behaviour within emerging technologies settings. Thus, the results of the present research contributions fill this important gap by taking on a theory-based empirical investigation of the determinants of AV acceptance by individuals in the context of a developed economy. Prior research has suggested that TAM and UTAUT2 are not complete and researchers were encouraged to extend the model by adding important constructs from Information Systems (IS) acceptance and use literature (Wang et al., 2003; Moon and Kim, 2001, Venkatesh et al, 2012; Venkatesh et al, 2016). This study investigated the effect of user Anxiety, Trust, Perceived Safety and other variables (i.e. Legal regulation self-efficacy) on BI towards acceptance of AV by extending the UTAUT2 model. Thus, the present study extended the UTAUT2 model by developing a theoretical model and subsequently validated the model with empirical data collected in this study. The validated model contributes better and has a more systematic understanding of AV acceptance and enhances the explanatory power of the UTAUT.

The second contribution of this research on IT/IS acceptance is the development of an online information visualisation tool with the ability to further explain consumer behavioural intention to adopt technology. This tool illustrates other aspects of the population from another angle otherwise difficult to interpret only with the SEM. This tool could be very useful for marketing firms and research and development teams.

8.4.2 Research implications

The model and the web-based system developed could be used by technology companies such as self-driving car manufacturers or any emerging technologies to measure people's behavioural intentions to adopt a technology. At the same time, they will be able to target specific groups, areas or points of society where they should focus and influence people's behaviour towards accepting their products. Furthermore, the model could be used by marketing departments to target their customers or to help technology companies to target specific social groups as it will give them a clear idea where they should be pitching their products on the market. It could also be used by customer service departments when dealing with customers or potential buyers and finally the model could be used in companies by research and development departments to further enhance future products. The implications of the findings of this research study are presented in two headings i.e. theoretical implications and marketing / management implications, which are described as follows.

The results of this study have a number of significant theoretical implications. Firstly, this research applied an extended UTAUT2 model in a new context of the Autonomous Vehicle acceptance. The success of the incorporation of the Efficacy, Anxiety and Legal Regulation in the UTAUT2 model is evident from the results. The results suggest that the proposed model of the Autonomous Vehicles acceptance demonstrates a considerable explanatory and predictive power. Thus, the integration of the internal and external factors with the UTAUT2 is both theoretically appealing as well empirically significant.

Secondly, the integrated model for the AV acceptance developed in this study can be employed for explaining other emerging technologies acceptance and usage behaviour such as RFID technologies, wearable devices and artificial intelligence technologies. This research has identified important factors from the extant literature on various domains. Therefore, comprehensive and parsimonious models developed for this research make important contributions to the literature on emerging technologies acceptance.

Third, the data for the present empirical study was collected using a multi methods approach, such as by electronic mail, face to face self-administered method and interviews with professional in the area of psychology, sociology and computer science. Combination of these methods together gives the advantages of versatility, speed, and cost effectiveness. In addition, Structural Equation Modelling (SEM) using the R programming statistical package was used to test the measurement and structural models. The use of this methodology employing sophisticated statistical tools has been limited in previous literature; and thus, this study sets a new pattern in the research on emerging and disruptive technologies applications.

8.5 Implications for Practice

Findings of this research study have many marketing, managerial and customer service implications for different stakeholders such as car manufacturers and emerging technology designers as discussed below.

The unprecedented development in the field of automation, electronics and artificial intelligence and its benefits (e.g. communications, transportation, distribution, and health) are compellingly different as organisations and companies develop systems that provide users with more reliable, safer and more enjoyable driving experiences. This study has provided useful information and valuable insights to car manufacturers and autonomous technologies system designers to better understand users' needs and in order to improve their services. Given the large investment in developing new information systems, an understanding of the factors influencing users' acceptance of autonomous technologies is useful for marketing firms so they can prioritise their resources in an effective way. For example, Social Influences were found to be one of the most significant factors that have a strong impact on users' intention towards acceptance of AV. In addition, based on the qualitative data, although the model doesn't support this, Trust and Perceived Safety were found to exert a significant impact on people's intention to adopt the AV technologies. In order to increase perceptions of usefulness, AV stakeholders could organise motivational sessions and educate users about potential threats to their security and privacy with their transportation and provide solutions (e.g. free security software) to avoid such threats. This would help to reinforce users' trust in the car manufacturing industry. In addition, AV companies could help build users' trust by offering an undertaking (i.e. statement of guarantee: depending on the situation) that they would indemnify monetary losses incurred by any unauthorised access. This would boost users' confidence in the AV manufacturing industry and would speed up the rate of acceptance of AV.

On the other hand, there appears to be a role for designers and manufacturers of AV. Such as that, the AV system designer and manufacturers must ensure that they design cars that provide users' a secure service for transportation. In addition, as this research has suggested, the users' positive judgment and confidence in their abilities to use AV in general would favourably influence their perceptions behavioural intention and later use behaviour. In order to increase technological self-efficacy, IT teams could organise technology training sessions and awareness seminars. This can increase general computer and internet self- efficacy and increase confidence of potential users of the systems because people who demonstrate higher technological self-efficacy are more readily prepared to use AV.

Moreover, this study signifies that Performance Expectancy, Hedonic Motivation and the Price Value of Autonomous Vehicle systems were identified as the most influential factor with a p-value less than 0.001 hence very significant. At the same time, Anxiety negatively influences the Behavioural intention; meaning that with greater Anxiety the smaller the behavioural intention, which corresponds with the correlation. Hence car manufacturers and software companies involved in developing AV technologies should make these vehicles secure, robust and cost effective.

This qualitative part of the study emphasised that technology companies and car manufacturers in general should think very carefully about the issues of privacy, security, safety, trust and regulation for these technologies to provide users with a secure services when using their products in order to develop trust and confidence in autonomous system.

This study suggested Social Influence as another important determinant influencing behavioural intention to use this technology. Thus, marketing and designers should take into consideration the influence of friends, family, celebrities, and expert's commentators as one of the important factors to develop an effective autonomous system.

Finally, the development of the online information visualisation tool illustrating the factors affecting different groups of users is another contribution more likely to assist marketing firms.

8.6. Limitations and directions for future research

As typical with empirical studies, this research is not without limitations. Due to the very sensitive nature of the topic, and the potential financial implications at stake, it was not possible to communicate with current car manufacturers developing self-driving technology despite several failed attempts. During the third phase of our investigation (which was quantitative), the questionnaire was given to participants belonging to various social classes including people working in car manufacturing and the taxi industry, company CEO's, university lecturers, students, practitioners and random people from the street. Most respondents were lecturers and students in various universities and alternative providers. The study had very few respondents from the general population. The questionnaire was designed to allow participations from any sector including existing stakeholders working in the manufacturing industry, regulators, public & safety organisations etc. It is recognized that due to the sensitive nature of the subject, the very limited number of companies currently developing the technology and working on its regulations had very few respondents who worked in the self-driving cars industry. Indeed, the researcher recognises that the aforementioned stakeholders could play an important role within the model development. This is a limitation of this investigation and will be considered for future research.

Even though the technology is only being tested in some UK cities, the technology is currently not available to the large public and that its specific launch date is still unclear and a few trends can be identified by reviewing experiments of those results that have been published. It seems to be most popular amongst young people and in urban environments; men, as well as those currently owning a vehicle with advanced driver assistance systems, tended to be most positive about using the technology.

For future work in this field, it may become necessary to get involved autonomous vehicles stakeholders working in the manufacturing industry, regulators, public & safety organisations in refining the model of factors influencing public acceptance of the technology. The introduction of this emerging technology will largely depend on the policies, laws and new legislations introduced to settle the issues related to liability, security and privacy of the passengers' data. Although it is difficult to quantify, it would therefore be interesting to investigate the relationship between safety level and segments of the population that intends to use the AVs. As the drivers would not be in control of the vehicle anymore, it is hypothesized that the crash rates or miles per casualty should be substantially lower than in today's cars.

Whilst the passion for driving and traffic conditions have already been included in some experiments, it may be an area for further exploration because even passionate drivers could enjoy being chauffeured in an autonomous vehicle on their daily commute slowed by traffic jams. The passion for driving might be restricted to certain road and traffic conditions. Furthermore, future experiments might focus on special dimensions of demand or classes of predictors. In addition, it will be interesting for future research to test and explore the model developed for this study in other cultural settings, such as Asian or Western developed countries. This will be valuable in providing evidence concerning the robustness of the research model across different cultural settings. It is understood that the robustness of the model may vary across different cultural settings and thus need to be empirically tested (Mao and Palvia, 2006). In the future, longitudinal studies could be undertaken to better understand Usage Behaviour (UB) and refine the model.

In addition, the data for this study was collected using a cross-sectional survey and interviews. Future research is needed to obtain longitudinal data to investigate what factors will influence individuals' perceptions as a result of actual usage of AV technologies. Prior literature indicates that individuals' perceptions are formed with the passage of time, experiences and continuous feedback from surroundings (e.g. Venkatesh and Davis, 2000; Davis et al., 1989). Thus, it is expected that future research will inspect the findings of this research with more in-depth investigations using longitudinal data. Future research could also be conducted to expand the research model by including additional factors. For example, perceived risk, cultural influence, social class or socio-economic status may also influence Usage Behaviour.

8.7. Concluding remarks

Technology often outpaces our ability as a society to come up with accepted norms of how it can be used. This has no doubt rung true for autonomous vehicles. It is predicted that in a close future, self-driving cars will be a reality on our roads. Overall some of the main recommendations surfaced:

- UK transportation services should assess the level of investment in road infrastructure that is required at the four stages of AVs and how this will impact on the type of infrastructure that is required. Serious research will be needed into this aspect in the immediate future.

- Perhaps the greatest barrier to innovation is the unknown element of future regulations that could be imposed. Without knowing all of the rules in their final form, questions remain about how fast tests can be enacted and how long the application process would take.

- Current policy states that a data-recording and data-sharing policy should be worked out with relevant standards-creating bodies in order to hasten the process of deployment. This is because sharing data will help manufacturers understand mistakes made by other developers and reduce any mistake duplication.

- Road pricing will perform a crucial task in ensuring that the travel advantages that AVs brings do not lead to rising traffic volumes and congestion.

- For people with mobility difficulties AVs can provide the freedom of flexibility that is required at a much lower cost than the on-demand transport that is currently available.

- If autonomous cars come to supplement bus services, should public transport authorities get into the business of operating them? In a world where shared self-driving cars are whisking us about, it’s unclear exactly who would own what and how they would be managed.

This chapter provided an overview and conclusion to the results and discussions of the research presented in this thesis. First the contents of each chapter were discussed briefly followed by drawing the main conclusions of this research. This was followed by a discussion of the research contributions and implications that this research has made in terms of the theory and practice. Following that, the research limitations were listed. Finally, the future research directions in Autonomous Vehicles acceptance were provided.

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Appendix A: University Ethical Approval

London South Bank
University

Direct line: 020-7815 6025
E-mail: mitchen5@lsbu.ac.uk
Ref: UREC 1555

Patrice Seuwou
[redacted]

Monday 19 October 2015

Dear Patrice

RE: Autonomous vehicles as a disruptive technology: A model for evaluating the public acceptance

Thank you for submitting this proposal and for your response to the reviewers' comments.

I am pleased to inform you that Full Chair's Approval has been given by Vice Chair, Rachel Taylor, on behalf of the University Research Ethics Committee.

I wish you every success with your research.

Yours sincerely,

N Mitchell

Nicola Mitchell

Secretary, LSBU Research Ethics Committee

cc:

Prof Shushma Patel, Chair, LSBU Research Ethics Committee

Appendix B: Questionnaire 1

Your opinion concerning the introduction of self-driving cars

This survey is being carried out to help us determine people opinions regarding the introduction of autonomous vehicles and the public acceptance of this disruptive technology in UK. A general explanation of what is meant by autonomous vehicles will be provided on the next page. Please take a moment to read that description carefully before continuing with the survey. Completing this survey is voluntary and by submitting this form, you agree that you are at least 18 years of age and you are also giving us the authorisation to use the information provided for research purposes only. It will take you just about 7 minutes to complete this questionnaire and all information provided will be anonymous and confidential.

*Required

A definition of autonomous vehicles

Autonomous vehicles are those in which at least some aspects of a safety-critical control (such as steering, throttle or braking) operate without direct driver input. Vehicles that provide safety warnings to drivers (for example, a forward-crash warning) but do not take control of the vehicle are not considered autonomous.
Autonomous vehicles may use on-board sensors, camera, GPS and telecommunications to obtain information in order to make decisions regarding safety-critical situations and act appropriately by taking control of the vehicle at some level. Examples of autonomous-vehicle technologies range from those that take care of basic functions such as cruise control, to completely self-driving vehicles with no human driver required

Section 1 – Market adoption

1. **1. How knowledgeable were you about autonomous / driverless / self-driving vehicles before participating in this survey?** *

   Please select only one answer on a 1-5 scale, where 1="Not at all knowledgeable" and 5="Extremely knowledgeable"
   Mark only one oval.

	1	2	3	4	5	
Not at all knowledgeable	◯	◯	◯	◯	◯	Extremely knowledgeable

2. **2. What is your general opinion regarding autonomous and self-driving vehicles?** *

   Even if you have never heard of autonomous or self-driving vehicles before participating in this survey, please give us your opinion based on the description you just read. Please select only one answer on a 1-5 scale, where 1="Very negative" and 5="Very positive"
   Mark only one oval.

	1	2	3	4	5	
Very negative	◯	◯	◯	◯	◯	Very positive

3. **3. How likely do you think it is that the following benefits will occur when using completely self-driving vehicles?** *

Please select only one answer for each row

Mark only one oval per row.

	Very unlikely	Somewhat unlikely	Neutral	Somewhat likely	Very likely
Fewer crashes					
Reduced severity of crashes					
Improved emergency response to crashes					
Less traffic congestion					
Shorter travel time					
Lower vehicle emissions					
Better fuel economy					
Lower insurance rates					

4. **4. How concerned would you be about driving or riding in a vehicle with self-driving technology?** *

Please select only one answer on a 1-5 scale, where 1=" Very concerned " and 5=" Not at all concerned"

Mark only one oval.

	1	2	3	4	5	
Very concerned						Not at all concerned

5. **5. How concerned are you about the following issues related to self-driving vehicles?" ***
Please select only one answer for each issue on a 1-5 scale, where 1=" Very concerned " and 5=" Not at all concerned"
Mark only one oval per row.

	Very concerned	Moderately concerned	Neutral	Slightly concerned	Not at all concerned
Safety consequences of equipment failure or system failure	⬭	⬭	⬭	⬭	⬭
Legal liability for drivers / owners	⬭	⬭	⬭	⬭	⬭
System security (from hackers)	⬭	⬭	⬭	⬭	⬭
Vehicle security (from hackers)	⬭	⬭	⬭	⬭	⬭
Data privacy (location and destination tracking)	⬭	⬭	⬭	⬭	⬭
Interacting with non-self-driving vehicles	⬭	⬭	⬭	⬭	⬭
Interacting with pedestrians and bicyclists	⬭	⬭	⬭	⬭	⬭
Learning to use self-driving vehicles	⬭	⬭	⬭	⬭	⬭
System performance in poor weather	⬭	⬭	⬭	⬭	⬭
Self-driving vehicles getting confused by unexpected situations	⬭	⬭	⬭	⬭	⬭
Self-driving vehicles not driving as well as human drivers in general	⬭	⬭	⬭	⬭	⬭
Riding in a vehicle with no driver controls available	⬭	⬭	⬭	⬭	⬭
Self-driving vehicles moving by themselves from one location to another while unoccupied	⬭	⬭	⬭	⬭	⬭
Commercial vehicles such as heavy trucks or semi-trailer trucks that are completely self-driving	⬭	⬭	⬭	⬭	⬭
Public transportation such as buses that are completely self-driving	⬭	⬭	⬭	⬭	⬭
Taxi that are completely self-driving	⬭	⬭	⬭	⬭	⬭
Trusting of the car manufacturers	⬭	⬭	⬭	⬭	⬭

6. **6. How interested would you be in having a completely self-driving vehicle as the vehicle you own or lease? ***
Please select only one answer.
Mark only one oval.

	1	2	3	4	5	
Very interested	⬭	⬭	⬭	⬭	⬭	Not at all interested

7. **7. How much EXTRA would you be willing to pay to have completely self-driving technology on a vehicle you own or lease in the future?** *

Please select only one answer.
Mark only one oval.

- Nothing
- £500 - £999
- £1000 - £4999
- £5000 - £10000
- More than £10000
- Other: ______________________

Section 2 – Industry impact and transformation

8. **8. What industries will be affected by driverless vehicles deployment?** *

Please select all that apply
Tick all that apply.

- [ ] Car manufacturing industry
- [ ] Apps industry
- [ ] Car insurance industry
- [ ] Oil industry
- [ ] Taxi industry
- [ ] Other: ______________________

9. **9. Assuming widespread adoption of driverless vehicles, which of the following will have the most impact in terms of determining faults in the event of accident?** *

Please select a maximum of two answers
Tick all that apply.

- [ ] Legal system
- [ ] Technology firms
- [ ] Insurance industry
- [ ] Original equipment manufacturers (OEMs) e.g. Ford, Mercedes Benz, etc...
- [ ] OEM suppliers e.g. Continental, Delphi, BOSCH. etc...
- [ ] Other: ______________________

Section 3 – Public acceptance

10. **10. What do you think would play an important role in the mass acceptance of autonomous vehicles?** *

Please select all that apply
Tick all that apply.

- [ ] Advertisement (Newspaper, TV, Internet, etc...)
- [ ] Mass acceptance by celebrities
- [ ] Law enforcement
- [ ] Reassurance from car manufacturers (Safety, privacy, trust, security)
- [ ] Car insurance discount for autonomous car owners
- [ ] Other: ______________________

11. **11. Amongst the following elements characterising various groups in our society, which key attributes do you think, will influence different groups in accepting or rejecting autonomous vehicles?** *

Please select all that apply
Tick all that apply.

- [ ] Gender
- [ ] Age
- [ ] Education
- [ ] Driving experience
- [ ] Voluntariness of use
- [ ] Facilitating conditions
- [ ] Social inluence
- [ ] Effort expectancy
- [ ] Performance expectancy
- [ ] Job relevance
- [ ] Other: ______________________

12. **12. Which of the following groups will have a major influence on the acceptance of autonomous vehicles?** *

Please select all that apply
Tick all that apply.

- [ ] Journalists
- [ ] Politicians
- [ ] Engineers
- [ ] Scientists
- [ ] Celebrities
- [ ] Friends
- [ ] Family members
- [ ] Legislators
- [ ] Other: ______________________

13. **13. Which of the following factors will have a major influence on the acceptance of autonomous vehicles?** *

Please select all that apply
Tick all that apply.

- [ ] Culture
- [ ] Society
- [ ] The system (e.g. Capitalism, Socialism …)
- [ ] Software installed (apps…)
- [ ] Hardware (e.g. Engines, car …)
- [ ] Trust
- [ ] Security of the vehicle
- [ ] Privacy of our information
- [ ] Other: ______________________

Now we would like to know some basic background information about you.

14. **14. What is your gender?** *

Mark only one oval.

- Male
- Female

15. **15. What is your age?** *

Mark only one oval.

- 18-24
- 25-34
- 35-44
- 45-54
- 55-64
- 65 & Over

16. **16. What is the highest qualification you have completed?** *

Mark only one oval.

- No formal qualifications
- GCSE or equivalent
- A level or equivalent
- Bachelor degree
- Master degree
- PhD
- Other:

Appendix C: Interview with Sociologist

Interview Questions (Sociologist)

A. Introductory Protocol

To facilitate my note-taking, I would like to audio tape our conversations today. Please sign the consent form. For your information, only the researcher and possibly supervisors on the project will be privy to the tapes which will be eventually destroyed after the completion of the degree. Furthermore, you are ensured that (1) all information will be held confidential, (2) your participation is voluntary, and you may stop at any time if you feel uncomfortable. Thank you for your agreeing to participate.

The interview is planned to take approximately 30- 45 minutes.

Introductory statement:

This interview is conducted in addition to the prior questionnaire. We are investigating the role played by human and non-human actants in the public acceptance of self-driving cars as a disruptive technology. As part of the study, we are interviewing experts in the field of Psychology and Sociology.

Key definitions:

- **A disruptive technology** is one that displaces an established technology and shakes up the industry or a ground-breaking product that creates a completely new industry.
- **An autonomous vehicle** (sometimes called a self-driving car, an automated car or a driverless car) is a robotic vehicle that is designed to travel between destinations without a human operator.

B. Semi – structured interview – list of questions

1. With your understanding of people and their interaction within society, which factors are more likely to influence people's behavioural intention with regards to acceptance or rejection of disruptive technology (i.e Self-driving car)?
2. What is the influence of the cultural actant on people's acceptance of the technologies that could be disruptive?
3. What is the influence of the structural actant (Social class, race, gender, religion – capitalist or socialist system) on people's acceptance of the technologies that could be disruptive?
4. What are the problems faced by people within society due to the introduction of disruptive technologies such the self-driving car?

5. What is the influence of the human actants regarding the introduction and the acceptance of disruptive technologies
6. What are the main indications that people have accepted and have adopted a new technology?
7. What are the key indicators for public acceptance of disruptive technologies?
8. What measure could be put in place to maximise people's acceptance of disruptive technologies?
9. What factors in modern society influence people to reject disruptive technologies?
10. If you were to propose a model for assessing what influence public acceptance of a new technology what would it look like?

C. De-briefing

Thank you for taking part, your time is much valued. If you would like to know more about the results of this research, please contact me on the email below.

seuwoup@lsbu.ac.uk

Appendix D: Interview with Psychologists

Interview Questions (Psychologist)

A. Introductory Protocol

To facilitate my note-taking, I would like to audio tape our conversations today. Please sign the consent form. For your information, only the researcher and possibly supervisors on the project will be privy to the tapes which will be eventually destroyed after the completion of the degree. Furthermore, you are ensured that (1) all information will be held confidential, (2) your participation is voluntary, and you may stop at any time if you feel uncomfortable. Thank you for your agreeing to participate.

The interview is planned to take approximately 30- 45 minutes.

Introductory statement:

This interview is conducted in addition to the prior questionnaire. We are investigating the role played by human and non-human actants in the public acceptance of self-driving cars as a disruptive technology. As part of the study, we are interviewing experts in the field of Psychology and Sociology.

Key definitions:

- **A disruptive technology** is one that displaces an established technology and shakes up the industry or a ground-breaking product that creates a completely new industry.
- **An autonomous vehicle** (sometimes called a self-driving car, an automated car or a driverless car) is a robotic vehicle that is designed to travel between destinations without a human operator.
- **Cognitive process: (psychology)** "the process of thinking", and operation that affects mental contents.

B. Semi – structured interview – list of questions

1. What is your general opinion about self-driving cars?
2. What would you identify as the key influences of Psychology in the development of new technologies?
3. Can you explain the typical cognitive process that one experiences when facing an eventual technology that could be disruptive like the self-driving car?
4. Can you talk about the cognitive indicators that underpin people thoughts with regards to the acceptance or the rejection of a new technology?

5. Do the changes in our environment influence our behavioural intentions towards acceptance or rejection of new technology that could be disruptive?

6. From a psychological perspective, what measure(s) could be put in place to maximise the public acceptance of this new technology?

7. Research shows that people are emotionally attached to their car, therefore with the introduction of autonomous vehicles and the car sharing services, what are the likely impacts on people's behaviour and on our society as a whole?

8. What are the key indicators that the public have accepted the technologies?

9. What could be the changes in behaviour and psychological problems emerging from the introduction of this new technology?

10. Can this aspect of human thought and behaviour be observed and measured to develop a model for understanding and evaluating the acceptance of disruptive technologies? ~(knowledge, attitude and practice models(KAP))

11. Regarding the public acceptance of autonomous vehicles, what do you think are the key pieces of the puzzle that will underpin the mass adoption? Can you rank them?

12. Is there anything you would like to add regarding the human and non-human factors influencing public acceptance of disruptive technologies?

C. De-briefing

Thank you for taking part, your time is much valued. If you would like to know more about the results of this research, please contact me on the email below.

seuwoup@lsbu.ac.uk

Appendix E: Interview with Computer Scientists

Semi – structured interview – list of questions

Section 1 – Actants playing a role within the assemblage

1. What is your general opinion about self-driving cars?

2. Research shows that some of the reasons driving the development of this technology are linked to:

    - Car accidents
    - Safety issues
    - High cost of mobility
    - Driving demographics
    - Parking space issues
    - Running out of space
    - Environmental issues
        - What are your views about this?

3. What is the influence of the cultural actant *(e.g. arts, beliefs, customs, institutions, and other products of human work and thought considered as a unit)* on people's acceptance of the technologies that could be disruptive (autonomous vehicles)?

4. With your understanding of people and their interaction within society, which factors are more likely to influence people's behavioural intention with regards to acceptance of self-driving cars? [e.g. *Gender, Age, experience, voluntariness of use, social influence, advertisement, TV, Newspaper, friends, movie stars, effort expectancy, performance, Job influence, expectancy, facilitating conditions?]*

5. What is the influence of the structural actant *(e.g. Social class, race, gender, – capitalist or socialist system)* on people's acceptance of the technologies that could be disruptive?

6. What factors in modern society influence people to reject disruptive technologies?

7. What measure could be put in place to maximise people's acceptance of disruptive technologies?

8. What are the main indications that people have accepted and have adopted a new technology?

9. What would you identify as the key influences of Sociology in the development of new technologies?

10. What would you identify as the key influences of Psychology in the development of new technologies?

11. Is there anything you would like to add regarding the human and non-human factors influencing public acceptance of disruptive technologies (e.g. autonomous vehicles)

12. Are you familiar with the Actor-Network Theory – A tool for analysing problem

Section 2 – Security Issues and Barriers to adoption of self-driving car

13. What is your opinion regarding cyber-security issues and hacking in relation to self-driving cars?

14. What do you think about the privacy issues for self-driving cars?

15. What do you think about the trust or lack of trust from the public towards the car manufacturers?

16. What do you think about legal aspect? (liability issues)?

17. What do you think will be the impact of the cost of these cars on social mobility in the UK?

18. What do you think issues related to standardisation, communication infrastructure

19. What may other dangers be associated with the introduction of such a technology?

20. Who should own the data generated and collected from these vehicles

    1. Shall we own it as a community
    2. Government
    3. Silicon Valley high tech companies

Section 3 – Public acceptance and adoption

21. What are the hypothetical problems people might face within society due to the introduction of disruptive technologies such the self-driving car?

22. Regarding the public acceptance of autonomous vehicles, what do you think are the key pieces of the puzzle that will underpin the mass adoption? Can you rank them?

    1. Cost,
    2. Level of education
    3. Maturity of the technology
    4. Human-computer interfaces
    5. Geopolitical factors
    6. Consumer acceptance,
    7. Infrastructure investment
    8. Legislation
    9. Media

23. What is the influence of the human actants (e.g. Journalists, politicians, engineers, scientists, celebrities, friends, family members etc...) regarding the introduction and the acceptance of disruptive technologies

24. Which industries part of our digital society will play a significant role in the mass acceptance of Autonomous vehicles?

Section 4 – Industry impact and transformation

25. What do you think about the implications for investment associated with the deployment of self-driving?
    1. Time saving and cost,
    2. Tangible and intangible benefits,
    3. Crash elimination,
    4. Data challenges,

5. New models for vehicle ownership (car sharing)
6. Productivity improvements
7. Improved energy efficiency,
8. New threats to personal privacy
9. Potential new business models

26. Which industries will be affected after the introduction of driverless cars?

27. What may be the implications of this disruptive technology on the job market?

28. Assuming widespread adoption of the technology, which organisations/sectors/bodies should be liable in the event of accidents?

29. What would be the benefits of introducing this technology

Appendix F: Questionnaire 2

2019-S3: Measuring Behavioural Intentions to Use Self-driving Cars

Dear Participant,

At the outset, I would like to thank you for taking time to participate in this academic research survey. My research topic is about future self-driving cars adoption.

A self-driving car is a vehicle that is capable of sensing its environment and navigating without human input. This survey is being carried out to help us measure people intention towards using self-driving cars. You will be asked for some basic personal information and be presented with some statements which can be answered using the scale provided. Please answer all questions as honestly as possible. Completing this survey is voluntary and by submitting this form, you agree that you are at least 18 years of age and you are also giving us the authorisation to use the information provided for research purposes only. It will take approximately 5-7 minutes to complete this questionnaire and all information provided will be anonymous and confidential. The survey has been approved by the ethics committee of London South Bank University. There are no identifying information of any respondents.

If you have any questions regarding the survey, you can write to me directly: My email: seuwoup@lsbu.ac.uk or patrice.seuwou@gsmlondon.ac.uk

Thank you for your time and assistance in my research and educational endavours. Your participation is highly appreciated.

Kind regards
Patrice Seuwou

*Required

Your driving experience

Please provide one response to every question, all questions must be answered

Google Self-Driving Car Project: A First Drive


http://youtube.com/watch?v=CqSDWoAhvLU

Example of self-driving car: Please watch this before proceeding any further

1. **How would you rate your current level of driving experience?** *

Please select only one answer

Mark only one oval.

- ◯ No driving experience
- ◯ Novice (Have not held a full stage driver's licence for more than one year)
- ◯ Intermediate
- ◯ Experienced
- ◯ Expert (Formula 1 driver level)

There are several different levels of autonomous-vehicle technology (Self-driving cars). Some of these technologies already exist now, while others are expected to become available in the future. Descriptions of each level of autonomous vehicle technology are shown below. Please take a moment to read each description carefully before continuing with the survey.

Current technology:
Level 0. No autonomous-vehicle technology.
Level 1. The vehicle controls one or more safety-critical functions, but they operate independently. The driver still maintains overall control.
Level 2. This level combines two or more technologies from Level 1, but they operate in coordination with each other. The driver still maintains overall control.
Future technology:
Level 3. This level provides limited self-driving technology. The driver will be able to hand control of all safety-critical functions to the vehicle, and only occasional control by the driver will be required.
Level 4. Completely self-driving vehicle. The vehicle will control all safety-critical functions for the entire trip.

2. **Based on the description provided above, please select the level of autonomy for the car you will be comfortable using.** *

   Mark only one oval.

   - ⬭ Level 0
   - ⬭ Level 1
   - ⬭ Level 2
   - ⬭ Level 3
   - ⬭ Level 4

Please provide one response to every question, all questions must be answered

You will be presented with some statements which are designed to measure your behavioural intention of using self-driving cars. Base on the Google self-driving car YouTube video you just watched and based on your expectations, please select only one answer from Strongly Disagree to Strongly Agree.

3. **Performance Expectancy** *

   [This represents the degree to which you believe that self-driving cars will increase your productivity] Please select only one answer for each row

   Mark only one oval per row.

	Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree
I would find self-driving cars useful in my daily life.	⬭	⬭	⬭	⬭	⬭	⬭	⬭
If I use self-driving cars, I will reach my destination safely	⬭	⬭	⬭	⬭	⬭	⬭	⬭
Using self-driving cars would enable me to accomplish my goals more quickly.	⬭	⬭	⬭	⬭	⬭	⬭	⬭
Using self-driving cars would increase my productivity.	⬭	⬭	⬭	⬭	⬭	⬭	⬭

4. Effort Expectancy *

[This section represents the degree of ease associated with learning how to use of self-driving cars] Please select only one answer for each row

Mark only one oval per row.

	Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree
Learning how to use self-driving car would be easy for me.	⬭	⬭	⬭	⬭	⬭	⬭	⬭
Interaction with self-driving cars would be clear and understandable.	⬭	⬭	⬭	⬭	⬭	⬭	⬭
I would find self-driving cars easy to use.	⬭	⬭	⬭	⬭	⬭	⬭	⬭
It would be easy for me to become skilful at using self-driving cars.	⬭	⬭	⬭	⬭	⬭	⬭	⬭

5. Social Influence *

[This section represents the degree to which you perceive that important people in your life believe you should use self-driving cars] Please select only one answer for each row

Mark only one oval per row.

	Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree
I would be proud to show the system to people who are close to me.	⬭	⬭	⬭	⬭	⬭	⬭	⬭
People whose opinions are important to me would like the system too.	⬭	⬭	⬭	⬭	⬭	⬭	⬭
In general, people who I like would encourage me to use the system.	⬭	⬭	⬭	⬭	⬭	⬭	⬭
I would take into consideration the advice from people important to me when making plans to use self-driving cars.	⬭	⬭	⬭	⬭	⬭	⬭	⬭

Appendix F: Questionnaire 2

6. Self-Efficacy *

[This section represents your belief in your ability and competence to use self-driving cars] Please select only one answer for each row: I could complete a task or activity using the system...

Mark only one oval per row.

	Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree
..if there was no one around to tell me what to do.	⬭	⬭	⬭	⬭	⬭	⬭	⬭
..if I could call someone for help if I got stuck.	⬭	⬭	⬭	⬭	⬭	⬭	⬭
..if I had a lot of time.	⬭	⬭	⬭	⬭	⬭	⬭	⬭
..if I had just the built-in help facility for assistance.	⬭	⬭	⬭	⬭	⬭	⬭	⬭

7. Perceived Safety *

Mark only one oval per row.

	Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree
Using the system requires increased attention.	⬭	⬭	⬭	⬭	⬭	⬭	⬭
The system distracts me from driving.	⬭	⬭	⬭	⬭	⬭	⬭	⬭
I feel safe while using the system.	⬭	⬭	⬭	⬭	⬭	⬭	⬭
Using the system decreases the accident risk.	⬭	⬭	⬭	⬭	⬭	⬭	⬭
I can use the system without looking at it.	⬭	⬭	⬭	⬭	⬭	⬭	⬭
I believe using self-driving car might be dangerous.	⬭	⬭	⬭	⬭	⬭	⬭	⬭

Appendix F: Questionnaire 2

8. **Anxiety** *

[This section represents the degree to which you respond to a situation with apprehension, uneasiness or feelings of arousal] Please select only one answer for each row

Mark only one oval per row.

	Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree
I have concerns about using the system.	⬭	⬭	⬭	⬭	⬭	⬭	⬭
I think I could have an accident because of using the system.	⬭	⬭	⬭	⬭	⬭	⬭	⬭
The system is somewhat frightening to me.	⬭	⬭	⬭	⬭	⬭	⬭	⬭
I fear that I do not reach my destination because of the system.	⬭	⬭	⬭	⬭	⬭	⬭	⬭
I am afraid that I do not understand the system.	⬭	⬭	⬭	⬭	⬭	⬭	⬭

9. **Trust** *

[This sections represents the degree to which you accept statements from car manufacturers as the truth without evidence or further investigation] Please select only one answer for each row

Mark only one oval per row.

	Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree
I believe self-driving car will be verified professionally.	⬭	⬭	⬭	⬭	⬭	⬭	⬭
I believe self-driving car will be reliable.	⬭	⬭	⬭	⬭	⬭	⬭	⬭
I believe self-driving car functions will be working in regard to my expectation	⬭	⬭	⬭	⬭	⬭	⬭	⬭
I believe that when using self-driving car, my privacy would be protected.	⬭	⬭	⬭	⬭	⬭	⬭	⬭

Appendix F: Questionnaire 2

10. Legal Regulation *

Mark only one oval per row.

	Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree
I believe that robust guidelines will be in place to regulate self-driving car manufacturers.	⬭	⬭	⬭	⬭	⬭	⬭	⬭
I believe that robust regulations will be put in place to protect self-driving car users.	⬭	⬭	⬭	⬭	⬭	⬭	⬭
I believe that the public liability insurance will protect users from personal damage.	⬭	⬭	⬭	⬭	⬭	⬭	⬭

11. Hedonic Motivation *

[The degree of fun or pleasure you will experience deriving from using self-driving cars] Please select only one answer for each row

Mark only one oval per row.

	Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree
Using self-driving cars would be fun, compared to traditional cars.	⬭	⬭	⬭	⬭	⬭	⬭	⬭
Using self-driving cars would be enjoyable, compared to traditional cars.	⬭	⬭	⬭	⬭	⬭	⬭	⬭
Using self-driving cars would be very entertaining, compared to traditional cars.	⬭	⬭	⬭	⬭	⬭	⬭	⬭

12. Price Value *

[The cost and pricing structure set by car manufacturers] Please select only one answer for each row

Mark only one oval per row.

	Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree
I believe that self-driving car would be reasonably priced.	⬭	⬭	⬭	⬭	⬭	⬭	⬭
I believe that self-driving car would be good value for the money.	⬭	⬭	⬭	⬭	⬭	⬭	⬭
I believe that purchasing a self-driving car would be a sound purchase.	⬭	⬭	⬭	⬭	⬭	⬭	⬭

13. **Behavioural Intention** *

[Your personal intention towards adopting self-driving cars] Please select only one answer for each row

Mark only one oval per row.

	Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree
I intend to use self-driving car when it becomes available.	⬭	⬭	⬭	⬭	⬭	⬭	⬭
I believe that using self-driving car in the future will be a good idea.	⬭	⬭	⬭	⬭	⬭	⬭	⬭
I have a plan to use self-driving car in the future.	⬭	⬭	⬭	⬭	⬭	⬭	⬭

Demographic questions

Now we would like to know some basic background information about you. All information provided will be completely anonymous and confidential.

14. **What is your gender?** *

Please select only one answer.

Mark only one oval.

- ⬭ Male
- ⬭ Female

15. **What is the highest qualification you have completed?** *

Mark only one oval.

- ⬭ No formal qualifications
- ⬭ GCSE or equivalent
- ⬭ A level or equivalent
- ⬭ Bachelor degree
- ⬭ Master degree
- ⬭ PhD
- ⬭ Other: ____________________

16. **What is your age?** *

Please select only one answer.

Mark only one oval.

- ⬭ 18 - 24
- ⬭ 25 - 34
- ⬭ 35 - 44
- ⬭ 45 - 54
- ⬭ 55 - 64
- ⬭ 65 & Over
- ⬭ Prefer not to say

17. **What is your postcode?** *

18. **Any other comments regarding your intention to use self-driving cars?**

Appendix G: Data Analysis with R Programming full source code

```
# installing required packages which haven't been installed yet
list.of.packages <- c("readxl","ggpubr","GPArotation","mvnmle",
                      "BaylorEdPsych", "moments", "apaTables", "psych",
                      "dplyr","ggplot2", "lavaan", "plsdepot", "plspm")
new.packages <- list.of.packages[!(list.of.packages %in% installed.packages()[,"Package"])]
if(length(new.packages)) install.packages(new.packages)

# loading required packages
library(readxl)
library(ggpubr)
library(GPArotation)
library(mvnmle)
library(BaylorEdPsych)
library(moments)
library(apaTables)
library(psych)
library(dplyr)
library(ggplot2)
library(lavaan)
library(plsdepot)
library(plspm)

#####################################

# loading the data
#data <- read_excel("Desktop/Patrice/data-pat3.xlsx")
```

Appendix G: Data Analysis with R Programming full source code

```
data <- read_excel(file.choose())

# create a data_frame of PE
dfpe <- data.frame(data$PE1,data$PE2,data$PE3,data$PE4)

# create a data_frame of EE
dfee <- data.frame(data$EE1,data$EE2,data$EE3,data$EE4)

# create a data_frame of SI
dfsi <- data.frame(data$SI1,data$SI2,data$SI3,data$SI4)

# create a data_frame of SE
dfse <- data.frame(data$SE1,data$SE2,data$SE3,data$SE4)

# create a data_frame of PS
dfps <- data.frame(data$PS1,data$PS2,data$PS3,data$PS4,data$PS5,data$PS6)

# create a data_frame of AX
dfax <- data.frame(data$AX1,data$AX2,data$AX3,data$AX4,data$AX5)

# create a data_frame of T
dft <- data.frame(data$T1,data$T2,data$T3,data$T4)

# create a data_frame of LR
dflr <- data.frame(data$LR1,data$LR2,data$LR3)

# create a data_frame of HM
dfhm <- data.frame(data$HM1,data$HM2,data$HM3)

# create a data_frame of PV
dfpv <- data.frame(data$PV1,data$PV2,data$PV3)
```

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```
# create a data_frame of BI
dfbi <- data.frame(data$BI1,data$BI2,data$BI3)

# checking the internal consistency


psych::alpha(dfpe)
psych::alpha(dfee)
psych::alpha(dfsi)
psych::alpha(dfse)
psych::alpha(dfps)
psych::alpha(dfax)
psych::alpha(dft)
psych::alpha(dflr)
psych::alpha(dfhm)
psych::alpha(dfpv)
psych::alpha(dfbi)

#internal consistency is pretty good as all the Cronbach's alpha ar greater than 0.7
# as the minimum was 0.80 for the Perceived Safety

# create a data frame with data
df  <- data[,4:46]




######################################
# create a data frame to investigate the multivariate outliers using the Mahalanobis
dfd <- df


m_dist <- mahalanobis(dfd, colMeans(dfd), cov(dfd))
dfd$m_dist <- round(m_dist, 2)
```

```
ggplot(dfd, aes(x = m_dist)) +
  geom_histogram(bins = 50) +
  labs(title = "Mahalanobis Distances",
       subtitle = "Histogram based on Mahalanobis Distances"
  ) +
  xlab("Mahalanobis Distance") +
  scale_y_continuous(breaks = seq(0, 60, 10))

# defining the outliers

dfd$outlier_maha <- "No"
dfd$outlier_maha[dfd$m_dist > 90] <- "Yes"



# Outliers removed
data$out  <- dfd$outlier_maha
data <- filter(data,out == "No")
# So we removed 15 outliers, which have the Mahalanobis distance > 90
df  <- data[,4:46]

# Littles chi-square statistics
data(EndersTable1_1)
LittleMCAR(df)

# but as there are no missing data, we do not have any problem and actually and can
continue

#################################################

# correlation -this funciton creates the "word .doc" document with the APA stuled table
# of correlations and basic descriptive statistics as Mean & SD
```

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```
dfcor <- data.frame(data$PE,data$EE,data$SI,data$SE,data$PS,data$AX,data$T,data$LR,
 data$HM,data$PV,data$BI,data$Gender,data$Age)

apa.cor.table(dfcor, filename="Table_desc_and_cor.doc", table.number=1)
# here is just the clean correlation matrix

# here is the correlation matrix
#cor(dfcor, method = "pearson")

# here is the correlation matrix, but rounded to the 2 decimals, si readibility is much better
round(cor(dfcor, method = "pearson"),2)
# look at the axiety as it is negativily correlated, that is good, and the maximum is for
# Perceived safety, which corresponds to what could we expect, as higher Perceived Safety
# implies less Anxiety

################################################
# checking the skewness
skewness(data$PE)
skewness(data$EE)
skewness(data$SI)
skewness(data$SE)
skewness(data$PS)
skewness(data$AX)
skewness(data$T)
skewness(data$LR)
skewness(data$HM)
skewness(data$PV)
skewness(data$BI)

# except the PV = price value, all the variables have the negative skewness,
#that mean that there is a long tail in the negative direction and on the other hand
#the positive skewness mean that there is a long tail to the positive direction
```

```
# but all the skewnesses are in the limit of [-1;1]


#####################################
# checking the kurtosis


kurtosis(data$PE)
kurtosis(data$EE)
kurtosis(data$SI)
kurtosis(data$SE)
kurtosis(data$PS)
kurtosis(data$AX)
kurtosis(data$T)
kurtosis(data$LR)
kurtosis(data$HM)
kurtosis(data$PV)
kurtosis(data$BI)

# all the variables have the kurtosis in the limit of 3 except the Self-Efficacy = 3.73 so
#they are called platykurtic e.g. are flatter, the Self-Efficacy which has the kurtosis greater than 3,
# that on is so-called leptokurtic e.g. is more thin
# https://en.wikipedia.org/wiki/Kurtosis



#####################################
# The next step is to determine the optimal number of factors
parallel <- fa.parallel(df, fm = 'minres', fa = 'fa')
# this is an usual test which help us to determine the optimal number of factors, as this test
# recommended 9 factors
# Parallel analysis suggests that the number of factors =  9
# we will look at 2 options, with 9 and 11 factors

# here we print the loading for the 11 factors and cut of for 0.6, 0.7 and 0.5
```

```
elevenfactor <- fa(df,nfactors = 11,rotate = "oblimin",fm="minres")
#print(threefactor)
print(elevenfactor$loadings,cutoff = 0.7)
print(elevenfactor$loadings,cutoff = 0.6)
print(elevenfactor$loadings,cutoff = 0.5)
# here we print the loading for the recommended 9 factors and cut of for 0.6 and 0.7

ninefactors <- fa(df,nfactors = 9,rotate = "oblimin",fm="minres")
#print(threefactor)
print(ninefactors$loadings,cutoff = 0.7)
print(ninefactors$loadings,cutoff = 0.6)

######################################
dtt <- data
# Confirmatory factor Analysis
#here is the full model

# this is the baisc proposed model, but it's performance is not good
model1 <- 'performance =~ PE1+PE2+PE3+PE4
effort  =~ EE1+EE2+EE3+EE4
social  =~ SI1+SI2+SI3+SI4
efficacy  =~ SE1+SE2+SE3+SE4
safety  =~ PS1+PS2+PS3+PS4+PS5+PS6
anxiety  =~ AX1+AX2+AX3+AX4+AX5
trust  =~ T1+T2+T3+T4
legal  =~ LR1+LR2+LR3
hedonic  =~ HM1+HM2+HM3
price  =~ PV1+PV2+PV3
behavioural  =~ BI1+BI2+BI3'

fit1 <- cfa(model1,data = dtt)
summary(fit1,standardized = T,fit.measures=T,rsq=T)
```

```
# SRMR= 0.077 < 0.08  is a good fit
# but other as
# Comparative Fit Index (CFI)                  0.852 < 0.9 !!!
#  RMSEA                                    0.087 >  0.08 !!!

####################################

# this second model is based on the 9 factor, which were recommended by the
# Parallel Analysis Scree Plots, with the cutoff
model2 <- 'performance =~ PE1+PE3+PE4
effort  =~ EE1+EE2+EE3+EE4
social  =~ SI2
efficacy  =~ SE2+SE3
anxiety  =~ AX2+AX3+AX4+AX5
legal  =~ LR1+LR2+LR3
hedonic  =~ HM1+HM2+HM3
price  =~ PV1+PV2
behavioural  =~ BI1+BI2+BI3'

fit2 <- cfa(model2,data = dtt)
summary(fit2,standardized = T,fit.measures=T,rsq=T)
# summary of this model, according to the
# https://www.cscu.cornell.edu/news/Handouts/SEM_fit.pdf

#  RMSEA         0.076 < 0.08 that is GOOD model
# Comparative Fit Index (CFI)   0.942 > 0.90 that is GOOD model
# SRMR    0.043 < 0.08 that is GOOD model
#####################################
#SEM based on the original model

Performance <- c(0,0,0,0,0,0,0,0,0,0,0)
```

```
Effort <- c(0,0,0,0,0,0,0,0,0,0,0)

Social <- c(0,0,0,0,0,0,0,0,0,0,0)

Efficacy <- c(0,0,0,0,0,0,0,0,0,0,0)

Safety <- c(0,0,0,0,0,0,0,0,0,0,0)

Anxiety <- c(0,0,0,0,0,0,0,0,0,0,0)

Trust <- c(0,0,0,0,0,0,0,0,0,0,0)

Legal <- c(0,0,0,0,0,0,0,0,0,0,0)

Hedonic <- c(0,0,0,0,0,0,0,0,0,0,0)

Price <- c(0,0,0,0,0,0,0,0,0,0,0)

Behavioural <- c(1,1,1,1,1,1,1,1,1,1,0)


#inner matrix

model_path <-
rbind(Performance,Effort,Social,Efficacy,Safety,Anxiety,Trust,Legal,Hedonic,Price,Behavi
oural)

colnames(model_path) <- rownames(model_path)

#plot the inner matrix

innerplot(model_path,box.size = 0.1)


#model variables

model_blocks <- list(4:7,8:11,12:15,16:19,20:25,26:30,31:33,34:37,38:40,41:43,44:46)

#maybe will be used later

#model_path <- list(c(4,6,7),8:11,13,17:18,)

model_modes <- rep("A",11)


#modelling the model

model_pls <- plspm(data,model_path,model_blocks,modes=model_modes)


#checking unidimensionality

model_pls$unidim

# here the column of Cronbach alpha , as all the values are greater than 0.7 we are happy as
this is good

# Dillon-Goldstein rho should be greater than 0.8, as this is OK, it is good
```

```
# 1st eigen value should be big and definitely greater than 1 and the second

# should be small and definitely smaller than 1

# we see that this is not ghe case of the "Perceived Safety", in the next second model it won't be


# plotting the loadings

# visualizing the loadings

plot(model_pls,what = "loadings")


# checking the outer model

model_pls$outer_model

# here is the table with the latent variables, and each variable's weight loadings

# and communality = reliabilities

# as we look at the communality, they shoudl be greater than 0.49, the varibles for which

# this not hold are the ones, which won't be in th emodel probably as PS


#What is a communality? A communality refers to the percent of variance in an observed variable that is

# accounted for by the retained components (or factors).

# communalities represent the amount of variability explained by the latent variable.


# chart of the loading-bar type

# here is a nice visualization of the loadings, with the 0.7 cut-off line,

#so we see that the worst is the Perceived Safety

ggplot(data= model_pls$outer_model, aes(x = name, y = loading, fill = block)) +

  geom_bar(stat = 'identity', position = 'dodge')+

# we add the threshold bar of 0.7

geom_hline(yintercept = 0.7,color= 'gray50')+

  #rotate the labels of x axis

theme(axis.text.x = element_text(angle = 90))+

  #add title

  ggtitle("Chart of the loading-bar type")
```

```
# Here is the plot of the model and path coefficient,
# the blue ones are positive and on the other hand the red one are negative
plot(model_pls,arr.pos =  0.35)
# here are the values in the table
model_pls$path_coefs

# Here are the estimates for the inner model
model_pls$inner_model

#effects
# Here are the effects, look only at the non zero ones- but those ones are the path loadings
model_pls$effects

#inner model summary
model_pls$inner_summary

# here are the AVEs, as the recomended values are greater than 0.5,
# all the factors are good, except the Perceived Safety

#####################################
#####################################
#####################################
#####################################
#####################################
#####################################
# So now we try the second model

#SEM based on the second model

Performance2 <- c(0,0,0,0,0,0,0,0,0)
Effort2 <- c(0,0,0,0,0,0,0,0,0)
Social2 <- c(0,0,0,0,0,0,0,0,0)
```

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```
Efficacy2 <- c(0,0,0,0,0,0,0,0,0)

Anxiety2 <- c(0,0,0,0,0,0,0,0,0)

Legal2 <- c(0,0,0,0,0,0,0,0,0)

Hedonic2 <- c(0,0,0,0,0,0,0,0,0)

Price2 <- c(0,0,0,0,0,0,0,0,0)

Behavioural2 <- c(1,1,1,1,1,1,1,1,0)


#inner matrix

model_path2 <-
rbind(Performance2,Effort2,Social2,Efficacy2,Anxiety2,Legal2,Hedonic2,Price2,Behaviour
al2)

colnames(model_path2) <- rownames(model_path2)

#plot the inner matrix

innerplot(model_path,box.size = 0.1)


#model variables


model_blocks2 <- list(c(4,6,7),8:11,13,17:18,27:30,35:37,38:40,41:42,44:46)

#maybe will be used later

#model_path <- list(c(4,6,7),8:11,13,17:18,)

model_modes2 <- rep("A",9)


#modelling the model

model_pls2 <- plspm(data,model_path2,model_blocks2,modes=model_modes2)


#checking unidimensionality

model_pls2$unidim

# here the column of Cronbach alpha , as all the values are greater than 0.7 we are happy as

# the minimal is 0.86, so this is good

# Dillon-Goldstein rho should be greater than 0.8, as the minimal is 0.91 so this is OK as
well

# 1st eigen value should be big and definitely greater than 1 and the second

# should be small and definitely smaller than 1
```

```
# efficacy is just one variable that why there are such a results, but it is OK


# plotting the loadings
# visualizing the loadings
plot(model_pls2,what = "loadings")


# checking the outer model
model_pls2$outer_model
# here is the table with the latent variables, and each variable's weight loadings
# and communality = reliabilities
# as we look at the communality, they shoudl be greater than 0.49,
# in this model, the minimal is 0.54 for AX5 and the second lowest is 0.74 for AX2, so this is OK



# chart of the loading-bar type
# here is a nice visualization of the loadings, with the 0.7 cut-off line,
#so we see that the worst is the Perceived Safety
ggplot(data= model_pls2$outer_model, aes(x = name, y = loading, fill = block)) +
  geom_bar(stat = 'identity', position = 'dodge')+
  # we add the threshold bar of 0.7
  geom_hline(yintercept = 0.7,color= 'gray50')+
  #rotate the labels of x axis
  theme(axis.text.x = element_text(angle = 90))+
  #add title
  ggtitle("Chart of the loading-bar type")
# we can see that al the loadings are greater than the 0.7 cut-off we chose it bo be as that


# Here is the plot of the model and path coefficient,
# the blue ones are positive and on the other hand the red one are negative
plot(model_pls2,arr.pos =  0.3)
# here are the values in the table
model_pls2$path_coefs
```

```
# Here are the estimates for the inner model
model_pls2$inner_model

#effects
# Here are the effects, look only at the non-zero ones- but those ones are the path loadings
model_pls2$effects



#inner model summary
model_pls2$inner_summary
# here are the AVEs, as all the values are greater than 0.7, this is above
# the recommended value of 0.5

# we else have to check the cross loadings
model_pls2$crossloadings

# the cross-loading look good as well as the values for
# each variables are highest in the corresponding column and not in the other factor!

# goodness of fit is 0.809 where the values > 0.7 are considered as very good
model_pls2$gof
# and the R squared of this second model is 0.77
# and as well what is important is mean redundancy which is 0.67 for the Behavioural

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```