User Acceptance of Autonomous Delivery Vehicles
– An Empirical Study in Germany –

S KAPSER

PhD

2019

User Acceptance of Autonomous Delivery Vehicles – An Empirical Study in Germany –

Sebastian Kapser

A thesis submitted in partial fulfilment of the requirements of the University of Northumbria at Newcastle for the degree of Doctor of Philosophy

Research undertaken in Newcastle Business School

December 2019

Abstract

The inevitable need to develop new delivery practices in last-mile delivery arises from the enormously growing business to consumer (B2C) e-commerce and the associated challenges for logistics service providers. Autonomous delivery vehicles (ADVs) will potentially revolutionise last-mile delivery with regard to efficiency, sustainability and customer orientation. However, if not widely accepted by end-consumers, the introduction of ADVs as a delivery option can be a substantial waste of resources.

At present, the research on consumers' receptivity of innovations in last-mile delivery, such as ADVs, is limited. This study is the first that investigates user acceptance of ADVs in Germany by utilising a theoretically extended and modified version of the Unified Theory of Acceptance and Use of Technology (UTAUT2) in the specific context of last-mile delivery. Quantitative data was collected through an online survey approach (n = 501) and structural equation modelling was undertaken.

The results indicate that *overall trust in technology* is the strongest predictor of *behavioural intention* (i.e., user acceptance), followed by *price sensitivity*, *performance expectancy*, *innovativeness*, *hedonic motivation*, *social influence* and *overall perceived risk*; whereas no effect could be found for *effort expectancy* and *facilitating conditions*. Additionally, *street performance* and *parcel drop-off performance* significantly influence *overall trust in technology*. The same is true for the effect of *perceived performance risk* during parcel drop-off and *perceived safety risk* when driving autonomously on *overall perceived risk*. Moreover, it has been found that *overall trust in technology* negatively influences *overall perceived risk*. Collectively, the *Autonomous Delivery Vehicle Acceptance Model* was able to explain 80 percent of the variance in *behavioural intention* to use ADVs.

These findings have not only important theoretical contributions but also managerial implications in the areas of technology acceptance and last-mile delivery innovations, which will support the long-term success of ADVs as a last-mile delivery option in Germany.

Table of Contents

List of Tables

List of Figures

List of Abbreviations

A .... Attitude
ABS .... Association of Business Schools
ADV-AM .... Autonomous Delivery Vehicle Acceptance Model
ADVs .... Autonomous Delivery Vehicles
AM .... Amotivation
AMOS .... Analysis of Moment Structures
ARTS .... Automated Road Transport Systems
ATM .... Automated Teller Machine
AVE .... Average Variance Extracted
AVs .... Autonomous Vehicles
B2C .... Business to consumer
BI .... Behavioural Intention
CATI .... Computer-Aided Telephone Interviewing
CFA .... Confirmatory Factor Analysis
CFI .... Comparative Fit Index
CO_2 .... Carbon Dioxide
C-TAM .... Combined Technology Acceptance Model
df .... degrees of freedom
DOI .... Diffusion of Innovation
e-commerce .... Electronic Commerce
EE .... Effort Expectancy
EFA .... Exploratory Factor Analysis
EM .... Extrinsic Motivation
EU .... European Union
FC .... Facilitating Conditions
GFI .... Goodness-of-Fit Index
GPS .... Global Positioning System
H .... Habit
HM .... Hedonic Motivation
IBM .... The International Business Machines Corporation
IM .... Intrinsic Motivation
INO .... Innovativeness

IP .... Internet Protocol
IS .... Information Systems
IT .... Information Technology
km/h .... kilometres per hour
MM .... Motivational Model
MPCU .... Model of Personal Computer Utilisation
N/A .... Not available
No. .... Number
PBC .... Perceived Behavioural Control
PC .... Personal Computer
PE .... Performance Expectancy
PEOU .... Perceived Ease of Use
PhD .... Doctor of Philosophy
PLS .... Partial Least Squares
PNFI .... Parsimony Normed Fit Index
PR_O .... Overall Perceived Risk
PR_PR .... Perceived Performance Risk
PR_SR .... Perceived Safety Risk
PS .... Price Sensitivity
PSR .... Price Sensitivity Reverse
PU .... Perceived Usefulness
PV .... Price Value
RDD .... Random Digit Dial
RFID .... Radio-Frequency Identification
RMSEA .... Root Mean Square Error of Approximation
SCT .... Social Cognitive Theory
SDT .... Social Determination Theory
SEM .... Structural Equation Modelling
SI .... Social Influence
SLT .... Social Learning Theory
SPSS .... Statistical Package for the Social Sciences
SSTs .... Self-Service Technologies
Std. .... Standard
TAM .... Technology Acceptance Model

TLI..Tucker Lewis Index
TPB ....Theory of Planned Behaviour
TRA..Theory of Reasoned Action
TT_O .... Overall Trust in Technology
TT_P... Parcel Drop-off Performance
TT_S... Street Performance
USA.. United States of America
UK...United Kingdom
UTAUT ....Unified Theory of Acceptance and Use of Technology

List of Publications

Kapser, S.; Abdelrahman, M. (in review) *Acceptance of Autonomous Delivery Vehicles for Last-Mile Delivery in Germany – Extending UTAUT2 with Risk Perceptions.* International Journal of Transportation Research Part C.

Kapser, S.; Abdelrahman, M. (in press) *Acceptance of autonomous delivery vehicles – Applying the UTAUT model to the context of last-mile logistics.* 8th Transport Research Arena TRA, Helsinki, Finland.

Kapser, S.; Abdelrahman, M. (2019) *Extending UTAUT2 to Explore User Acceptance of Autonomous Delivery Vehicles*. 25th American Conference on Information Systems AMCIS 2019, Cancun, Mexico.

Kapser, S. (2019) *Users' Acceptance of Autonomous Delivery Vehicles for Home Delivery: The Case of Germany.* Northumbria University Business and Law School Faculty and Doctoral Conference, June 2019.

Kapser, S. (2018) *Nutzerakzeptanz von autonomen Zustellfahrzeugen [User Acceptance of Autonomous Delivery Vehicles]*. Poster Presentation. Research Day: Baden-Württemberg Center of Applied Research (BW-CAR), Stuttgart, Germany.

Marsden, N.; Bernecker, T.; Zöllner, R.; Sußmann, N.; Kapser, S. (2018) *BUGA:log – A Real-World Laboratory Approach to Designing an Automated Transport System for Goods in Urban Areas.* 24th International Conference on Engineering, Technology and Innovation (ICE/ITMC) *Special Issue*, Stuttgart, Germany.

Kapser, S. (2018) *BUGA:log: Investigating the Public Acceptance of Autonomous Delivery Vehicles in Urban Transportation Systems.* Poster Presentation. 7th Transport Research Arena TRA, Vienna, Austria.

Dedication

I dedicate this thesis to…

… my lovely wife ***Carolin****,*

and

…my lovely son ***Ben****.*

Acknowledgements

This thesis would not have been possible without my extraordinary supervisor, Dr Mahmoud Abdelrahman. I deeply appreciate his valuable time, critical comments, advice, as well as his constant encouragement and support throughout this journey.

Moreover, I want to thank the faculty of Business and Transportation at Heilbronn University of Applied Sciences, especially Prof Dr Ralf Dillerup and Prof Dr Tobias Bernecker, who made it possible through a joint PhD programme, to carry out this research at Northumbria University Newcastle Business School.

Furthermore, a special thanks goes to the Doctoral College at Heilbronn University of Applied Sciences. Without the financial support provided, I would not have been able to attend training courses and conferences during my PhD journey.

I also want to thank all participants who took part in the English and German pre-tests as well as all participants who took the time to fill in the online questionnaire, which was the basis for this research project. Without their responses it would not have been possible to carry out this research.

Finally, I want to express my deepest appreciation to my wife Carolin who took the time to discuss and read my thesis carefully many times. Without her love, friendship and relentless support, I would not have been able to finish this journey. Also, I want to thank my son, Ben. He helped me with his happiness and constant smile to never forget the most important thing in life – family.

Declaration

I declare that the work contained in this thesis has not been submitted for any other award and that it is all my own work. I also confirm that this work fully acknowledges opinions, ideas and contributions from the work of others.

Any ethical clearance for the research presented in this thesis has been approved. Approval has been sought and granted by the Faculty Ethics Committee (reference no. 4410) on 24/09/2018.

I declare that the Word Count of this Thesis is 81,819 words (excluding references, footnotes, and appendices).

Name: Sebastian Kapser

Signature:

Date 19/12/2019

Chapter 1: Introduction

In the following subchapters, the PhD thesis entitled “User Acceptance of Autonomous Delivery Vehicles – An Empirical Study in Germany –” will be introduced. First, the research background and the significance of the investigated topic is presented, followed by a clear presentation of the research question and the underlying research objectives. Finally, the research process as well as the outline of this thesis is presented.

1.1 Background and Significance

Over the last decade, last-mile delivery, also referred to as “home delivery”, has received a great deal of attention, which can mainly be traced back to the enormous growth of the business-to-consumer (B2C) e-commerce (i.e., electronic commerce) (e.g., Weltevreden, 2008; Visser *et al.*, 2014; Chen *et al.*, 2019; Liu *et al.*, 2019a; Vakulenko *et al.*, 2019). In the case of Germany, the total B2C e-commerce turnover accounted for 53.3 billion euros[1] in 2018, which is more than triple as much as in 2009 (Handelsverband Deutschland, 2019).

Despite the fact that e-commerce is still one of the smallest distribution channels when it comes to private purchases in Germany (around 10.1 percent in 2018), it is, nevertheless, the one growing fastest. In the last five years the German B2C e-commerce grew on average almost 11 percent every year[2] (Handelsverband Deutschland, 2019). This positive trend will further continue in the years to come. It is forecasted that the B2C e-commerce will approximately grow by 8.5 percent and will account for 57.8 billion euros in 2019 (see Figure 1.1) (Handelsverband Deutschland, 2019).

[1] Including tangible and digital products; excluding physical services.
[2] Own calculation based on the values provided by Handelsverband Deutschland (2019).
(11.3 + 12 + 10.8 + 10.5 + 9.1) ÷ 5 = 10.74 percent.

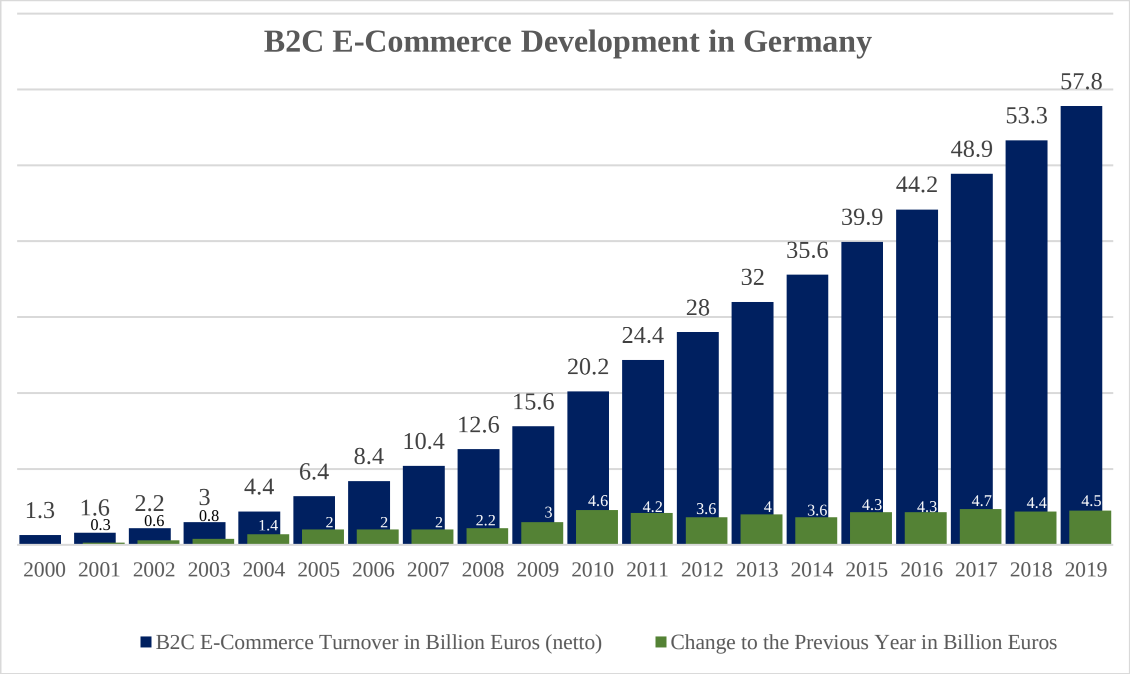

Figure 1.1: B2C E-Commerce Development in Germany adopted from Handelsverband Deutschland (2019)

In this regard, the increasing popularity of online shopping directly impacts the number of parcels that need to be delivered to customer's homes (Weltevreden, 2008; Visser *et al.*, 2014; Chen *et al.*, 2019; Liu *et al.*, 2019a; Vakulenko *et al.*, 2019). Whilst in 2009 only 805 million[3] parcels were delivered to private homes in Germany, the number dramatically increased to 1,830 million[4] parcels in 2018 (BIEK, 2019). This is an increase of approximately 227 percent.[5] Following the positive trend of private online purchases, a further increase of parcel shipments for the upcoming years is forecasted. In 2019, the number of B2C parcel shipments will likely reach 1,980 million[6] and by 2023, the number of parcels shipped to private homes in Germany will likely have already exceed 2,000 million parcels (BIEK, 2019).

Consequently, the increasing number of shipments leads to an increase of delivery vehicles (e.g., vans or light trucks) in residential areas (Weltevreden, 2008; Liu *et al.*, 2019a), which imposes a variety of negative externalities (i.e., social costs). These

[3] Own calculation based on the values provided by BIEK (2019); 2.23 billion shipments in 2009 (total cep volume); 80.5 percent parcel segment (2.23 ÷ 100 × 80.5) = 1.79 billion parcels; 45 percent B2C segment (1.79 ÷ 100 × 45) = 0.805 billion = 805 million B2C parcels.
[4] Own calculation based on the values provided by BIEK (2019); 3.52 billion shipments in 2018 (total cep volume); 83.9 percent parcel segment (3.52 ÷ 100 × 83.9) = 2.95 billion parcels; 62 percent B2C segment (2.95 ÷ 100 × 62) = 1.83 billion = 1,830 million B2C parcels.
[5] Own calculation: 1,830 ÷ (805 ÷ 100) = 227.3 percent
[6] Own calculation based on the values provided by BIEK (2019); 3.68 billion shipments in 2019 (total; forecast); 83.9 percent parcel segment (2018) (3.68 ÷ 100 × 83.9) = 3.09 billion parcels; 64 percent B2C segment (forecast 2019) (3.09 ÷ 100 × 64) = 1.98 billion = 1,980 million B2C parcels.

include, but are not limited to, road congestion effects and increasing noise as well as air emissions (Weltevreden, 2008; Mangiaracina *et al.*, 2017; Liu *et al.*, 2019a). Since these negative externalities have not only a major impact on the life quality and the economic competitiveness of urban areas but also on the overall traffic safety (Savelsbergh and van Woensel, 2016), governments react with traffic restrictions (e.g., low emission zones, road closures), which in turn negatively impacts the freight delivery activities (Dablanc and Montenon, 2015; Schönberg *et al.*, 2018). Alongside the governmental restrictions, logistics service providers are also faced with increasing customer demands for service quality. For instance, customers are looking for faster delivery options (same-day, same-hour delivery), more flexible delivery options, as well as cheaper and environmentally friendlier delivery options (Florio *et al.*, 2018; Schröder *et al.*, 2018; Vakulenko *et al.*, 2019). As such, the last-mile delivery process, which is already the most cost-intensive part of the transportation process (Melo and Macharis, 2011; Brown and Guiffrida, 2014; Albright, 2017), will ultimately include increasing operational costs.

The e-commerce revolution as well as the more demanding customers have turned the traditional last-mile delivery on its head and conventional delivery practices do not seem suitable to cope with this fast-changing environment efficiently. Therefore, the necessity of adjusting and developing new delivery practices arises (Joerss *et al.*, 2016; Marsden *et al.*, 2018; Florio *et al.*, 2018; Vakulenko *et al.*, 2019). Meeting the need for change, especially autonomous delivery vehicles (ADVs), which are defined as electric and self-driving ground vehicles (see subchapter 2.2), are believed to have the potential to revolutionise the market of last-mile delivery (Marsden *et al.*, 2018; Schröder *et al.*, 2018) and will likely compete with the traditional home delivery practices by 2025 (Joerss *et al.*, 2016).

ADVs are a disruptive technological innovation in logistics (Deutsche Post DHL, 2018a) that will make the overall last-mile transportation process more efficient (e.g., decreasing transportation costs), more sustainable (e.g., CO_2 local emission free), and more customer-focused (e.g., more flexible and convenient) (Joerss *et al.*, 2016; Marsden *et al.*, 2018; Deutsche Post DHL, 2018a; Schröder *et al.*, 2018). Therefore, ADVs are believed to be a good compromise between efficiency, sustainability and customer convenience. However, as with other technological developments the feasibility should always be balanced against the customer perceptions as well as their behavioural responses (Collier and Kimes, 2012). In other words, even though ADVs might be technically able to contribute to last-mile efficiency, the successful implementation of ADVs cannot be realised unless end-customers accept the innovative service concept for home delivery. Marsden *et al.* (2018) support this view by stating that user acceptance of ADVs is one of the main aspects that need to be further investigated to be able to introduce ADVs in a successful manner. The other way around, if not widely accepted, the development and introduction of ADVs as an alternative delivery option can be a substantial waste of resources. Therefore, it is imperative to understand the customer perspective in this regard.

As such, this study answers the call from Deutsche Post DHL, which is the major logistics service provider globally, to enhance the understanding of the end-consumers regarding logistical services (Deutsche Post DHL, 2018a, 2018b). According to Wang *et al.* (2018a) this is increasingly important especially due to the rising power of end-consumers to dictate how the delivery of their goods should be organised within the last-mile (Wang *et al.*, 2018a). Moreover, because a misunderstanding of ADVs will very likely influence user acceptance as much as an accurate conception, it is important to assess user acceptance early in the developing process to be able to identify and overcome obstacles as well as to evaluate different alternatives (Kollmann, 1998; Fraedrich *et al.*, 2016). Overall, this study provides fruitful insights into the consumer's decision-making when deciding on the options of last-mile delivery.

At present, ADVs are still in its developmental stage and research on its acceptance is very limited. Only few studies have investigated the acceptance of ADVs for home delivery (Rohleder, 2016; Eurobarometer, 2017; Joerss *et al.*, 2016; Prümm *et al.*, 2017; Braun and Buckstegen, 2017; Marsden *et al.*, 2018). However, these studies are rather descriptive in nature, as they primarily investigate acceptance dichotomously (answer: yes/no) and little emphasis is placed on the behavioural components involved. As stated before, last-mile delivery is an end-customer-oriented service, which includes a strong behavioural element (Collins, 2015); therefore, it is imperative to identify the factors that determine the acceptance of ADVs as a delivery option to be able to design, develop and promote ADVs as an accepted alternative to its conventional delivery option (i.e., van delivery).

From a practical point of view, the findings of this study are mainly relevant for two stakeholder groups. The first are developers and designers (e.g., automobile industry, universities, and start-up companies) who currently develop and test ADVs. These stakeholders can benefit from the findings, since they are able to incorporate the aspects that are considered important for the actual customer in the development process (e.g., usefulness, fun aspects, etc.). As such, ADVs can be developed with the customer in mind. Second, logistics service providers or other last-mile delivery service providers (e.g., start-up companies), who will likely adopt ADVs for last-mile delivery due to its promise of a 40 percent cut of costs (Joerss *et al.*, 2016; Deutsche Post DHL, 2018a), can also benefit from the findings of this study. For instance, they can use the findings to develop customer-tailored market introduction strategies (e.g., developing a customer tailored pricing strategy).

In summary, this research is an important step towards the understanding of users' acceptance of ADVs as an innovative last-mile delivery option. As such, this study will not only enrich the academic literature in the fields of technology acceptance and logistics innovations but also will provide guidance for businesses including logistics service providers and vehicle developers on how to develop and promote ADVs in a successful manner.

1.2 Research Question and Objectives

The overall purpose of this research is to identify the key factors that drive the uptake of ADVs as a delivery option in the German last-mile delivery market. However, this research does not claim to be fully representative of the entire German population (see subchapter 4.4.2.3 for more details). Rather, it tries to give first insights into the acceptance of Germans regarding ADVs for last-mile delivery. Within this thesis, the following research question will be answered by fulfilling the research objectives listed on the following page.

Research Question:

What are the factors that affect user acceptance of autonomous delivery vehicles (ADVs) in last-mile delivery in Germany?

Research Objectives:

(1) Determining the factors that positively or negatively influence user acceptance of ADVs in last-mile delivery.
(2) Developing a theoretical framework that describes the relationships between the factors and user acceptance of ADVs in last-mile delivery.
(3) Empirically test the validity of the theoretical framework in Germany.

1.3 Research Process

The research process consists of seven major steps, which were carried out to conduct this research study (see Figure 1.2). The first step included a general review of relevant literature in the context of last-mile delivery to get a detailed overview of the market, its drivers as well as its development. Here, it was found that especially ADVs have the potential to revolutionise last-mile delivery in a way that is more efficient, sustainable and customer-focused and have also the potential to compete against traditional home delivery practices. This was the foundation and starting point for investigating users' acceptance of ADVs and built the scope of this research project.

In a second step, ADVs as well as user acceptance were defined precisely. Next, the models and theories regularly used to investigate user acceptance of new technologies were reviewed. This was followed by a review of existing literature on the acceptance of ADVs. As a result, the research gap (i.e., limited research on user acceptance of ADVs) was identified and the research question as well as its underlying objectives could be developed.

Since only a limited number of studies could be identified that explicitly investigated the acceptance of ADVs, this study turned, in a third step, to a broader literature review. In doing so, two distinct but overlapping research areas were identified (i.e., self-service technologies and autonomous vehicles) based on the characteristics of ADVs (i.e., driving autonomously and dropping off parcels with technology – human interaction). Drawing on the research question, these two areas were systematically reviewed to identify the main factors influencing user acceptance of self-service technologies (SSTs) and autonomous vehicles (AVs). As a result, perceived risk, trust in technology, and innovativeness were identified to be of special importance in both evaluated research areas.

In the fourth step, based on previous literature, the selection, justification, and modification of the underlying research model (i.e., UTAUT2) was performed. This resulted in the final theoretical research framework, which was utilised in this study to investigate user acceptance of ADVs. Based on this theoretical framework, the hypotheses were developed. Up to this point, the research was purely theoretical, and the literature was used deductively.

In a fifth step, the research design to test the hypotheses empirically in a partial representative manner for the German population was developed and applied. This step included several important steps: (1) research strategy: survey; (2) data collection method: self-administrated online questionnaire; (3) pre-testing and translation of the questionnaire; (4) sampling: non-probability quota sampling; and (5) data analysis: structural equation modelling. At the end of this step, the final data collection took place.

In a sixth step, the data was analysed using structural equation modelling (SEM). In doing so, a two-step approach was conducted starting with the evaluation of the measurement model and proceeding with the structural model. This yielded to the fact that 12 out of 14 hypotheses could be supported by the gathered data in this research study. Next, the theoretical research framework was modified by dropping the insignificant constructs and re-estimated. As a result, the Autonomous Delivery Vehicle Acceptance Model (ADV-AM) was developed. Alongside the data analysis procedures, this step also included the discussion of the research findings in regard to the research question and previous literature.

In the final stage of this research the conclusions could be drawn. This included the outline of the theoretical contributions, the managerial implications, as well as the presentation of the research limitations and the proposal for further research. Figure 1.2 on the following page graphically illustrates the research process of this thesis.

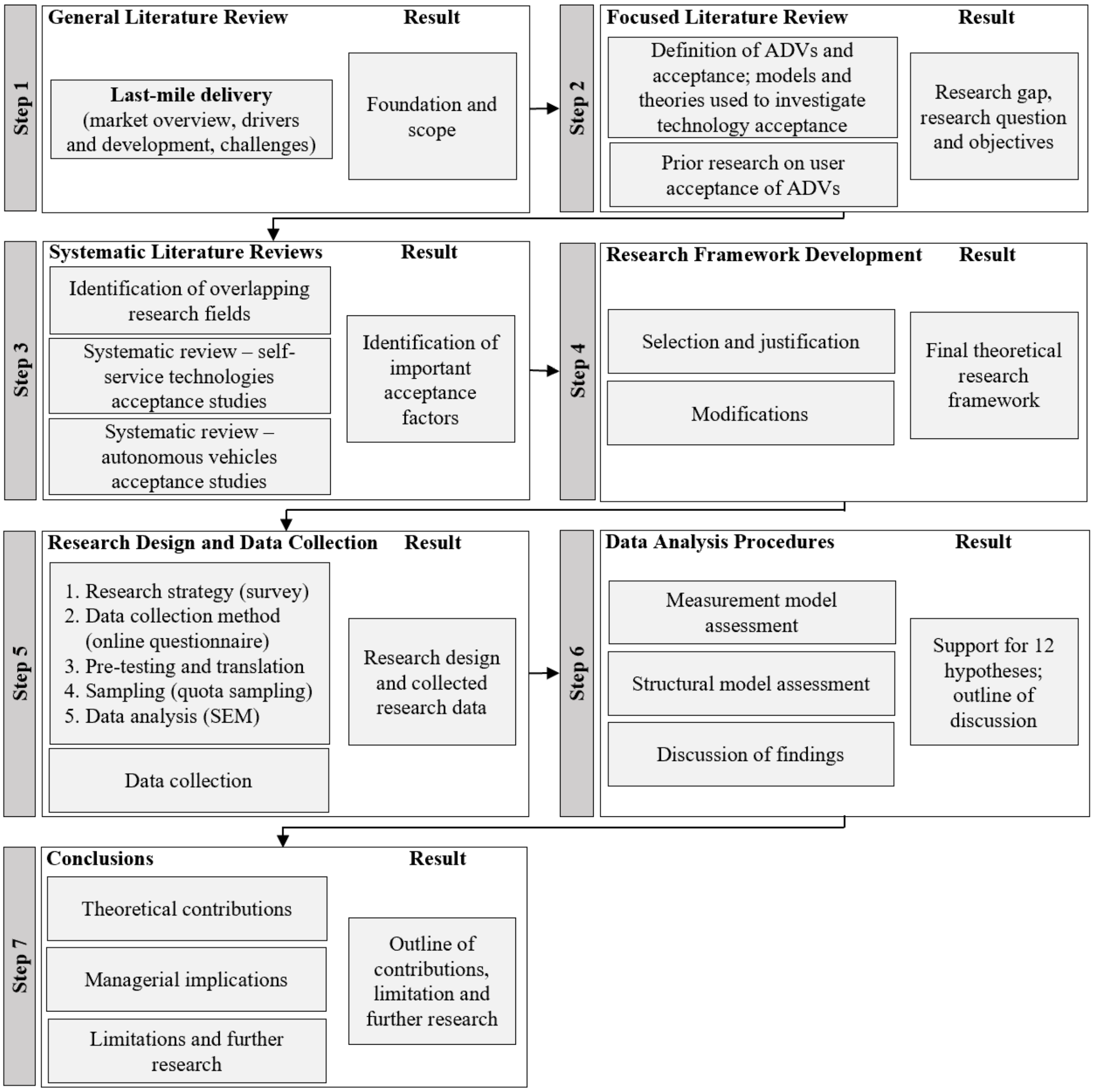

Figure 1.2: Process of Research Project

1.4 Outline of the Thesis

Within this section, the outline of the thesis will be briefly described. Overall, this thesis consists of eight chapters. ***Chapter 1*** includes the background and significance of this thesis, the research question and objectives, as well as the research process.

Chapter 2 includes the definition of ADVs and user acceptance as well as the review of eight models and theories dominantly used to explain technology acceptance in various fields. In addition, it encompasses previous research studies in the field of user acceptance of ADVs and the identification of overlapping research fields. Moreover, this chapter comprises two systematic literature reviews (area of SSTs and AVs) as well as the analysis of the literature found. Additionally, the theoretical findings will be consolidated and discussed. Finally, the selection and justification of the underlying research model (i.e., UTAUT2) is presented and the originality of the research, including the research gaps, are outlined.

Chapter 3 comprises the theoretical research framework development. This includes the presentation of the theoretical research framework and its various constructs. Furthermore, the framework modifications and extensions are presented and discussed, followed by the presentation of the summary of the research hypotheses and construct definitions. Finally, the theoretical research framework and the operationalisation of its constructs is shown.

Chapter 4 encompasses the underlying research methodology. This includes the research philosophy, the research approach, as well as the research design applied, which in turn includes the research strategy, the data collection method, the sampling strategy, as well as the data analysis techniques applied. Within this chapter, each methodological choice will be presented with a clear reasoning.

Chapter 5 comprises the descriptive data analysis, including the data screening procedures and the descriptive statistics (i.e., data normality, demographic characteristics and profiles, as well as the measures of central tendency and variability). Moreover, the answers to the open question in the questionnaire are presented and discussed.

Chapter 6 includes the structural equation modelling analysis. Starting with the presentation of the goodness-of-fit indices, followed by the evaluation of the measurement model analysis (model fit, inspection and modification procedures, construct validity) and the structural model analysis (structural model fit, hypotheses testing). Chapter 6 also includes the re-estimation of the theoretically developed research framework, which in turn includes the measurement model analysis as well as the structural model analysis. As such, the final "Autonomous Delivery Vehicle Acceptance Model" could be developed.

Chapter 7 summarises and discusses the findings of the descriptive analysis of chapter 5 as well as the findings of the structural equation modelling analysis of chapter 6 in regard to the research question and previous research that has been presented in chapter 2 as well as the hypotheses presented in chapter 3. This includes the discussion of the verified Autonomous Delivery Vehicle Acceptance Model (ADV-AM) and its underlying relationships. Moreover, the insignificant paths of the theoretically developed research framework are discussed. Furthermore, the applicability of UTAUT2 in the context of ADVs for last-mile delivery will be discussed.

Chapter 8 comprises an overall summary of the research study and its findings. Also, it includes the presentation of the theoretical contributions and managerial implications. Finally, this chapter also presents the limitations of this research study and shows potential research areas that can be further investigated in future research.

1.5 Conclusion

Within this chapter, the underlying PhD thesis was introduced. It was outlined that the current last-mile delivery practices are not believed to be able to cope with the enormously growing e-commerce, the increasing governmental restrictions as well as the rising customer demands efficiently. In this context, ADVs are stated to be more efficient, sustainable, as well as customer-focused. Despite its potential, little research exists on the user acceptance of ADVs. This gap will be filled by answering the research question and fulfilling the research objectives of this thesis. Finally, this chapter presented the research process and showed the outline of the thesis.

Chapter 2: Literature Review

2.1 Introduction

In the following, the concept of autonomous delivery vehicles (ADVs) will be defined and presented. Next, the term "user acceptance" will be reviewed and defined for this research project. As a result, an operational definition will be presented. Afterwards, a review of the eight models and theories previously utilised to explain technology acceptance in various fields will be presented. This includes general assumptions underlying the models and theories, empirical evidence, as well as model and theory limitations. In addition, the Unified Theory of Acceptance and Use of Technology (UTAUT) and its extension (UTAUT2), which incorporates all eight models and theories into one unified model, will be presented. This is followed by a brief summary of all discussed models and theories.

Furthermore, previous research related to this research project will be presented. This includes not only the research conducted in the area of user acceptance of autonomous delivery vehicles (ADVs) but also in the areas of user acceptance of self-service technologies (SSTs) as well as user acceptance of autonomous vehicles (AVs) in general (e.g., autonomous cars). Following the analysis of the previous literature, a consolidation and discussion of the theoretical findings will take place. Next, the selection and justification of the research model utilised in this study will be outlined. Finally, this chapter will close with the originality of the research and the major research gaps identified that will be filled within this research.

2.2 Definition and Classification of Autonomous Delivery Vehicles

In this thesis, autonomous delivery vehicles (ADVs) are defined as electric and self-driving ground vehicles that drive on sidewalks and streets with approximately 5 – 10 km/h. They are equipped with various cameras, sensors, and GPS (global positioning system) for navigating, security, and safety reasons (Lee *et al.*, 2016; Marsden *et al.*, 2018). This enables ADVs to manage all driving tasks by themselves without human intervention. In other words, they are "capable of navigating in a road network, detecting obstacles in the surroundings, and running safely without human intervention" (Piao *et al.*, 2016, p. 2169).

Considering the characteristics of ADVs, the main mean behind those vehicles is the service delivery. In other words, ADVs are designed to deliver parcels and other smaller goods like groceries to the doorstep (Marsden *et al.*, 2018). Since this service delivery is based on a human – technology interaction through an online interface (i.e., mobile app), ADVs are considered to be a self-service technology (SSTs) in the context of last-mile delivery.

ADVs will only start their delivery journey when the recipient has set the date and timeslot in which he/she wants to receive the ordered goods (e.g., groceries). Once the ADV arrives at the delivery destination, the recipient receives a message through the mobile app to collect the orders. To authorise and to open the locker of the vehicle the recipient must connect their smartphone via Bluetooth to the vehicle. Additionally, help and support can be utilised via the mobile app or, depending on the type of ADVs, directly through the interface of the vehicle. Once the delivery is completed, the vehicle continues its delivery journey or returns to the urban hub, depending on the type of ADV (Lee *et al.*, 2016; Marsden *et al.*, 2018).

In general, two types of ADVs can be differentiated (Joerss *et al.*, 2016): first, small ADVs (i.e., parcel delivery robots) that have only one locker in which they can carry goods; and second, larger ADVs that are equipped with several lockers (see Figure 2.1).

a

b

Figure 2.1: Small ADV (a) (Starship Technology, 2017) and Large ADV (b) (Hochschule Heilbronn, 2019)

Both types of vehicles try to fill a certain niche in the market of last-mile delivery. On the one hand, small ADVs are considered to fill the niche for instant delivery in urban areas with a high density. This is the case because they can only carry one parcel at a time as well as travel only a restricted distance (i.e., 5 – 30 minutes) from their base station (i.e., urban hub) due to battery limitations. On the other hand, larger ADVs can carry more than one parcel and therefore are generally considered as an alternative to today's last-mile delivery practices. These are not only suitable for high density urban areas and average density areas but also for certain parts of rural areas with a generally low average density (Joerss *et al.*, 2016). See Figure 2.2 for an overview of potential operation sites.

Increasing drop density/decreasing costs →

Product categories	Rural areas with low to average density²	Urban areas with average density³	Urban areas with high density⁴
Regular parcel¹			
High reliability shipments		Large ADVs with several lockers	
Same day			
Instant			Small ADVs (parcel robots)

1) between order day + 1 day until delivery and order day + 4 days until delivery; 2) below 50,000 inhabitants; 3) 50,000 – 1 million inhabitants; 4) above 1 million inhabitants

Figure 2.2: Operation Sites of Small and Large ADVs adopted from Joerss et al. (2016)

Compared to conventional last-mile delivery services, the use of ADVs offers several benefits, mainly to three stakeholder groups. From the logistics service providers perspective, ADVs are able to operate more cost efficiently due to the substitution of labour as well as the elimination of the inefficiency caused due to failed and re-deliveries (Joerss *et al.*, 2016; Jennings and Figliozzi, 2019). From the customer perspective, ADVs make the overall delivery process more flexible and convenient. This is the case because the recipient decides the time and place where the delivery takes place; therefore, ADVs are more customer-focused (Marsden *et al.*, 2018). As such, ADVs avoid the need to wait at home for deliveries, which directly reduces unnecessary opportunity costs (i.e., waiting time) because they can engage in other activities rather than waiting. Finally, from a societal perspective, ADVs minimise the negative externalities (e.g., local air pollutions) due to the use of electric power instead of fuel energy (Joerss *et al.*, 2016; Marsden *et al.*, 2018).

At present, there are already several organisations and institutions working on the development of small ADVs for last-mile delivery. Amongst others, these are Starship Technology (co-founder of Skype) (Starship Technology, 2017), Dispatch (MIT and Pennsylvania University) (Dispatch, 2019), and Marble (Marble, 2019). However, only a few organisations and institutions have developed larger ADVs with several lockers: for instance, the ADV developed by Nuro (Nuro, 2016), which is an American robotics firm, or the ADV developed by Heilbronn University of Applied Sciences. Nuro's delivery vehicle has four large lockers (two on each side), whereas the vehicle from Heilbronn University of Applied Sciences has sixteen lockers (eight on each side; see Figure 2.1b), which makes the delivery process even more efficient. To date, the ADV developed by Heilbronn University of Applied Sciences is the first large autonomous vehicle, to the best of my knowledge, that has been tested for several logistical purposes (e.g., parcel delivery and reverse logistics) in a real urban environment at the event area of the federal gardening show in Heilbronn (Germany) in 2019.

2.3 Definition of User Acceptance

The term "acceptance" is used in everyday life. It is used not only when new product innovations failed or city misplanning took place but also when political announcements were withdrawn or television shows were dropped (Lucke, 1995; Kollmann, 1998). Eventually, it became a buzzword in society as well as in academia. Due to this general use in society and the interdisciplinary use in academia, a heterogeneous variety of definitions has occurred over the last decades (Nabih *et al.*, 1997; Adell, 2010; Adell *et al.*, 2017). This led to the fact that the term "acceptance" is often used as synonymous or intermingled with constructs like adoption, diffusion, or tolerance (Nabih *et al.*, 1997; Williams *et al.*, 2009). However, this unfortunate mixture makes it even harder to define what acceptance actually is and led not only to theoretical confusion but also to misinterpretations in the acceptance research (Nabih *et al.*, 1997; Williams *et al.*, 2009). Therefore, within this thesis it is imperative to provide a clear operational definition of user acceptance.

As already stated, there are various acceptance definitions discussed in the literature, for instance, attitudinal and behavioural acceptance (Kollmann, 1998; Kollmann, 2000) or social and practical acceptance (Nielsen, 1993). According to Adell (2010), who investigated the occurrence of acceptance definitions, acceptance definitions can be classified into five categories: (1) use of the word accept; (2) satisfying needs and requirements (i.e., usefulness of the system); (3) sum of all attitudes; (4) willingness to use; and (5) actual use. Viewing the acceptance categories in this way, they might to some extent be seen as a continuous process (Adell, 2009, 2010). Starting from assessing the usefulness of a system towards the actual use of a system. The latter categories include the earlier ones (see Figure 2.3). However, this continuous view cannot include category 1, where acceptance is defined only with the word "accept" (Adell *et al.*, 2017; Adell, 2010). Moreover, these classifications of acceptance definitions suggest that acceptance is a multifaceted concept, and due to the selection of only one category, the scope of the definition is limited (Rahman *et al.*, 2018).

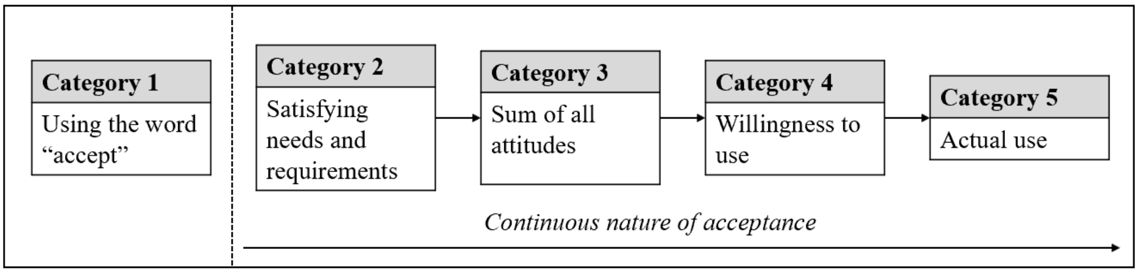

Figure 2.3: Definition Categories of Acceptance adopted from Adell (2009, p. 28)

Working on user acceptance of ADVs makes it crucial to understand the user-centred view, since the user decides to use or not use ADVs as a delivery alternative. Acceptance lies on the individual decision of a person; therefore, it is based on individual attitudes, experiences, expectations, and subjective evaluations of the system as well as the effects of using it (Schade and Baum, 2007). A misunderstanding of ADVs will very likely influence user acceptance as much as an accurate conception. Even though it is not possible to assess the use of a system that is still in the development stage, as it is the case with ADVs, it is desirable to predict user acceptance of ADVs as early as possible in the development process to be able to identify and overcome obstacles as well as evaluate different alternatives (Kollmann, 1998; Adell, 2009). However, it needs to be borne in mind that predicting user acceptance at this stage of technological development and introduction does not necessarily mean that potential users use the system when available. Within this thesis, the following definition, adopted from Adell (2010), is proposed for the context of user acceptance of ADVs for last-mile delivery:

User acceptance is defined as the degree to which an individual intends to use ADVs as a delivery option, when available, and incorporates it into his/her everyday life.

This definition focuses on the intention rather than the actual behavioural use; therefore, it can be utilised early in the development process of new technologies, which is necessary in this study. Nevertheless, it also shows that intention may lead to actual use behaviour in the future. Furthermore, this definition incorporates the user-centred view of acceptance. Finally, it implies that there are various degrees of user acceptance, and therefore it is not limited to acceptance or rejection; rather it has a more continuous nature (Adell, 2010; Adell *et al.*, 2017).

2.4 Theories and Models of Technology Acceptance

After precisely defining ADVs as well as the term "user acceptance" for this research study, the following subchapters will present a variety of theories and models used to predict, explain, understand, as well as assess user acceptance of technological innovations. In doing so, it will focus on three major disciplines that have contributed to the development of technology acceptance, adoption, and usage theories: social psychology and sociology, which focuses mainly on the process of how user acceptance evokes; and information systems, which mainly focuses on the constructs that contribute to user acceptance on an individual level.

On one hand, for instance, social psychology contributed the *Theory of Reasoned Action (TRA)* (Ajzen and Fishbein, 1975). Yet, it was extended to the *Theory of Planned Behaviour (TPB)* (Ajzen, 1985). On the other hand, information systems contributed the *Technology Acceptance Model (TAM)* (Davis, 1985; Davis *et al.*, 1989), which used the *TRA* as a foundation, and yet has a couple of extensions like the *TAM2* (Venkatesh and Davis, 2000) and *TAM3* (Venkatesh, 2000) as well as the most recent theory regarding user acceptance of technology, the *Unified Theory of Acceptance and Use of Technology*

(UTAUT 1-2) (Venkatesh *et al.*, 2003; Venkatesh *et al.*, 2012), which is an aggregation of various theories and models from different disciplines. Moreover, *UTAUT* not only focuses on the aforementioned theories but also on theories regarding the adoption of technology, like *Diffusion of Innovation (DOI)* (Rogers, 1983, 2003), or user centric theories, like the *Social Cognitive Theory (SCT)* (Bandura, 1977), the *Motivational Model (MM)* (Deci and Ryan, 1985), and the *Model of PC Utilization* (Thompson *et al.*, 1991). Even though, most theories were applied to consumer contexts, Venkatesh *et al.* (2012) have developed the *UTAUT2* explicitly for investigating technology acceptance in a consumer context.

To obtain an overview as well as a more in-depth understanding of all models and theories unified in the UTAUT/UTAUT2, they will be presented in the following by stating their core assumptions as well as empirical justification. Moreover, if discussed in the literature, their major limitations will also be presented. At the end of this chapter, a brief summary of the presented theories and models is outlined.

2.4.1 Theory of Reasoned Action

The Theory of Reasoned Action (TRA) developed by Ajzen and Fishbein (1975) originates from the field of social psychology. The theory development can be traced back to the period between 1918 – 1970, when researchers tried to explain the impact of attitudes on individuals' behaviour (Al-Qeisi and Al-Abdallah, 2013). However, the contributions of the influence of attitude on behaviour were rather inconsistent. On one hand, it was argued that attitude had either a direct or indirect effect on behaviour; on the other hand, it was believed to be a unidimensional or multidimensional construct (Ajzen and Fishbein, 1980). By developing the TRA, Ajzen and Fishbein (1980, p. 4) aimed at overcoming this problem by introducing the construct behavioural intentions (BI) and thereby developing a theory that "could explain virtually any human behaviour".

One of its core assumptions is that "human beings are usually quite rational and make systematic use of the information available to them" rather than being controlled by unconscious motives (Ajzen and Fishbein, 1980, p. 5). Thus, people consider the implications of any actual behaviour in advance to their engagement (Ajzen and Fishbein, 1980).

The theory defines relationships between salient beliefs, attitudes, norms, intentions, and behaviour (Ajzen and Fishbein, 1980). According to the theory, the main premise is that actual behaviour (i.e., in the case of technology acceptance research: use or rejection of the technology) is directly determined by the intentions rather than attitudes to perform that behaviour. However, Ajzen and Fishbein (1980) bear in mind that this correspondence is not always believed to be perfect; they argue that when "barring unforeseen events, a person will usually act in accordance with his or her intention" (Ajzen and Fishbein, 1980, p. 5). Therefore, intention can be seen as the individual's measure of the strength of his or her intention to perform a particular behaviour (Davis *et al.*, 1989).

Since the theory does not only want to predict but also explain human behaviour, it is posited that behavioural intention itself is a function of two constructs: attitude toward the behaviour, which is of personal nature, and subjective norm, which reflects the social influences (Ajzen and Fishbein, 1980). Attitude toward the behaviour is defined as an "individual's positive or negative evaluation of performing the behavio[u]r" in question (Ajzen and Fishbein, 1980, p. 6). In more detail, one's attitude "is determined by beliefs about the consequences of the behaviour and the affective evaluation of these consequences" (Dillon and Morris, 1996, p. 12). Here, "[b]eliefs are defined as the individual's subjective probability that performing a given behavio[u]r will result in a given consequence" (Ajzen and Fishbein, 1975, p. 29). Affective evaluation is an implicit evaluative response to the consequence; thus, the attitude construct is stated to be general in nature and not fixed to any given belief set (Ajzen and Fishbein, 1975). External stimuli influence the attitude construct through adjustments in the person's belief structure (Ajzen and Fishbein, 1980). Subjective norm is defined as a person's perception of the social pressure from important referent others to perform the behaviour (Ajzen and Fishbein, 1980). Thus, it is "determined by an individual's normative beliefs and motivation to comply with perceived norms" (Dillon and Morris, 1996, p. 12).

Both attitude and subjective norms are believed to be important determinants of behavioural intention. However, the attitudinal considerations may in some cases be more important than the normative ones in forming intention, or the other way around (Ajzen and Fishbein, 1980). Thus, the determinants are relatively independent to each other. Furthermore, the relative weights of both determinants maybe different from person to person. To sum it up, Ajzen & Fishbein (1980) generally believe that the use of attitude and subjective norm are sufficient to determine actual behaviour (see Figure 2.4).

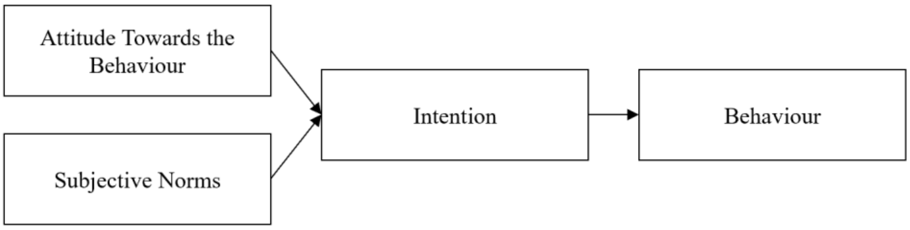

Figure 2.4: Theory of Reasoned Action adopted from Ajzen and Fishbein (1980, p. 8)

Since its development, the TRA has been used extensively in various fields to explain one's individual behaviour (Davis, 1985). Not only was it successful in situations like voting in an election (Bowman and Fishbein, 1978), predicting the consumption of alcohol (Schlegel *et al.*, 1992), and watching electronic sports (Xiao, 2019), but also did it provide accurate results in the field of technological usage (Taylor and Todd, 1995b). Sheppard *et al.* (1988) conducted a meta-analysis and analysed 87 studies that utilised the TRA to test the utility of the proposed constructs. As a result, they were able to support the model. A more recent meta-analysis by van den Putte (1991) supports these findings. Overall, it can be stated that the theory of reasoned action "was exceptionally robust and offered strong predictive utility, even when used to investigate situations and activities falling outside the original boundary conditions of the theory" (Dillon and Morris, 1996, p. 13).

Despite the wide use of the theory in behavioural and acceptance studies, it also has certain limitations that should be addressed. The greatest limitation is that the theory is restricted to correspondence (Ajzen, 1985). In this regard, Sheppard *et al.* (1988) state that in order for the theory to predict a specific behaviour, attitudes and intentions must agree not only on action, target, context, and period but also on specificity. Thus, the theory assumes that the behaviour is completely under volitional control and therefore applies only to behaviours that are thought out in advance of the action, consciously. Consequently, impulsive and irrational decisions as well as habitual actions, or any other behaviour that is not consciously considered is not captured within this theory (Bentler and Speckart, 1979). Furthermore, the TRA has also been criticised in terms of its comprehensiveness (Hale *et al.*, 2002). According to Ajzen and Fishbein (1975) variables that are not explicitly specified in the theory are external variables that can influence behavioural intention only through attitudes or subjective norms. However, detractors have argued that attitude and subjective norm are not sufficient to predict behavioural intention directly or behaviour indirectly, and other constructs like affect might improve the model's explanatory power (Hale *et al.*, 2002).

2.4.2 Theory of Planned Behaviour

Considering the critique and major limitation of the TRA – that the theory is only applicable when the behaviour is totally under volitional control – Ajzen (1985) proposed the theory of planned behaviour (TPB). The TPB is an extension of the TRA and was specifically developed for situations where the behaviour is not totally under volitional control (Ajzen, 1985, 1991). In fact, the only difference between these two theories – the TRA and the TPB – is the incorporation of perceived behavioural control (PBC) (see Figure 2.5) within the more general model of beliefs, attitudes, intentions, and behaviours, which has received a great deal of attention in theories and models related to social cognition (Armitage and Conner, 2001).

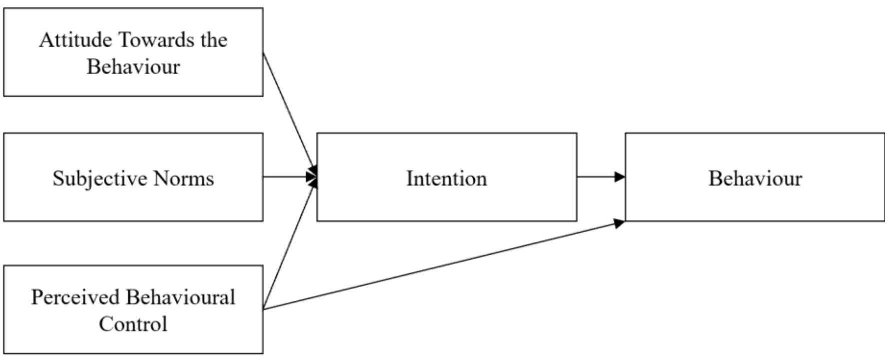

Figure 2.5: Theory of Planned Behaviour adopted from Ajzen (1991, p. 182)

Perceived behavioural control "is determined by the availability of skills, resources, and opportunities, as well as the perceived importance of those skills, resources, and opportunities to achieve outcomes" (Dillon and Morris, 1996, p. 16). It is a function of control beliefs as well as the power perceived (Hale *et al.*, 2002). In this regard, it is believed to be most compatible with Bandura's (1977) concept of self-efficacy (Ajzen, 1991). This construct is concerned with the "judgement of how well one can execute courses of action required to deal with prospective situations" (Bandura, 1982, p. 122). Although Ajzen (1991) postulates that PBC and self-efficacy are synonyms, there are several authors who plead in favour for a distinction between these two constructs (Armitage and Conner, 2001; Dillon and Morris, 1996). For instance, Bandura (1992) has argued that self-efficacy focuses more on the cognitive perceptions of control, which is based on internal control factors, whilst perceived behavioural control also mirrors more general external facets.

In addition to the existing relationships of the TRA (subjective norms, attitudes → intention → behaviour), Ajzen (1991) proposes that PBC does not only determine behavioural intention but also behaviour directly. As stated in the TRA, if a person has control over the behaviour or action, intentions are believed to be efficient to predict behaviour. However, in situations where behavioural intentions account only for a limited variance in behaviour, it is stated that perceived behavioural control should be independently predictive of behaviour (Ajzen, 1991). Therefore, it is postulated that both intentions as well as PBC are important in predicting behaviour. However, it is also argued that depending on the prevalence of certain conditions one construct may be more important than the other (Ajzen, 1991).

Similar to the TRA, the TPB has also been applied extensively in many different fields. It has not only been used to examine weight loss (Schifter and Ajzen, 1985) and to examine information systems (Taylor and Todd, 1995b; Mathieson, 1991) but also as a foundation to investigate the acceptance of autonomous vehicles (Angelis *et al.*, 2017; Chen and Yan, 2018) or self-service technologies (Herrero Crespo and Rodriguez del Bosque, 2010; Al-Ajam and Md Nor, 2015; Yeap *et al.*, 2016). According to the meta-analysis conducted by Armitage and Conner (2001), the main premises of the theory could be verified. However, they also found that PBC only contributed on average two percent to the variance in behaviour. This small explanatory power can be explained by the fact that PBC is not a predictor for every behaviour (Ajzen and Fishbein, 2005). If the behaviour is under volitional control, the intention itself is enough to predict a specific behaviour accurately. However, if the behaviour is not completely under volitional control, then the construct can increase the explanatory power of the model (Madden *et al.*, 1992). This is believed to be the reason why the explanatory power is fluctuating in certain investigations (Notani, 1998).

Even though Ajzen tried to improve the TRA with PBC to overcome the main criticism of volitional control, authors have found additional limitations to their theory. First, the theory has been criticised for incorporating only one aggregated variable (i.e., PBC) to answer all non-controllable elements of the behaviour (Taylor and Todd, 1995a). However, through the aggregation it is not possible to identify individual factors that specifically determine behaviour. Second, and just like the criticism on the TRA, the TPB has also been criticised in regard to its comprehensiveness, and it is believed that other constructs like habit might also predict intentions and behaviour (Eagly and Chaiken, 2011; Hale *et al.*, 2002). Third, the theory has been criticised in regard to its positive relationship between PBC and BI. However, it is only reasonable for positively valanced behaviours and not for negatively valanced behaviours (Hale *et al.*, 2002; Eagly and Chaiken, 2011). In other words, when a person is positively disposed towards a certain behaviour and perceives that he/she has control over it, it might cause a change of intentions. However, even though a person perceives that he/she has control over a certain behaviour, he/she might still not change his/her intention if he/she is negatively disposed towards that behaviour (Hale *et al.*, 2002).

2.4.3 Technology Acceptance Model (1-3)

Despite the aforementioned general theories that were developed to explain “virtually any human behavio[u]r“ (Ajzen and Fishbein, 1980, p. 4), Davis (1985) proposed the Technology Acceptance Model (TAM). The TAM, which is based on the TRA, was specifically developed for the prediction of the acceptance of computer information systems (Venkatesh *et al.*, 2007). The model incorporates accumulated findings from over a decade of information systems research (Davis *et al.*, 1989).

The goal of the TAM was to predict and explain user acceptance for a range of computer technologies before users had experience with such systems (Dillon and Morris, 1996), whilst at the same time offering a parsimonious and theoretically justified model (Davis *et al.*, 1989). Thus, the model is helpful for researchers and practitioners simultaneously by identifying why a particular system might not be accepted and pursue appropriate corrective steps. One of the key purposes of the TAM is, therefore, to provide a foundation of the impact of external factors (Davis *et al.*, 1989). Thus, the attempt was to identify a few fundamental factors, which were identified in previous research, that deal with the cognitive as well as affective factors of computer acceptance. In this context, the TRA was only used as a theoretical foundation for the relationships among those variables (Davis *et al.*, 1989).

The main constructs in TAM are perceived usefulness (PU) and perceived ease of use (PEOU) (Davis, 1985). Davis (1985) postulates that these two constructs are sufficient to determine technology acceptance. On one hand, PEOU "represents the extent to which a person believes that using a technology will be free of physical and mental effort" (Davis, 1985, p. 26). He found support for this construct in a meta-analysis by Tornatzky and Klein (1982). They investigated the relationship between an innovations' characteristics and its adoption and found that complexity was a consistent contributor in technology adoption. On the other hand, PU is defined as "the degree to which an individual believes that using a particular system would enhance his or her job performance" (Davis, 1985, p. 26). Support for this construct was found in an exploratory study by Schultz and Slevin (1975). Furthermore, PEOU is postulated to determine PU since the easier a technology is to use (i.e., perceived ease of use), the more useful (i.e., perceived usefulness) it can be (Davis, 1985). Overall, both determine attitude (A), which directly determines the actual usage (Davis, 1985). In contrast to the TRA, Davis (1985) did not include subjective norm into the TAM because of the fact that Ajzen and Fishbein (1975) acknowledge that it is the least understood part of the TRA.

In a later development of the TAM by Davis *et al.* (1989), it is suggested that an individual can perceive a system as useful without forming any attitude toward using it (see Figure 2.6). This is based on the idea that people in an organisational setting will form intentions towards specific behaviours if they believe that this behaviour increases their performance, no matter what positive or negative feelings they may create. This relationship is driven extrinsically. For instance, people with higher performance usually receive rewards like pay increases or promotions (Vroom, 1995). This led to the incorporation of behavioural intention (BI) into the TAM, as originally proposed in the TRA by Ajzen and Fishbein (1980). In line with the TRA, TAM assumes that the effect of external variables are completely mediated by the beliefs PEOU and PU (Davis *et al.*, 1989).

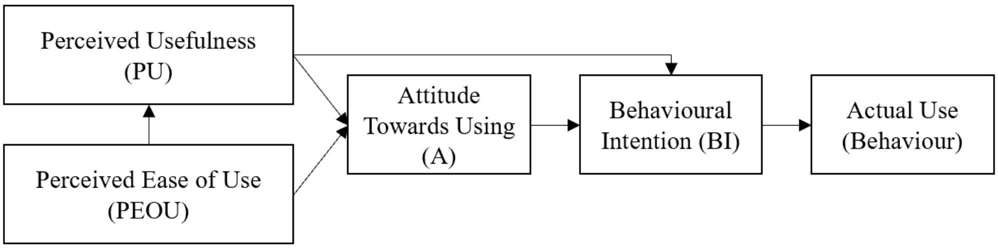

Figure 2.6: Technology Acceptance Model adopted from Davis et al. (1989, p. 985)

Applying the slightly changed model, Davis *et al*. (1989), found empirical evidence for the direct influence of PU and PEOU on BI and as a matter of fact excluded the attitude (A) construct from their model because attitude was only able to partially mediate the effects of PU and PEOU on BI. Even though this contradicts to the TRA structure, this decision finds support by previous research that provides theoretical justification and empirical evidence of a direct relationship between beliefs and BI (Bagozzi and Phillips, 1982). Davis *et al.* (1989) argue that the decision of using an information system is largely cognitive driven. In fact, if the affective facet is not activated completely, attitude, which is based on cognitive and affective facets, will not be able to capture the impact of performance considerations in one's intention (Davis *et al.*, 1989). This led to the final development of the TAM (Davis and Venkatesh, 1996) (see Figure 2.7).

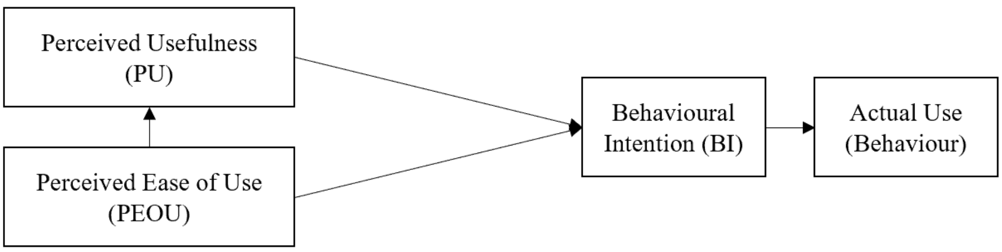

Figure 2.7: Final Technology Acceptance Model adopted from Davis and Venkatesh (1996, p. 20)

To date, the TAM and its adaptations have been used extensively as a theoretical foundation of many empirical studies (Shang and Wu, 2017; Hussein, 2017). Not only was the paper by Davis *et al.* (1989) hugely cited (*The Social Science Citation Index* (2016) indicates 6,800 citations), but the TAM has also been most often used when investigating information systems (29 percent of all studies) (Williams *et al.*, 2009). Overall, TAM has been stated to be highly robust and reliable (Mathieson, 1991; Adams *et al.*, 1992). In fact, in a comparison of a variety of models, TAM was superior compared to the more general theories like the TRA (Mathieson, 1991). This is in line with Venkatesh *et al.* (2007), who stated that TAM is generally speaking more suitable to predict intentions than the TRA.

With the introduction of additional technological innovations and new research areas, the areas where the TAM was applied expanded over the last decades. Although most studies that have applied the TAM focused on the analysis of information technology (Legris *et al.*, 2003), in more recent studies the TAM has also been used as a basis for a variety of other fields. For instance, TAM has been applied to investigate the user acceptance of autonomous cars (Choi and Ji, 2015; Panagiotopoulos and Dimitrakopoulos, 2018; Rahman *et al.*, 2018) or the acceptance of self-service technologies (Hota and Mishra, 2018; Kaushik and Kumar, 2018; Kazancoglu and Kursunluoglu Yarimoglu, 2018). For an additional overview of research fields in which TAM has been applied, see the review by Marangunić and Granić (2015). However, it is worth mentioning that most studies used model extensions to predict acceptance adequately.

Despite the extensive use of the model, it is not without shortcomings (Benbasat and Barki, 2007; Yousafzai *et al.*, 2007; Legris *et al.*, 2003). Typically, the criticism of the TAM can be divided into three main categories: (1) the variables within the model; (2) the theoretical foundation underlying the TAM; and (3) the methodology applied.

(1) The variables within the model. One of the most significant aspects is the criticism on their main constructs (i.e., PEOU and PU). Even though Benbasat and Barki (2007) do not doubt the original intention of Davis (1985) – that he wanted to study the influence of system characteristics – little effort has been drawn on the meaning and the antecedents behind that. In this regard, Benbasat and Barki (2007) argue that it is of little additional value to repeatedly show that some beliefs (i.e., PU and PEOU) are influential without understanding how to influence those. Thus, the constructs are treated mainly as “black boxes” and very few researchers have investigated those (Benbasat and Barki, 2007). In addition to this, TAM has also been criticised in regard to its comprehensiveness. In more detail, it has been stated that TAM has a deterministic approach that does not consider users’ individual characteristics (Agarwal and Prasad, 1998).

(2) **The theoretical foundation underlying the TAM.** Bagozzi (2007) criticised the poor theoretical relationships that were drawn among the constructs used in TAM. He especially doubts the relationship between behavioural intention and behaviour. He stated that behaviour should be a more fundamental goal in TAM research. Thus, behavioural intention is believed to not be representative enough in studying actual behaviour because the time between the formation of behavioural intention and behaviour is considered full of uncertainties, which could influence one's decision to adopt and use a technology. Although the relationship between behavioural intention and behaviour has been proven in many studies, Bagozzi (2007) argues that one's intention could be subjected to reflection and evaluation, which could lead to reformulation of their intentions and finally to a different action.

(3) **The methodology.** Furthermore, not only the model itself but also the chosen methodology for applying it has been criticised (Legris *et al.*, 2003; Lee *et al.*, 2003). Most of the studies used student samples (Legris *et al.*, 2003). On one hand, this is believed to be the case because the data needed is easy to collect; however, on the other hand, the results are not generalisable to a broader population. Furthermore, Legris *et al.* (2003) and Yousafzai *et al.* (2007) argue that students have different motives and motivations, including obtaining grades and rewards. In this context, using employees as samples instead of students involves the disadvantage that the systems are not believed to be generally voluntarily used, which is seen as one of the main requirements for applying the TAM adequately. Furthermore, TAM studies have been criticised for the fact that they use self-reported data to measure the system usage instead of real actual usage data. Some researchers argue that self-reported data is subjectively driven and is thus unreliable for the measurement of actual usage behaviour (Legris *et al.*, 2003; Yousafzai *et al.*, 2007). In addition, using self-reported measures includes the risk of common method bias (Podsakoff *et al.*, 2003), meaning that people will answer in a way that they believe the social norm would answer. Nevertheless, many studies have used self-reported usage data (Lee *et al.*, 2003).

Extensions of the Technology Acceptance Model (TAM 2 and TAM 3):

Taking into consideration the criticism of Benbasat and Barki (2007) that PU and PEOU are seen as "black boxes", Venkatesh and Davis (2000) proposed an extension of the original TAM – the TAM2 (see Figure 2.8).

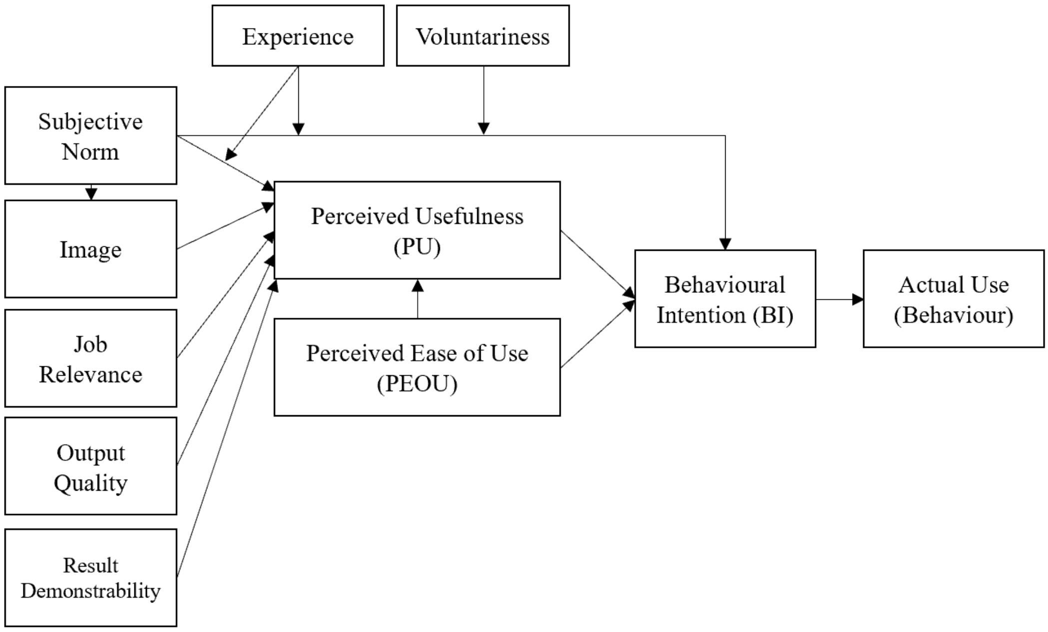

Figure 2.8: Technology Acceptance Model 2 adopted from Venkatesh and Davis (2000, p. 188)

Here, they identified theoretical constructs that could be used to describe the usefulness of a system in detail. These are social influence processes (subjective norm, image, and voluntariness) as well as cognitive instrumental processes (result demonstrability, job relevance, and output quality) (Venkatesh and Davis, 2000). As such, Venkatesh and Davis (2000) were able to provide more detail into the question what makes a system useful in a mandatory as well as a voluntary setting. However, for the construct "subjective norm", an effect on usefulness was only found in a mandatory setting, not in a voluntary one.

Following the extension of TAM to the TAM2, Venkatesh (2000) introduced the TAM3, which tries to explain perceived ease of use in more detail (see Figure 2.9).

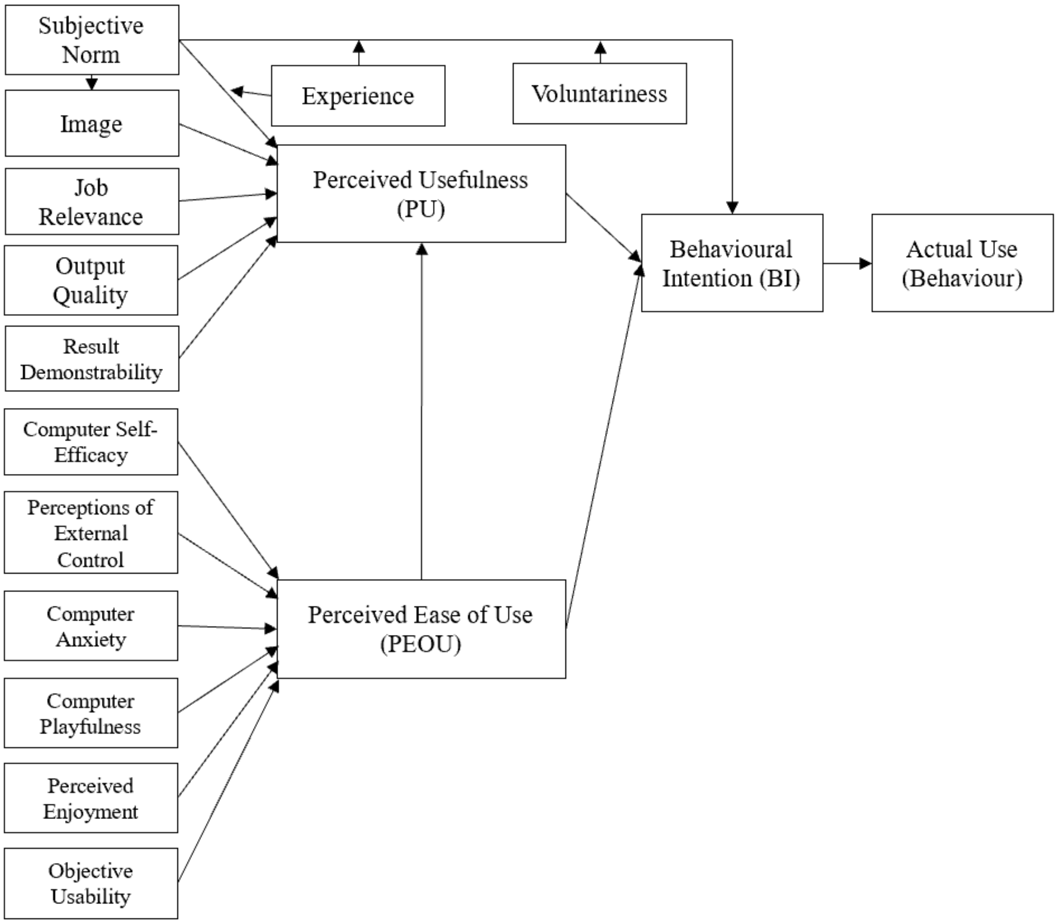

Figure 2.9: Technology Acceptance Model 3 adopted from Venkatesh (2000, p. 357)

Here, they identified two groups of antecedents: anchors and adjustments. Anchors are stated as general beliefs about information systems and computers, whereas, adjustments are based on direct experiences with the technology. Within both groups, Venkatesh (2000) proposed determinants, which have been identified in previous research (Davis *et al.*, 1992; Venkatesh and Davis, 1996). The proposed model was proven in three different organisations with 246 participants. Measurements were taken over a three-month period. The results indicated strong support for the proposed variables used to explain PEOU (Venkatesh, 2000). However, despite its comprehensiveness, neither TAM2 nor TAM3 attracted much attention in the academic literature, which has been found in the extensive literature search in this thesis. Rather some construct (e.g., perceived enjoyment) were studied as direct determinants of behavioural intention instead of PEOU as proposed by TAM3 (Koenig-Lewis *et al.*, 2015b).

2.4.4 Combined TAM

Considering the fact that the TAM and other models used to predict technology acceptance were merely used in situations where participants already had some experience with the technology, Taylor and Todd (1995b) proposed the combined TAM (C-TAM-TPB) to measure whether current acceptance models are suitable to measure acceptance of experienced and inexperienced users. In doing so, they incorporated the beliefs proposed by TAM – perceived usefulness and perceived ease of use – into the general model of TPB (Taylor and Todd, 1995b). Thus, not only attitude and perceived usefulness but also subjective norm, which was not incorporated in the final version of TAM but has been found to have a significant influence in IT usage adoption (Mathieson, 1991; Thompson *et al.*, 1991), and perceived behavioural control are factors of behavioural intention (Taylor and Todd, 1995b) (see Figure 2.10).

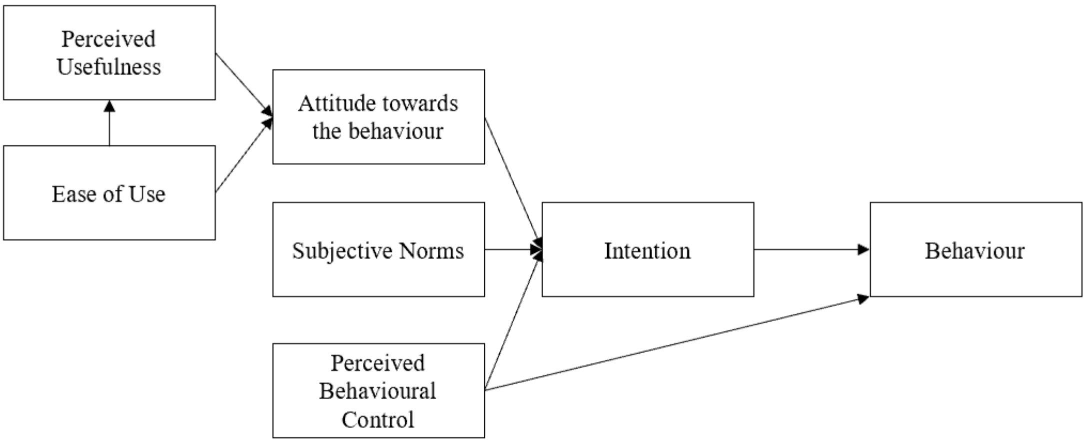

Figure 2.10: Combined TAM adopted from Taylor and Todd (1995b, p. 562)

They could prove that the model is suitable for both user groups; however, the variance of experienced users was not only higher in attitude (21 percent vs. 17 percent) but also in behavioural intentions (60 percent versus 43 percent). Within both groups, all proposed determinants where significant except attitude. Experience is considered to be a moderator within the model. Perceived usefulness, perceived behavioural control, and attitude were all more salient when the amount of experience increased. However, subjective norm decreased with increasing experience (Taylor and Todd, 1995b). Overall, the augmented version of the TAM can be applied to investigate usage behaviour also in situations where users did not have any prior experience with the system, suggesting that technology acceptance models can be used diagnostically prior to implementation. However, compared to the original TAM or the original TPB, the model combination proposed by Taylor and Todd (1995b) did not find much attention in the academic literature and has been applied rarely to investigate technology acceptance. For instance, Chen and Chen (2009) utilised the combined TAM to investigate user acceptance of automotive telematics.

Despite the general ability to prove the model powerful, Taylor and Todd (1995b) critically reviewed their own study and found some limitations. First, the study included only student samples. Thus, the operation of perceived behavioural control and subjective norm might be different in mandatory contexts, like the workplace. Second, other factors that might correlate with experience as a moderator like gender were not included in this study. Thus, for future studies this might be worth considering. Third, the model was only tested within a specific information system program context. Therefore, the results might not be generalisable to other technology contexts (Taylor and Todd, 1995b).

2.4.5 Diffusion of Innovation Theory

Diffusion is postulated as the process “by which an innovation is communicated through certain channels over time among the members of a social system” (Rogers, 1983, p. 5). An “innovation is an idea, practice or object that is perceived as new by an individual or other unit of adoption” (Rogers, 1983, p. 11). Thus, it is not necessary for a product or service to be new in general. It is enough that this product/service is new to a person or context.

Within the context of technology acceptance research, it is stated that the diffusion of innovation theory (DOI) is the most principal theoretical perspective (Dillon and Morris, 1996). The DOI has been applied both on the individual level (Rogers, 1983) and on the organisational level (Zaltman *et al.*, 1973) of analysis. Overall, the DOI provides information on the process that every technological innovation moves through from the stage of invention until extensive use or rejection (Rogers, 1983). Since the theory was not specifically developed for the context of technology acceptance, the model can be applied within a range of areas. In fact, this paradigm can be used to understand the process of diffusion and social change by any discipline (Rogers, 1983). Furthermore, the theory consists of numerous facets that facilitate or hinder technology implementation and adoption (Fichman, 1992), including the innovation-decision process, characteristics of the innovation, as well as the innovators' characteristics.

Innovation-decision process:

The innovation-decision process constitutes the stages through which an individual or any other unit of decision-making has to pass (see Figure 2.11 on the following page). This includes (1) knowledge; (2) persuasion; (3) decision; (4) implementation; and (5) confirmation (Rogers, 1983).

(1) "***Knowledge*** occurs when an individual (or other decision-making unit) is exposed to the innovation's existence and gains some understanding of how it functions.

(2) ***Persuasion*** occurs when an individual (or other decision-making unit) forms a favo[u]rable attitude toward the innovation.

(3) ***Decision*** occurs when an individual (or other decision-making unit) engages in activities that lead to a choice to adopt or reject the innovation.

(4) ***Implementation*** occurs when an individual (or other decision-making unit) puts an innovation into use.

(5) ***Confirmation*** occurs when an individual (or other decision-making unit) seeks reinforcement of an innovation-decision already made, but he or she may reverse this previous decision if exposed to conflicting messages about the innovation." (Rogers, 1983, p. 164).

Although it is called an innovation decision process, the steps can sometimes not be clearly differentiated because they blend into each other. Rogers (1983), therefore, states that a clear distinction between the stages proposed should not be expected. Furthermore, the length of the steps might be different from person to person. He postulates that the differences in the length of adoption are partly related to the characteristics of the innovator as well as the innovation itself.

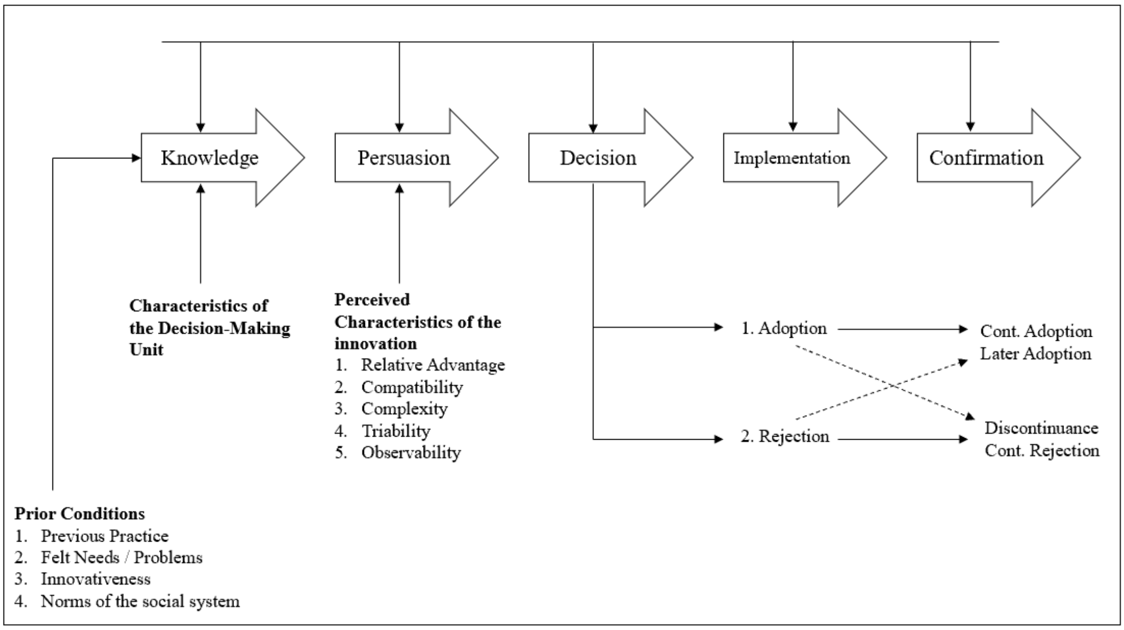

Figure 2.11: Innovation Diffusion Process adopted from Rogers (1983, p. 165)

Perceived characteristics of the innovation:

In previous diffusion research, the focus was on the "user" and not on the innovation itself (Rogers, 1983). Thus, innovations were equally treated from the perspective of their analysis. Rogers pointed out this oversimplification and stated its incorrectness. He developed a standard classification scheme of perceived characteristics of an innovation but emphasised the importance that the measures are not universal and should be developed within each study rather than using existing scales from previous research (Rogers, 1983).

The Diffusion Theory (DOI) posits five characteristics of innovations that might affect their diffusion (Rogers, 1983):

(1) ***Relative advantage*** is defined as being superior to already existing products/services.

(2) ***Compatibility*** comprises the consistency with social norms, past experiences, and current needs of its users.

(3) ***Complexity*** encompasses the degree of the ease of use regarding a certain innovation.

(4) ***Triability*** describes the degree to which an innovation can be experienced before the final commitment to use it.

(5) ***Observability*** comprises the degree to which the outputs of an innovation is clear to see.

However, Rogers (1983) states that the use of each characteristic on its own is insufficient to predict innovation adoption. Nevertheless, diffusion studies have proven that innovations that afford advantages, include low complexity, are compatible with existing practices and beliefs, can be tested before adopting (i.e., triability), as well as the observability of the advantage of the innovation will generally be more quickly diffused than an innovation that is described by the opposite characteristics (Rogers, 1983). Thus, the combination of those five characteristics is important in predicting innovation adoption.

Types of Innovators:

The diffusion of innovation theory suggest that the characteristics of the adopters are also relevant (Rogers, 1983). Here, Rogers (1983) divides those adopters regarding the time when they adopt a technology or innovation into five categories:

(1) ***Innovators – Venturesome*** (2.5 percent): One of this consumer's salient attributes is venturesomeness. They are not only eager to try and experience new ideas but also have the financial resources to absorb potential losses and the abilities to apply complex technological knowledge.

(2) ***Early Adopters – Respectable*** (13.5 percent): They are believed to be more integrated into the social system than innovators. They are considered as being the opinion leader whom potential adopters ask for advice and information regarding the innovation. Overall, they are also serving as a role model within the social system. This is the reason why change agents use this type of adopter to speed up the diffusion process.

(3) ***Early Majority – Deliberate*** (34 percent): People who are considered to be part of the cluster of the early majority adopt new innovations before the average member of the system. Even though they communicate with their peers on a regular basis, they seldomly hold leadership positions. Nevertheless, the bridging position of the

early majority between the early and the late adopters makes them an important link in the innovation diffusion network.

(4) ***Late Majority – Sceptical*** (34 percent): In contrast to the early majority, the late majority adopts innovations after the average adopter in the social system. Here, the adoption is driven by either economic necessity or peer pressure. Overall, uncertainties need to be removed completely before people belonging in this group feel safe enough to adopt the innovation.

(5) ***Laggards – Traditional*** (16 percent): People who belong in this group are the last to adopt an innovation within the social system. Decisions are taken based on past behaviour. Interactions usually take place only between “traditionals” like themselves. They generally have little financial resources available and thus cannot afford the failure of an innovation. When they finally adopt an innovation, innovators might already try the superior version of the innovation.

By targeting only opinion leaders, marketers believe that other adopters will automatically follow. However, research has indicated that innovators (2.5 percent) are usually more likely to be abnormal social deviants and adopt innovations not based on any rational choice (Sheth, 1981). Thus, for technology adoption the other innovation types are also relevant.

Considering the empirical power, it has been shown in many studies that DOI is a well-researched tool to predict user adoption. For instance, Wang *et al.* (2018a) and Yuen *et al.* (2018) applied the DOI as a theoretical foundation to the context of last-mile delivery and investigated the user acceptance of parcel lockers, and Kapoor *et al.* (2015) investigated user acceptance of online ticketing. Overall, Tornatzky and Klein (1982) found in their meta-analysis that three out of the five characteristics of innovation diffusion play a major role when it comes to innovation adoption: compatibility, relative advantage, and complexity. Whilst they found proof that the first two (i.e., compatibility and relative advantage) are positively related to innovation adoption, the latter (i.e., complexity) is negatively related at marginally significant levels. No significant proof, however, was found for triability and observability. Similar results were found in a more recent meta-analysis by Weigel *et al.* (2014).

Despite its wide spread use, the DOI also has shortcomings, which will be presented in the following. First, authors have criticised the conceptualisations of the constructs. The construct “relative advantage” is not clearly defined. For instance, an innovation could be advantageous because of its low complexity or low price (Tornatzky and Klein, 1982). Second, some research posits that the DOI is at best a descriptive tool and less strong in its explanatory power (Clarke, 2009). Third, DOI has been criticised for its innovation demand perspective rather than focusing on innovation supply (Attewell, 1992). The demand perspective assumes that adoption will occur at a rate governed by the diffusion of knowledge about the innovation and the time needed for the adopters to capture the benefits. Innovation suppliers, however, can influence this because they often launch marketing as well as educational initiatives on specific types of businesses (Attewell, 1992). Additionally, Attewell (1992) points out that for complex innovations, sometimes adoption does not occur even if much information and knowledge is diffused. Finally, Dillon and Morris (1996, p. 10) state that even though the DOI provides information on the diffusion of an innovation over time, it “provides little explicit treatment of user acceptance.” However, the characteristics of an innovation (e.g., the perceived compatibility, etc.) may drive his/her adoption decision. Thus, researchers interested in user acceptance of technology most notably focus on the theoretical work derived from information systems, social psychology, and sociology.

2.4.6 Social Cognitive Theory

Over the years, many theories and models have been developed that aim to explain the developmental changes that people go through over their lifetimes. These theories differ not only in the conceptions of human nature they adopt but also in what they deem to be the basic causes and mechanisms of human motivation and behaviour (Wood and Bandura, 1989). The social cognitive theory (SCT) belongs to the most powerful theories to explain human behaviour (Venkatesh *et al.*, 2003). The theory has its roots in the social learning theory (SLT), which was developed by Miller and Dollard (1941). They were the first to introduce the principle of learning through models. Since then, subsets of models that are based on SLT, with emphasis on cognitive variables, postulate that human cognition is a mediator between stimulus and response. Although a variety of versions of SLTs exists, all share three basic tenets (Al-Qeisi and Al-Abdallah, 2013):

Tenet (1): Reward and punishment (response consequences) influence an individual's behaviour.

Tenet (2): Observational learning, which describes the process in which humans can learn by observing others and through participating in behaviour.

Tenet (3): Humans are likely to model observed behaviour that they identify with themselves or are attached to emotionally.

Several authors have contributed to the SLT, but Bandura (1986) has led the effort in developing the cognitive SLT. To avoid misinterpretations and to differentiate his theory from traditional SLTs, he named his theory "social cognitive theory" (SCT). Within this theory, behaviour is defined as a triadic, dynamic, reciprocal, and bidirectional interaction of cognitive and other personal factors including demographics and personality, the external environment, and the behaviour (see Figure 2.12) (Al-Mamary *et al.*, 2016; Compeau and Higgins, 1999; Wood and Bandura, 1989). Due to "the bidirectionality of influence, people are both products and producers of their environment" (Wood and Bandura, 1989, p. 362). This is contrary to the TPB, TAM, and DOI amongst others, which all assume that there are only unidirectional relationships within their theories and models (see Figure 2.12).

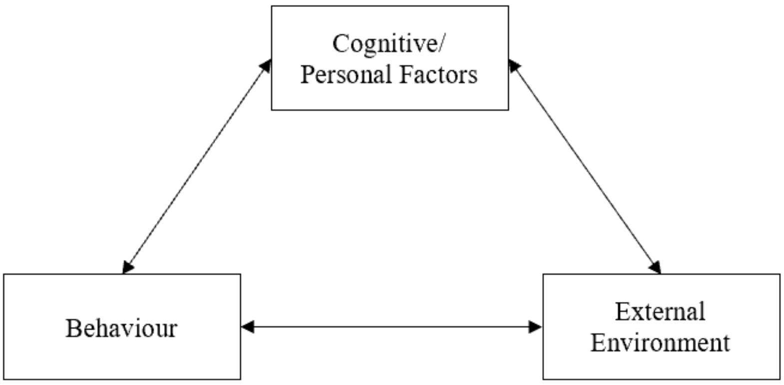

Figure 2.12: Social Cognitive Theory adopted from Wood and Bandura (1989, p. 362)

Observational learning is governed by four key aspects:

(1) ***Attention*** is a process in which people "selectively observe in the profusion of modelling influences and what information they extract from ongoing modelled activities" (Wood and Bandura, 1989, p. 362).

(2) ***Retention*** "involves an active process of transforming and restructuring information about events in the form of rules and conceptions" (Wood and Bandura, 1989, p. 362).

(3) ***Reproduction*** "is achieved through a conception-matching process, in which people's centrally guided patterns of behavior are enacted and the adequacy of their actions is compared against their conceptual model" (Wood and Bandura, 1989, p. 362)

(4) ***Motivation:*** Learners are more likely to conduct specific behaviour if they know that the outcome will be positive (Wood and Bandura, 1989).

Overall, the SCT is considered a model for predicting, understanding, and altering human behaviour. Human behaviour is guided by two sets of expectations, which are believed to be the major cognitive forces within the theory: outcome expectancies and self-efficacy (Compeau and Higgins, 1999). If people believe that a certain behaviour is related to a certain favourable outcome, they are more likely to pursue that behaviour. The second set of expectations – self-efficacy – is one's perceived ability to perform a particular behaviour. Bandura (1977, p. 193) states that self-efficacy, in addition to outcome expectations, must be considered, since "individuals can believe that a particular course of action will produce certain outcomes, but if they entertain serious doubts about whether they can perform the necessary activities, such information does not influence their behavio[u]r."

Similar to other models and theories that aim to predict human behaviour (i.e., TRA or TPB), the SCT is general and broad in nature; therefore, it has been applied to various research fields and proven powerful. These include, but are not limited to, understanding human behaviour in career choices (Lent and Brown, 1994), coaching athletics (Connolly, 2017), organisational behaviour (Bandura, 1988) as well as health promotions (Bandura, 1998). In addition, it has also been applied to areas of behaviour in classrooms including achievement and learning (Schunk, 1989). In information systems research Compeau and

Higgins (1999) applied an extended version of SCT to the research field of computer utilisation.

Despite the wide application in many different research fields and its general validity, it has also been criticised. First, it has been criticised for its definition of self-efficacy. Eastman and Marzillier (1984) believe that there is a fundamental ambiguity in the definition, as Bandura attempts to define self-efficacy expectations independently of outcome expectations. Second, it has been criticised for its proposed interplay of constructs. Due to the triadic, dynamic, as well as reciprocal interaction, it is not clear to which extent each of these factors influence behaviour and whether one is more influential than another. Third, and general in nature, the SCT has been found to be very difficult to apply (Al-Mamary *et al.*, 2016).

2.4.7 Motivational Model

"Motivation concerns energy, direction, persistence and equifinality – all aspects of activation and intention" (Ryan and Deci, 2000, p. 69). Over the years, motivation researchers have identified two main categories of motivated behaviour. They distinguish between extrinsic and intrinsic motivation (Deci and Ryan, 1985; Ryan and Deci, 2000; Davis *et al.*, 1992). On the one hand, "extrinsic motivation refers to the performance of 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). On the other hand, intrinsic motivation "refers to the performance of an activity for no apparent reinforcement other than the process of performing the activity per se" (Davis *et al.*, 1992, p. 1112). Within the body of psychology research, a significant number of studies has supported general motivation theory in explaining behaviour (Venkatesh *et al.*, 2003). Here, many theories and models, based on general motivation theory, have been developed for a specific context. A review of the underlying tenets of these theories can be found in Vallerand (1997).

In the field of motivation theories, the self-determination theory (SDT) by Deci and Ryan (1985) has received a considerable amount of attention. Their theory investigates peoples' "inherent growth tendencies and innate psychological needs that are the basis for their self-motivation and personality integration, as well as for the conditions that foster those positive processes" (Ryan and Deci, 2000, p. 68). What is more, the SDT also investigates social environments that are counteractive towards these tendencies (Ryan and Deci, 2000). The overall theory of self-determination is presented as a continuum (see Figure 2.13).

Besides the two general categories usually considered in motivation research, the SDT encompasses three types of motivation: extrinsic, intrinsic, and amotivation. Deci and Ryan (1985) claim that amotivation (left side of the model) needs to be taken into account to understand human behaviour. Amotivation is defined as "the state of lacking the intention to act" (Ryan and Deci, 2000, p. 72). To the right of amotivation, five classifications of motivated behaviour are considered. Even though many motivational researchers have treated motivation as a unitary concept, those five identified classifications are considered as being distinct types of motivation. On the far right of the continuum, intrinsic motivation is placed, which covers the actions that are done because of their inherent satisfaction. Extrinsic motivation covers the continuum between amotivation and intrinsic motivation and has four distinct characteristics of regulation that are being ordered along a self-determination continuum: external regulation, introjected regulation, identified regulation, and integrated regulation (see Figure 2.13) (Ryan and Deci, 2000).

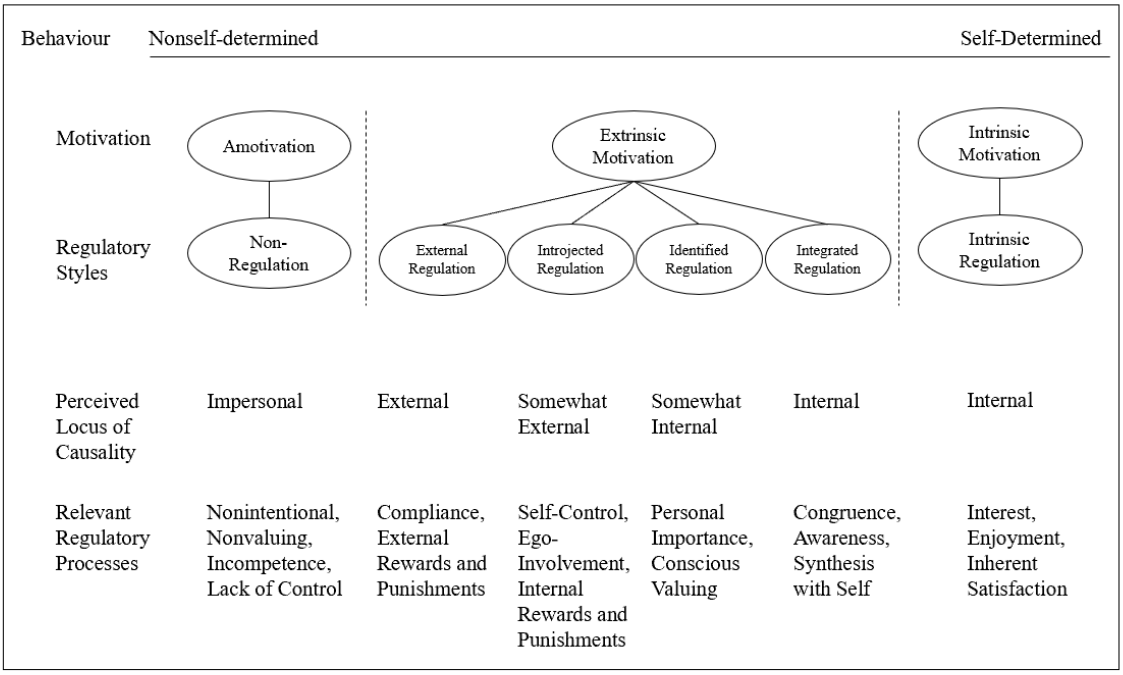

Figure 2.13: Motivational Model adopted from Ryan and Deci (2000, p. 72)

Taking into consideration the SDT from Deci and Ryan (1985), Vallerand (1997) further developed the SDT to the Hierarchical Model of Motivation (see Figure 2.14). Besides the fact, that this model explains motivation along the same SDT continuum, it postulates that motivation operates on three distinct levels: the global level, the contextual level, as well as the situational level. Even though Vallerand (2000) acknowledged a large degree of similarity between the SDT and the Hierarchical Model of Motivation, he explicitly stresses four areas in which the models differ:

1. "The importance of hierarchical structure of motivational processes.
2. The role of psychological needs in the motivational sequence.
3. Individual differences in needs.
4. The different role of the need for relatedness." (Vallerand, 2000, p. 312)

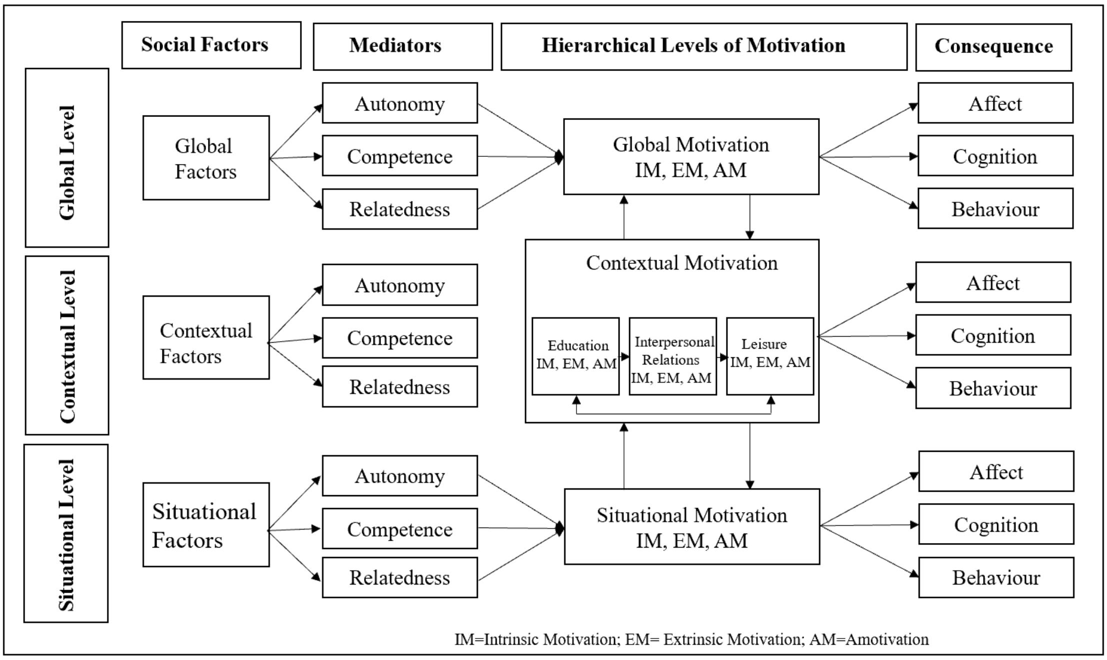

Figure 2.14: Hierarchical Model of Motivation adopted from Vallerand (2000, 313)

The motivation model postulates that motivation needs to be considered from multidimensional perspectives. In doing so, Vallerand (2000) proposed four distinct prerequisites that are pivotal to the hierarchical model. First, he states that all motivations (i.e., intrinsic motivation (IM), extrinsic motivation (EM), as well as amotivation (AM)) that play a crucial role in an individual's psychological processes, should be taken into consideration when measuring motivation. Second, all of these prerequisites (i.e., IM, EM, and AM) exist at three different levels: global (i.e., most general; person's personality), contextual (i.e., specific life context), and situational (i.e., most specific; here and now motivation). Third, it is assumed that motivation at any given level results from environmental conditions and social factors as well as the transformation of motivation between the three levels, meaning that global motivation can influence contextual motivation that can influence situational motivation (top-down effect). What is more, the impact of social factors is assumed to be mediated by an individual's own perception of competence, autonomy, and relatedness at any level. Fourth, there is also a recursive effect. This means, that lower levels can influence the upper levels. For instance, the influence of global motivation is stronger on the contextual level than on the situational level. Finally, the outcome of motivation is believed to carry cognitive, affective, and behavioural consequences at each level (Vallerand and Lalande, 2011; Vallerand, 2000).

Motivation theory has been applied in many research fields. For instance, within the domain of information systems, Davis *et al.* (1992) applied motivational theory based on Deci and Ryan's (1985) intrinsic and extrinsic motivation, to understand users' motivation of utilising information systems at the workplace. From this view, extrinsic motivation is supported by expected rewards (e.g., raise of bonus) provided through the technology's usefulness in achieving these goals. In this context, intrinsic motivation refers to enjoyment of using information systems regardless of their outcome. As found in other information systems studies (Davis *et al.*, 1989), the primary finding was that behavioural intention to use computers at the workplace is mainly influenced by people's perceptions of usefulness of the information systems for improving their job performance and only in a second step by the degree of enjoyment. Furthermore, the interaction effect observed between usefulness and enjoyment was greater when those information systems were perceived to be more useful (Davis *et al.*, 1992). Thus, by increasing the enjoyability of a certain system, one is able to enhance the acceptance, however, only for systems that are believed to be useful. If a system is believed to be useless, increasing its enjoyability does not affect its acceptance (Davis *et al.*, 1992). Additional studies in the information technology field have also been conducted (Igbaria *et al.*, 2016; Venkatesh and Speier, 1999).

Despite the use of motivational theories in various contexts, these theories are not without criticism. For instance, the self-determination theory by Deci and Ryan (1985) has been criticised because it differentiates only between the global and the individual level without resulting into an integrated model (Vallerand, 1997; Schäfer, 2011). This criticism was solved by Vallerand (1997) after considering the situational, contextual, and global levels in their theoretical model. However, these models have not attracted much attention in the technology acceptance literature, which might mainly be due to the enormous complexity of the models as well as the little focus on the factors that actually influence acceptance.

2.4.8 Model of PC Utilisation

Due to the huge diversity of models in different disciplines that describe the relationships between attitudes, values, and other behavioural dispositions, Triandis (1979) presented a model, very general in nature, which he believed is able to describe behaviours in any culture. Thus, the variables constituting behaviour are abstract and general enough to be considered as relevant in behavioural investigations.

Besides the fact that Triandis' (1979) theory incorporates factors from the TRA, he also modifies and redefines them (Thompson *et al.*, 1991). For instance, a distinction is made between beliefs that are linked to emotions of acting (at the moment of action) and beliefs that are linked to future consequences by acting. Triandis (1979) assumes that behavioural intentions are influenced by (1) peoples' feelings (affect); (2) social factors; and (3) expected consequences of a specific behaviour. However, behaviour is determined by habits, behavioural intentions, as well as by facilitating conditions (Triandis, 1979).

Despite the broad model acceptance in the psychological literature, it has not been used in the technology acceptance field, in particular in information systems research (Thompson *et al.*, 1991). Thompson *et al.* (1991) adopted and applied a subset of Triandis' model to the context of information systems by investigating the utilisation of PCs, calling the theory "Model of PC Utilisation" (MPCU). They assume that PC utilisation is determined by affect, habits, social norms, expected consequences, and facilitating conditions (see Figure 2.15).

Although traditional behavioural models included behavioural intentions to predict usage behaviour, Thompson *et al.* (1991) sought to predict usage behaviour directly without the mediating effect of behavioural intention. Excluding intentions was mainly due to the interest on actual behaviour. Additionally, due to measurement issues, the authors excluded habits. Since the model was tested in an organisation, the dimensions of perceived consequences included two near-term consequences: job fit and complexity. Additionally, a long-term consequence, such as planning, was included. The overall results show that social factors, complexity, job-fit, as well as long-term consequences had a significant effect on PC utilisation. However, affect as well as facilitating conditions did not appear to influence PC utilisation. The authors justified the results as follows: PCs are seen as tools for managers, thus, the affect aspect is irrelevant. For the unpredicted outcome of facilitating conditions, the authors stated a measurement issue. Although it has been developed for the context of PC utilisation due to its nature, the modified model is suitable to predict acceptance and use for a variety of technologies (Venkatesh *et al.*, 2003).

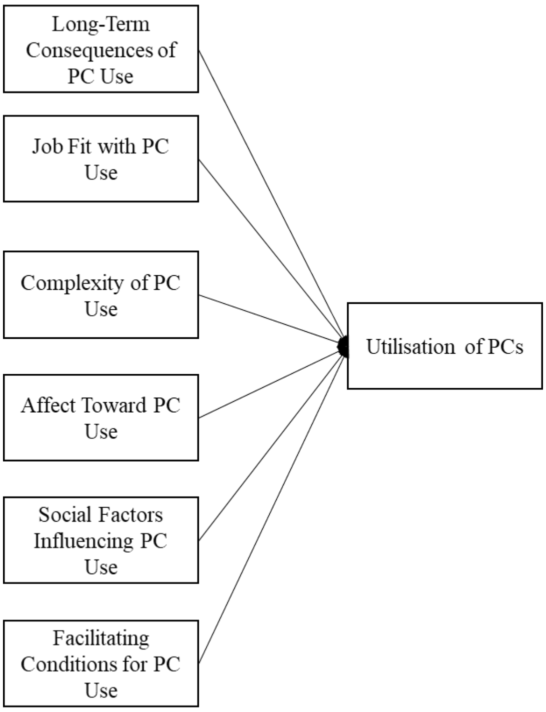

Figure 2.15: Model of PC Utilisation adopted from Thompson et al. (1991, p. 131)

Despite the valuable findings in their study, Thompson *et al.* (1991) also critically reflected upon them. Thus, some limitations in their study were found that should be considered. First, they mention that the respondents in their study were only from one organisation. Thus, it is not possible to generalise these findings directly to other organisations. Second, perceptions were used to operationalise utilisation. They believe that it would have been a better approach to obtain precise statistics through an electronic monitor. This would have been helpful in either confirming or disconfirming the perceptions of the respondents. Third, a problem of discriminant validity was found between social factors and facilitating conditions. They argue that technical support is only one part of facilitating conditions and therefore other parts should be included in future studies. In this regard, they also state the close relationship between the technical support, which is provided by the organisation, and social factors. Finally, they call for a revisit of affect in their model. They postulate that affect is an important construct; however, in the current items it does not measure all possible facets. Thus, further items should be included (Thompson *et al.*, 1991).

2.4.9 Unified Theory of Acceptance and Use of Technology (1–2)

Since researchers were more and more confronted with the situational choice of using one theory or model and ignoring others, Venkatesh *et al.* (2003) felt the need to synthesise the most prominent theories and models in technology acceptance research into one unified model. In doing so, they reviewed eight models, which have been used to explain and understand technology acceptance behaviour. These are the TRA, TPB, TAM, Combined TAM, DOI, SCT, MM, and the MPCU, which were discussed in the previous subchapters. In comparison to previous studies, only four studies reported empirically based comparisons of two or more models (Venkatesh *et al.*, 2003). Thus, synthesising the models was a new procedure in technology acceptance literature. After reviewing the eight models, Venkatesh *et al.* (2003) identified five shortcomings of prior models and theories:

1) **Technologies:** relatively simple, and individual-orientated
2) **Participants:** most of the previous studies used student samples
3) **Time of measurement:** most studies were undertaken well after acceptance or rejection decision
4) **Nature of measurement:** generally cross-sectional
5) **Voluntary versus mandatory contexts:** Studies were merely conducted in voluntary settings

Taking into consideration the shortcomings in previous technology acceptance studies, Venkatesh *et al.* (2003) compared the eight theories/models in an empirical longitudinal field study, which was conducted in four organisations among employees. The focus was on new technology for the workplace. The measurement was carried out before the introductory training, one month after the introduction and three months after the implementation. Furthermore, they studied the moderating effects of some variables that have been stated in previous research. These include age, gender, experience, and voluntariness. Except from the MM and SCT, the predictive power of the models and theories increased with the inclusion of the moderators. Moreover, the similarities of the models were studied. In doing so, they identified seven contracts that were significant in predicting behavioural intention or usage behaviour in one or more of the individual models or theories. Additionally, based on existing user acceptance literature they excluded attitude, computer self-efficacy, and anxiety as direct determinants of behavioural intention. Overall, they hypothesised that performance expectancy, effort expectancy, and social influence, have direct effects on behavioural intention, whereas behavioural intention and facilitating conditions have direct effects on use behaviour. These constructs will be presented in Table 2.1 as well as in Figure 2.16 on the following page.

Table 2.1: Constructs of the Unified Theory of Acceptance and Use of Technology

Construct	Explanation	Theoretical Roots
Performance expectancy	"the degree to which an individual believes that using the system will help him or her to attain gains in job performance" (Venkatesh *et al.*, 2003, p. 447)	Perceived usefulness (Davis, 1989; Davis *et al.*, 1989); extrinsic motivation (Davis *et al.*, 1992); job-fit (Thompson *et al.*, 1991); relative advantage (Moore and Benbasat, 1991); outcome expectancy (Compeau and Higgins, 1999).
Effort expectancy	"the degree of ease associated with the use of the system" (Venkatesh *et al.*, 2003, p. 450)	*Perceived ease of use* (Davis *et al.*, 1989; Davis, 1989); *complexity* (Thompson *et al.*, 1991); *ease of use* (Moore and Benbasat, 1991)
Social influence	"the degree to which an individual perceives that important others believe he or she should use the new system" (Venkatesh *et al.*, 2003, p. 451)	*Subjective norm* (Ajzen, 1991; Davis *et al.*, 1989; Taylor and Todd, 1995b; Mathieson, 1991; Ajzen and Fishbein, 1975); *social factors* (Thompson *et al.*, 1991); *image* (Moore and Benbasat, 1991)
Facilitating conditions	"the degree to which an individual believes that an organizational and technical infrastructure exists to support use of the system" (Venkatesh *et al.*, 2003, p. 453)	*Perceived behavioural control* (Taylor and Todd, 1995b; Ajzen, 1991); *facilitating conditions* (Thompson *et al.*, 1991); *compatibility* (Moore and Benbasat, 1991)

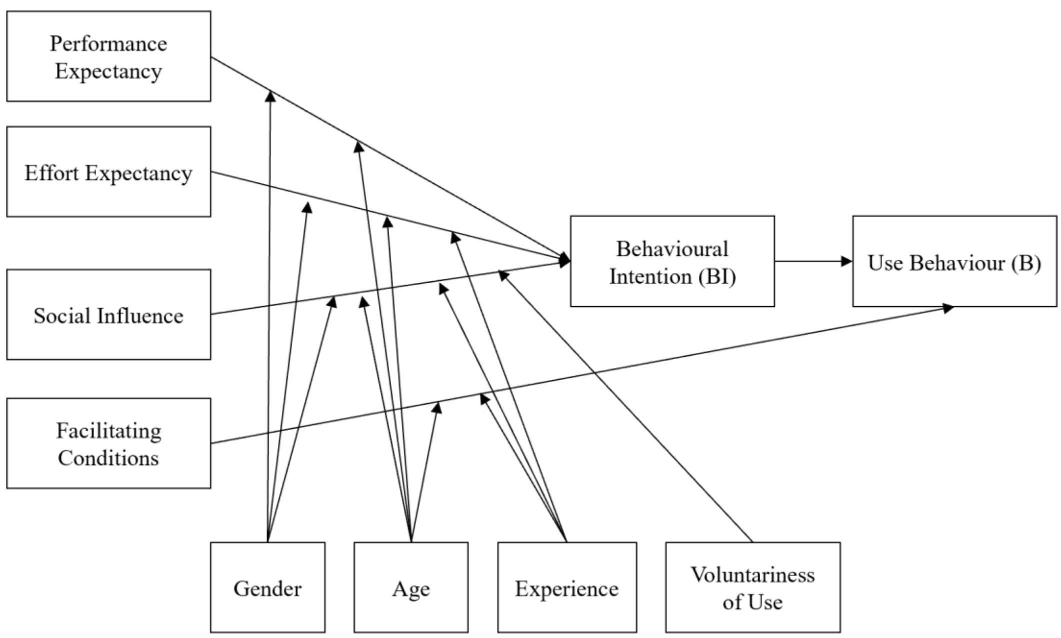

Figure 2.16: Unified Theory of Acceptance and Use of Technology adopted from Venkatesh et al. (2003, p. 447)

In their empirical test of the UTAUT model, Venkatesh *et al.* (2003) collected data from four organisations and cross validated it with new data collected from two organisations. As a result, they were able to establish support for the UTAUT model. Overall, the model explained about 70 percent of the variance in behavioural intention. In comparison to other theories and models used to predict behavioural intention, this is a major improvement because those usually predicted only around 40 percent of the variance in behavioural intentions. Thus, UTAUT has been empirically proven to be superior to other competing theories and models (Venkatesh *et al.*, 2003).

Since the introduction of the UTAUT by Venkatesh *et al.* (2003), the model has been applied in technology adoption and diffusion research as a theoretical lens through which researchers investigated user intentions and behaviours. The model has been used in various contexts, including internet, web-sites, tax payment systems, mobile technology, and e-commerce (Williams *et al.*, 2015). Additionally, the model was also used with different control factors or moderators such as gender, age, voluntariness, experience, income, and education, and focused upon various user groups (e.g., students, and professionals) (Williams *et al.*, 2015). However, as Venkatesh *et al.* (2012) showed, most studies applying the UTAUT model only employed a subset of the constructs. Moreover, the moderators were mainly dropped. This is consistent with the meta-analysis findings by Williams *et al.* (2015). They not only found that “no single study was seen to support all UTAUT relationships” but also that “all UTAUT relationships are supported by at least one study” (Williams *et al.*, 2015, p. 456).

Since its introduction in 2003, the model has become increasingly popular. In a meta-analysis it was found that the number of UTAUT publications has increased year upon year and that this upward trend will continue in the future (Williams *et al.*, 2015). Overall, the original article of Venkatesh *et al.* (2003) has been cited around 5,000 times (Williams *et al.*, 2015). Interestingly, analysing the journals and conference proceedings where UTAUT studies were published in the last years, the landscape of UTAUT researchers is broad and diverse. This is contradictory to the findings of Lee *et al.* (2003), who conducted a meta-analysis of TAM studies and found that TAM outputs were published in a relatively small number of journals (Williams *et al.*, 2015).

Due the broad and diverse use of UTAUT, Venkatesh *et al.* (2012) were interested in the contexts and extensions UTAUT was used in. In reviewing the literature, they were able to identify three major UTAUT extensions/integrations. For the first type of extension, UTAUT has been used in new contexts (e.g., new technologies: health information systems (Chang *et al.*, 2007); and new cultural settings: China, India (Gupta *et al.*, 2008)). The second type includes the incorporation of additional constructs in order to expand the endogenous (dependent) theoretical mechanisms drawn in the UTAUT model (Sun *et al.*, 2009), and the third type includes the addition of exogenous (independent) constructs (Neufeld *et al.*, 2007). All these extensions and integrations of UTAUT expanded not only the understanding of technology adoption but also the theoretical boundaries of theory (Venkatesh *et al.*, 2012).

Despite the aforementioned use of UTAUT as a powerful tool in explaining technology acceptance in various contexts, UTAUT has also been criticised. For instance, Bagozzi (2007) states that despite its extensiveness (i.e., various constructs), it can be argued that there are important independent constructs left out, which might be uncovered in future research. Dwivedi *et al.* (2019) argue that the four exogenous constructs (independent) modelled in the original UTAUT only represent technology attributes (i.e., performance expectancy and effort expectancy) as well as contextual factors (i.e., social influence and facilitating conditions), whereas individual factors have been neglected. Therefore, they postulate that “individual characteristics that describe the dispositions of the users may be influential in explaining their behaviours” (Dwivedi *et al.*, 2019, p. 721).

Alongside this criticism of the model, Williams *et al.* (2015) also found shortcomings in the studies that applied UTAUT. The limitation most often mentioned is the focus on a single subject within the study, that is, most UTAUT studies focus only on one culture, country, organisation, person, and age group. Furthermore, most studies focused only on a specific task at a given point in time, which according to Lee *et al.* (2003) limits the generalisability of the findings. Additional limitations in UTAUT studies mentioned in the literature are sample size, sample selection (i.e., student samples), and no use of moderating variables (Williams *et al.*, 2015). Regarding the moderating variables, it is, however, argued that they are not “universally applicable to all contexts and hence run the danger of being non-relevant in certain settings”, which is considered to be the reason for dropping moderators in most of the UTAUT studies (Dwivedi *et al.*, 2019, p. 729).

Further Development of UTAUT:

Despite the positive development of UTAUT, Venkatesh *et al.* (2012) found that there is still a need of investigating and theorising constructs that would apply specifically to a consumer context. However, a trend in theory and model development has been found to focus more on specific contexts rather than on the general applicability of theories in previous years (Venkatesh *et al.*, 2012). Moreover, some authors argue that a change of constructs within a model can lead to rendering, altering, and creating new relationships (Johns, 2006; Alvesson and Kärreman, 2007). Since the original UTAUT model was developed to predict employee technology acceptance and use, Venkatesh *et al.* (2012) further developed the UTAUT with specific focus on private consumers (UTAUT2). They expanded and modified the UTAUT model by adding additional constructs that were proven powerful in previous consumer studies, excluding moderators that are not believed to be powerful in a consumer context and modifying the relationships between the constructs. Taking into consideration previous literature and study results in the consumer domain, they identified hedonic motivation (e.g., enjoyment), price value, and habit as additional predictors of behavioural intention and use of technology (see Figure 2.17 on the following page) (Venkatesh *et al.*, 2012). Furthermore, they excluded the moderator voluntariness because of the fact that consumers are believed to behave only on a voluntary basis, unlike in the workplace context. The added constructs and their theoretical roots are presented in Table 2.2 on the following page.

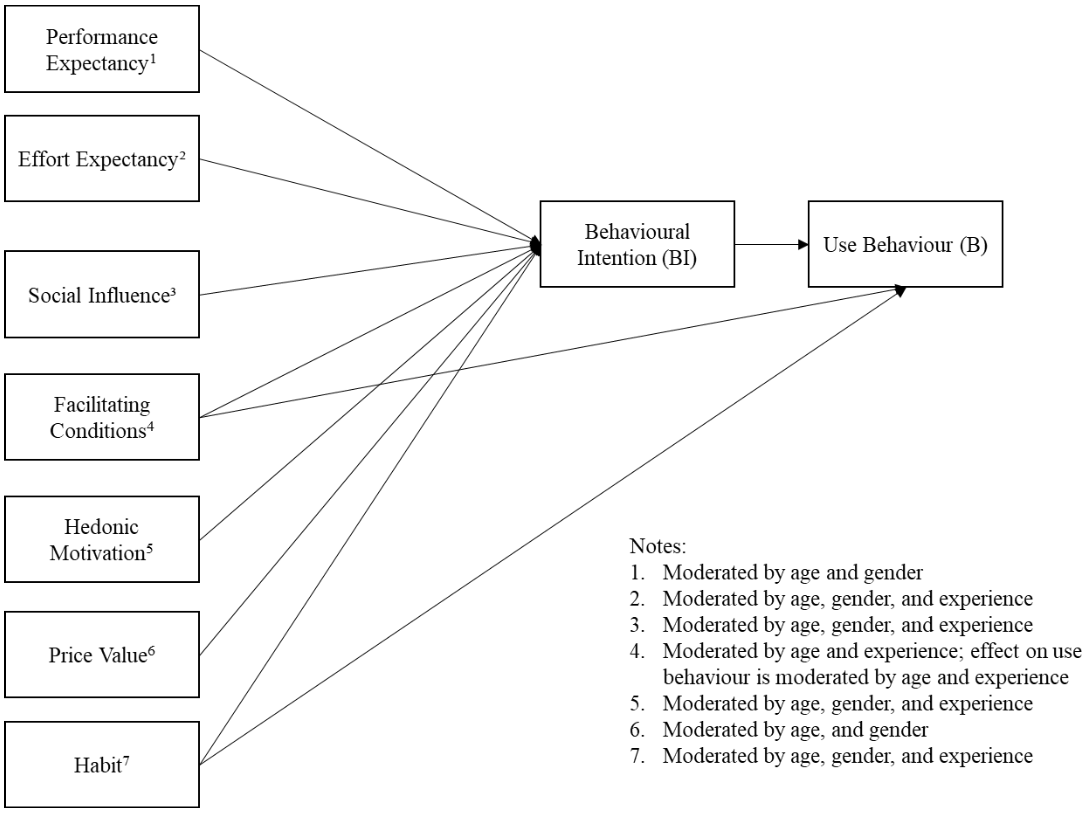

Figure 2.17: Unified Theory of Acceptance and Use of Technology 2 adopted from Venkatesh et al. (2012, p. 160)

Table 2.2: Constructs of the Unified Theory of Acceptance and Use of Technology 2

Construct	Explanation	Theoretical Roots
Hedonic motivation	"the fun or pleasure derived from using a technology" (Venkatesh *et al.*, 2012, p. 161)	Information systems (van der Heijden, 2004); consumer context (Childers *et al.*, 2001)
Price value	"consumers' cognitive trade-off between the perceived benefits of the applications and the monetary costs for using them" (Venkatesh *et al.*, 2012, p. 161)	Technology usage (Chan *et al.*, 2008); marketing research (Zeithaml, 1988)
Habit	"the extent to which people tend to perform behaviors automatically because of learning" (Venkatesh *et al.*, 2012, p. 161)	Information systems (Limayem *et al.*, 2007)

Since its introduction in 2012, UTAUT2 has been used in several technology acceptance studies. For instance, Alalwan *et al.* (2018b) applied UTAUT2 in the context of online banking, Yahia *et al.* (2018) utilised the model in the context of social-commerce and Madigan *et al.* (2017) investigated the user acceptance of automated shuttles. All found a general applicability in their context. It is worth mentioning that most of the studies that applied UTAUT2 as a foundation extended it with additional constructs like perceived risk (Tamilmani *et al.*, 2018b).

Although UTAUT2 is considered to be the newest and most comprehensive research model available to date in the information systems and technology acceptance literature, it has also been criticised. For instance, Choi (2016) states that even though UTAUT2 considers hedonic motivation (e.g., enjoyment), it is not clear what determines this factor ("black box"). Therefore, they call for a more detailed analysis of hedonic motivation. Following this criticism, the criticism stated for the TAM that the constructs are treated as "black boxes" (Benbasat and Barki, 2007), also holds true for UTAUT as well as UTAUT2.

2.5 Summary of User Acceptance Theories and Models

Overall, the coverage of the theories and models used to explain, predict, and understand user acceptance is domain-specific. The majority of the theories were originally developed in an organisational context, underestimating the importance of the private user context (Venkatesh *et al.*, 2012). Besides the fact that the theories were developed in different disciplines, most of the theories and models have overlapping edges (Williams *et al.*, 2011; Dillon and Morris, 1996). Thus, some of the constructs are similarly conceptualised. Such similarities indicate the pivotal importance of these constructs. However, treating these conceptually similar constructs as distinct complicates the literature massively (Blut *et al.*, 2016). This was the reason why Venkatesh *et al.* (2003) called for a unified theory. In doing so, they included and summarised constructs from the eight theories and models mentioned above in one unified theory (i.e., UTAUT). The theories and models discussed in this chapter are compared against each other in Table 2.3 with focus on the constructs studied to explain behavioural intention or usage behaviour, respectively.

Table 2.3: Summary and Comparison of Technology Acceptance Theories and Models

Model	Discipline derived	Constructs
TRA	Social psychology	Attitudes toward the behaviour + subjective norm
TPB	Social psychology	Attitude toward the behaviour + subjective norm + perceived behavioural control
TAM	Information Systems	Perceived usefulness + perceived ease of use
TAM2	Information Systems	Perceived usefulness (determined by: subjective norm, image, job relevance, output quality, result demonstrability) + perceived ease of use
TAM3	Information Systems	Perceived usefulness (determined by: subjective norm, image, job relevance, output quality, result demonstrability) + perceived ease of use (determined by: computer self-efficacy, perceived external control, computer anxiety, computer playfulness, perceived enjoyment, objective usability)
Combined TAM	Information systems	Attitude (determined by: perceived usefulness, perceived ease of use) + subjective norm + perceived behavioural control
DOI	Innovation management	Relative advantage + compatibility + complexity + triability + observability
SCT	Social psychology	Cognitive factors (attitudes, expectations, knowledge) + environmental factors (social norm, influence on others) + behavioural factors (skills, practice, self-efficacy)
MM	Social psychology	Intrinsic motivation + extrinsic motivation + amotivation
MPCU	Social psychology	Peoples' beliefs + affect + social norms + perceived consequences + habit + facilitating conditions
UTAUT	Information systems	Performance expectancy + effort expectancy + social influence + facilitating conditions
UTAUT2	Information systems	Performance expectancy + effort expectancy + social influence + facilitating conditions + habit + hedonic motivation + price value

Comparing and contrasting these theories and models, it can be summarised that there are models and theories which are highly parsimonious but are not comprehensive enough to be acknowledged as sufficient or complete (e.g., TRA or TAM). Moreover, there are models considered complete in covering a huge variety of constructs that contribute to user acceptance behaviour (e.g., hierarchical model of motivation) but are considered complex as well as impractical to utilise in single investigations. Furthermore, due to the increasing confusion to use one theory or model over the other to investigate technology acceptance, Venkatesh *et al.* (2003) investgated the similarities of the presented theories and models in Table 2.3 and synthesised them in their unified theory of acceptance and use of technology (UTAUT/UTAUT2), which are stated to be comprehensive and parsimonious at the same time (Venkatesh *et al.*, 2003; Venkatesh *et al.*, 2012). Since this unified theory summarises what is known in the technology acceptance research it is stated to be a good foundation for further research of new technologies (Venkatesh *et al.*, 2003) and as such is also believed to be a good theoretical foundation within this research study (see subchapter 2.7 for a detailed justification for using UTAUT2 in this research study).

2.6 Previous Research Related to this Study

After reviewing and discussing the most prominent theories and models in the domain of technology acceptance, the following subchapters will review the research studies that are related to the underlying topic of this thesis. This includes the acceptance research of innovative technologies in logistics as well as the presentation of acceptance research in the field of autonomous delivery vehicles (ADVs). Additionally, the chapter presents the overlapping research fields and turns to a broader literature related to ADVs, namely, user acceptance of self-service technologies (SSTs) and user acceptance of autonomous vehicles (AVs) in general.

2.6.1 User Acceptance of Autonomous Delivery Vehicles

According to Rogers (1983, p. 11), "an innovation is an idea, practice, or object that is perceived as new by any individual or other unit of adoption." Following this definition ADVs are an innovation in last-mile delivery because they are objects (i.e., ADVs) that are new to the end-customer. In general, however, innovation studies have not attracted much attention in the field of logistics (Flint *et al.*, 2005; Wagner and Sutter, 2012). For instance, Cagliano *et al.* (2017) investigated mobile-tools enabled services in e-supply chain management, and Fu *et al.* (2015) evaluated the adoption of RFID (radio-frequency identification) in the logistics industry. However, studies that investigated innovations in logistics are mainly undertaken from an organisational perspective (Wang *et al.*, 2018a, 2018b). As a result, consumer receptivity, which is important to the successful implementation of innovations in last-mile logistics, has not received much attention and only a limited number of studies has been conducted. For instance, Wang *et al.* (2018a) investigated the diffusion of automated parcel stations in Singapore and Yuen *et al.* (2018) as well as Yuen *et al.* (2019) evaluated the intentions to use self-collection services for last-mile delivery in Singapore and China, respectively.

Since the introduction of last-mile delivery innovations has attracted only little attention in the literature (Yuen *et al.*, 2019; Wang *et al.*, 2018a; Yuen *et al.*, 2018), little is known about the acceptance of ADVs for last-mile delivery. This was assessed through an extensive online literature search (i.e., Google Scholar), which has been conducted four times throughout the thesis' process (last search in October 2019) by using the following search string:

("autonomous delivery vehicle" OR "automated delivery vehicle*" OR "self-driving delivery vehicle*" OR "robot delivery") AND ("last-mile logistics" OR "last-mile delivery" OR delivery OR home-delivery OR transportation) AND (adoption OR acceptance)*

Collectively, only five studies could be identified that in particular investigated the user acceptance of ADVs. An overview of these studies is presented in Table 2.4 on the following page.

Table 2.4: General Acceptance Studies of ADVs

Title	Authors / year	Research Strategy	Country	Sample Selection	No. of participants	Main Findings
Attitudes towards the impact of digitalisation and automation on daily life	(Eurobarometer, 2017)	survey	European Union	EU citizens	27,901	41% of participants (overall EU citizens) would feel uncomfortable with drone or robot delivery; 48% of Germans would feel uncomfortable with drone or robot delivery.
The future of logistics – How Germans think of parcel robots and drones	(Braun and Buckstegen, 2017)	survey	Germany	Germans 18 + years.	2,023	42% of the participants stated to have rather negative or negative attitudes towards robot or drone delivery; only 9% would prefer robot or drone delivery over the conventional delivery options; 62% believe that drones and robots are rather risky or risky when operating on streets; 59% believe that there is rather a potential risk or a risk of theft; only 26% believe that this kind of system should be implemented.
Avant-garde in last mile – new ways of urban logistics	(Prümm *et al.*, 2017)	survey	Germany	Germans 18+ years.	1,018	68% of the participants would rather not or definitely not use robot delivery.
Parcel delivery – The future of last mile	(Joerss *et al.*, 2016)	survey	Germany, China and United States	Germans, Chinese and US citizens	4,700	Over 40% of participants would use autonomous parcel lockers; among younger customers (aged 18 to 34), ADVs are even more popular, with well above 50% stating that they would definitely or likely use this delivery option.
From E-Commerce to M-Commerce	(Rohleder, 2016)	survey	Germany	German internet users older than 14 years	1,158	61% of the participants would not use autonomous robot delivery.

However, these studies are rather descriptive in nature (i.e., acceptance yes/no scale) and little weight is placed on the behavioural components of users' acceptance decision of ADVs. Additionally, the attempt to conceptualise the users' acceptance of ADVs through exploring the theoretical relationships between the variables and consumers' intention (i.e., user acceptance) is missing. This might be due to the fact that these studies did not consider theoretical models for investigating user acceptance. This result is in line with the findings by Grawe (2009), who found that within the logistics literature a very limited number of theory-based research has been conducted.

To reduce the bias of one database (i.e., Google Scholar), the literature search was broadened by using two academic databases, i.e., Scopus (Elsevier), and Web of Science (Thompson Reuter) to undertake further searches. These databases are widely used to locate peer-reviewed scientific journals and conference proceedings in various disciplines and are therefore especially suitable in this context because this topic is interdisciplinary (i.e., combines knowledge from information systems, business, management, psychology, etc.). In other words, it is believed that by using databases that provide access to various disciplines, a more complete overview of the relevant research studies will be provided.

The search was also conducted four times throughout the thesis process (last search October 2019) and used the same search string as outlined before. The first bracket was limited to abstract, title, and keywords, whereas the rest of the search string was unlimited (i.e., searching all fields). Additionally, no timespan was set. As such, the search string was very broad in order to locate as many relevant papers as possible. However, in both databases the recurring search revealed only one paper (Marsden *et al.*, 2018) that investigated user acceptance of ADVs. Even though a backwards search as well as a forward search was conducted, no additional relevant papers could be identified that investigated the acceptance of ADVs, which shows the early stage of the acceptance research in the field of ADVs in last-mile logistics. In this regard, it is worth mentioning that by including one of the existing technology acceptance theories into the search string, no results were found at all. Therefore, to the best of my knowledge, there is only one study so far that has investigated user acceptance of ADVs in more detail, but it still neglects the use of an underlying theory to investigate user acceptance. The findings will be presented in more detail in the following.

Marsden *et al.* (2018) conducted a qualitative study in 2016 as well as a quantitative study in 2017, exploring the attitudes and perceptions of citizens of Heilbronn (Germany) regarding autonomous ground vehicles used for logistical purposes (i.e., ADVs) at the event area of the federal gardening show in Heilbronn. In doing so, the authors conducted eight semi-structured interviews with representatives of different stakeholder groups (i.e., cross-section of the population of Heilbronn). The aim of the qualitative interviews was to explore the daily routine of citizens of Heilbronn (i.e., shopping behaviour, etc.) and try to identify whether they have positive or negative attitudes towards ADVs in the federal gardening show, which is a semi-public space.

The data was analysed using thematic analysis. On the one hand, the qualitative findings show that the interviewees found ADVs an innovative technology and liked the approach of testing ADVs on semi-public roads before moving to public roads. On the other hand, they had major concerns about the safety in the event area, since no driver would be involved. In general, using electric self-driving vehicles for logistical purposes in urban areas was seen as a way to reduce air pollution and thus as an environmentally friendly transportation system. In a next step, the findings of the thematic analysis were taken to develop item-based questions for the quantitative study.

The quantitative survey was conducted in 2017 with a representative sample for Heilbronn (n = 500). Participants were randomly selected and called via computer-aided telephone interviewing (CATI). Here, in two open questions participants had the option to state what they liked or disliked about ADVs in the event area of the federal gardening show. The results of the open questions revealed 460 positive and 477 negative aspects of ADVs. Content analysis revealed that "environmental friendliness" and "innovative system" stated 23 percent as positive associations, whereas 18 percent stated "accidents/danger" and "risky/safe" as negative associations. Furthermore, the analysis of the item-based questions using a Likert Scale (1 = totally agree and 5 = totally disagree) revealed similar findings. Most participants agreed that ADVs are "innovative" and "environmentally friendly", whereas they agreed that the negative aspects were, "uncanny", "dangerous", and "not trustworthy". Overall, the findings show that despite the many positive associations, people also have major concerns about safety and see ADVs as a potential risk in the event area of the federal gardening show in Heilbronn.

These findings need to be examined with care because, so far, this study is only representative of the population of one city (i.e., Heilbronn) and focuses on ADVs on a semi-public road system. Thus, the perceptions and attitudes might change when considering ADVs on fully public roads. In that scenario, negative associations might even increase. Additionally, investigating user acceptance with a representative sample for Germany instead of a sample, which is representative for only one city, might reveal different findings.

In summary, Marsden *et al.* (2018) concluded that ADVs have great potential to revolutionise last-mile delivery, thus making it more efficient and customer-orientated. However, they also acknowledge that before these systems can be considered a standard in last-mile delivery, more research is needed, especially in the areas of technical implementation and user acceptance. Thus, this provides support to investigate user acceptance of ADVs in last-mile delivery in more detail in this thesis with a broader focus on Germany as well as public instead of semi-public spaces. Nevertheless, the findings by Marsden *et al.* (2018) will be taken as a starting point in this thesis because this was the first study investigating user acceptance of ADVs in greater detail in last-mile delivery.

2.6.2 Related Research Fields and Search Strategy

Due to the limited research found with specific focus on users' behavioural intention (i.e., user acceptance) of ADVs, this thesis turned to a broader literature on users' behavioural intention of related research fields. Taking the main characteristics of ADVs into consideration – dropping-off parcels at the recipients' home and driving autonomously on public roads – there is, despite its distinct branches, an overlap with two research fields: first, the field of self-service technologies (SSTs), and second, the field of autonomous vehicles (AVs). This will be outlined in more detail in the following.

First, the parcel drop-off process via ADVs is without any human – human interaction, in contrast to the conventional last-mile delivery process. In other words, recipients must interact with the technology by themselves. This includes for instance setting the delivery time online or connecting their smartphone to the vehicle for opening the parcel locker and collecting the parcel. Performing a service through technology devices (e.g., mobile devices and kiosks) without a customer – employee interaction is defined as a self-service

(Meuter *et al.*, 2000). Therefore, ADVs are considered a special form of SSTs in the domain of last-mile delivery.

Despite the fact that SSTs can be categorised into three different purposes (vertical) as well as three interfaces (horizontal) (see Table 2.5), in this thesis all types of SSTs are considered to contribute valuable findings. This is the case because ADVs comprise many characteristics from various SSTs types. For instance, the recipient has to set the delivery time via the internet or the mobile app. In addition to this, the parcel collection through the recipient can only be proceeded by connecting the smartphone to the vehicle via Bluetooth. Thus, studies that investigate internet/online SSTs are believed to be of the same importance as mobile SSTs. Moreover, as stated in subchapter 2.2, some ADVs also have an interface from which support can be reached (e.g., voice response). Therefore, kiosk-based as well as voice response SSTs are also relevant in this study. Thus, all three types of SSTs proposed by Meuter *et al.* (2000) are considered relevant in this study and will be considered in this review.

Table 2.5: Self-Service Technology Categorisation adopted from Meuter et al. (2000, p. 52)

	Interactive voice Response/telephone	Online/internet	Interactive kiosks
Customer Service	Telephone banking, flight information	Package tracking, account information	ATMs, hotel check-in/out
Transaction	Telephone banking, prescription refills	Retail purchasing, financial transactions	Pay at the pump, car rental
Self-Help	Information telephone lines	Internet information search, distance learning	Tourist information

Second, ADVs drive autonomously on public roads (i.e., without a driver), which is also the case for AVs (i.e., autonomous cars, shuttles, and buses). However, it needs to be considered in this context that the acceptance perspective of AVs is mainly from inside the vehicle (i.e., passenger perspective). However, in the context of ADVs, the perspective changes to outside the vehicle, since ADVs only carry goods. Nevertheless, it is likely that traffic participants have similar perceptions and associations regarding AVs as for ADVs when these systems drive autonomously on public roads or sidewalks.

This assumption is in line with the findings by Hulse *et al.* (2018), who were the first to investigate the risk perceptions of AVs from the perspective of pedestrians and other traffic participants. They found that the perception of related safety risks plays a role for vehicle passengers (i.e., actively involved in AVs) and pedestrians (i.e., passively involved in AVs) alike. Thus, it is assumed to be important to investigate the context related factors that drive the acceptance of AVs to then identify relevant factors that influence the acceptance of ADVs in the context of last-mile delivery.

Overall, the combination of these literature streams might provide a more comprehensive model of ADVs acceptance. Thus, this study takes the research of self-service technologies (SSTs) and autonomous vehicles (AVs) as a base to identify the constructs that are likely to be relevant in the area of ADVs. As such, this study is interdisciplinary because it combines knowledge from two different contexts (SSTs and AVs) for studying user acceptance of ADVs (see Figure 2.18).

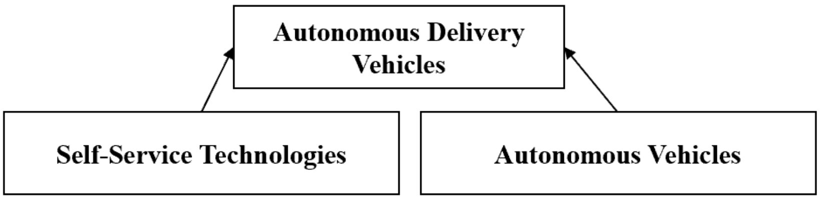

Figure 2.18: Related Research Fields of ADVs

In the following subchapters the research fields of SSTs as well as AVs will be systematically reviewed. The systematic review method was chosen due to its replicable, scientific, and transparent process (Cook *et al.*, 1997; Tranfield *et al.*, 2003). As such, systematic literature reviews are argued to provide an efficient as well as high quality technique for identifying and evaluating extensive literature studies (Mulrow, 1994). As a matter of fact, it provides guidance on theory development as well as future research directions. Furthermore, undertaking a systematic literature review ensures completeness and rigour of the review itself and makes the overall review more reliable (Lim *et al.*, 2018; Greenhalgh and Peacock, 2005; Greenhalgh *et al.*, 2004). Moreover, due to their positivistic origin, systematic reviews sit especially comfortably with quantitative studies (Tranfield *et al.*, 2003) and therefore this search method is perfectly suited to this thesis.

However, it needs to be considered that the reviews will only provide a snapshot of the current state of acceptance research conducted in the area of SSTs and AVs. It does not, however, pretend to cover the sum of all the literature available in these specific areas. It will rather offer an informative and focused evaluation of literature selected based on the usefulness that is needed to comprehensively answer the underlying research question in this thesis. In doing so, the guidelines for conducting and reporting a systematic literature review from Moher *et al.* (2009) and Okoli and Schabram (2010) were taken into consideration, which led to the following six steps:

(1) ***Purpose of the Literature Review:*** identifying the purpose and the intended aims of the review.

(2) ***Identification/Literature Search:*** all details of the literature search need to be presented clearly. This includes the selection of relevant databases, the keywords, the search string applied as well as any restriction of the literature search (e.g., timespan).

(3) ***Screening:*** excluding duplicates and setting the detailed inclusion criteria for studies that will be further reviewed in detail.

(4) ***Eligibility:*** clear description of the criteria that are used to justify the inclusion of articles for review synthesis.

(5) ***Data Extraction:*** systematically extract the applicable information from each study.

(6) ***Synthesis:*** combining the facts extracted from the studies.

Within the following subchapters, the research areas (i.e., SSTs and AVs) will be briefly explained before the systematic review will be presented based on the process outlined previously.

2.6.3 User Acceptance of Self-Service Technologies

Self-service technologies (SSTs) are "technological interfaces that enable customers to produce a service independent of direct service employee involvement" (Meuter *et al.*, 2000, p. 50). By introducing SSTs, companies do not only complement traditional interpersonal services (e.g., ATMs) but also substitute them completely (e.g., online banking) (Blut *et al.*, 2016). Due to their contribution to a firm in terms of profitability, productivity, and cutting labour costs and the increasing customer demand, SSTs have been introduced frequently in various contexts in the last decades, for instance, online banking (Alalwan *et al.*, 2018a), self-scanning check-outs in supermarkets (Dabholkar *et al.*, 2003), information systems in the area of fitness and health (Mohamad and Cresswell, 2019) as well as technology-based tour guides in museums (Hammady *et al.*, 2019). In the context of transportation and logistics, SSTs are still a novelty. Nevertheless, some examples exist, for instance self-check-in kiosks have been introduced to airports (Gelderman *et al.*, 2011) and self-collecting parcel lockers have been introduced to the last-mile delivery process (Yuen *et al.*, 2018; Wang *et al.*, 2018a; Yuen *et al.*, 2019).

However, despite this fast development, it is still not clear what determines consumers' acceptance to use self-services (Meuter *et al.*, 2005; Blut *et al.*, 2016; Yen and Gwinner, 2003). The benefits of SSTs can only be realised when the user accepts these new technologies comprehensively (Meuter *et al.*, 2005). However, this will not be the case until users fully understand the benefits of using them and feel comfortable with it. Furthermore, Curran and Meuter (2005) acknowledge that it is even more challenging to encourage consumers to use new technology in a service setting than employees at the workplace. Thus, there is a need to find out more about the factors determining user acceptance of SSTs.

The systematic literature review will be presented as a next step, following the six steps outlined before (i.e., purpose of the literature review, identification/literature search, screening, eligibility, data extraction, and synthesis).

2.6.3.1 Systematic Review of SSTs Acceptance Studies

(1) Purpose of the Literature Review

The systematic literature review of SSTs acceptance studies was conducted in September 2018 with the aim to create an overview of the various constructs that are relevant in intention adoption formation (i.e., acceptance formation) in the field of SSTs, in other words, to identify the constructs that significantly determine behavioural intention in the field of SSTs. However, as stated before, the aim is not to cover the sum of the literature available but rather to focus on the evaluation of purposefully selected literature that is needed to answer the research question.

(2) Identification/Literature Search

The same databases as for the literature review of ADVs studies, i.e., Scopus (Elsevier), and Web of Science (Thompson Reuter), were used to undertake the search. Since this systematic review focuses on self-service technologies, this term is used as a keyword in addition to its common abbreviations (i.e., SSTs and SST). To identify additional relevant keywords for the area of technology adoption, high-class academic journal papers were screened, and the keywords relevant for this study and most regularly used were selected. The screening process was limited to some journals listed in the Academic Journal Guide 2015 by the Association of Business Schools, which regularly publishes articles in the field of technology adoption (i.e., MIS Quarterly, Journal of the Association for Information Systems, Computers in Human Behaviour). Additionally, to limit the search to studies that have utilised technology acceptance theories, all theories taken into consideration by Venkatesh *et al.* (2012) and Venkatesh *et al.* (2003) in UTAUT2 and UTAUT were included into the search string. As a result, the following search string was developed:

("self-service technology" OR sst OR ssts) AND (adoption OR acceptance OR "user acceptance" OR "technology acceptance" OR "technology adoption" OR consumer) AND ("unified theory of acceptance and use of technology" OR utaut OR utaut2 OR "technology acceptance model" OR tam OR tam2 OR tam3 OR "theory of reasoned action" OR tra OR "theory of planned behavio" OR tpb OR "diffusion of innovation" OR "innovation diffusion theory" OR doi OR idt OR "social cognitive theory" OR sct OR "combined tam" OR c-tam OR "combined tam-tpb" OR "motivational model" OR mm OR "model of pc-utilization" OR mpcu)*

The initial search on Scopus and Web of Science encompassed *"all fields"* for the first bracket (i.e., *"self-service technology" OR sst OR ssts)*, which was necessary to also capture articles that have mentioned a specific SST (e.g., check-in kiosks or online banking), but not the term "self-service technology" in the title, keywords or abstracts. For the second and third bracket the search was limited to *title, abstract, or keywords* to increase the likelihood of identifying papers that have empirically investigated one of the technology acceptance theories synthesised in UTAUT/UTAUT2 or have empirically investigated UTAUT or UTAUT2 itself. The timespan of this initial search was limited to the last 10 years (i.e., 2008 – 2018), which seemed reasonable for covering the latest technology acceptance research in the field of SSTs. Finally, the search was limited to publications in English. Overall, this search strategy yielded a total of **346 papers on Scopus and 34 papers on Web of Science**.

(3) Screening

Before the papers could be screened, the accessibility of all identified papers was checked. This process revealed 175 papers on Scopus and 33 papers on Web of Science (i.e., 208 accessible papers). Furthermore, the papers found in both databases were compared (i.e., title comparison) to identify any overlaps. As a result, 19 papers overlapped (i.e., 156 unique papers on Scopus; 14 unique papers on Web of Science, and 19 overlapping papers). Next, the title and the abstract of these papers were screened based on two criteria: first, it was checked whether the articles investigated an actual self-service technology in a consumer context (e.g., customer, patient, etc.). Here, as stated before, self-service technologies are defined as "technological interfaces that enable customers to produce a service independent of direct service employee involvement" (Meuter *et al.*, 2000, p. 50). As a result, this revealed 133 unique papers on Scopus, 14 unique papers on Web of Science, and 17 overlapping papers (N = 164). Second, it was checked whether the research utilised one of the existing technology acceptance theories as a baseline model. The screening process revealed 120 unique papers on Scopus, 11 unique papers on Web of Science, and 17 overlapping papers that investigated an actual SST in the consumer context (N = 148 papers).

(4) Eligibility

In a next step, the papers identified that investigated an actual SST in the consumer context and utilised one of the existing technology acceptance theories were fully reviewed based on three screening criteria: first, it was checked whether they used a quantitative approach as the main methodology and investigated the constructs and their relationships empirically. As a result, 119 unique papers were identified on Scopus, 10 unique papers on Web of Science, and 16 overlapping papers. Second, only studies that analysed the relationships between their proposed constructs and behavioural intention were selected. This revealed 80 unique papers on Scopus, 9 unique papers on Web of Science, and 12 overlapping papers (N = 101). In a final step, only studies that provide statistical evidence (e.g., regression coefficients) for the impact of the constructs on behavioural intention were selected for data synthesis. **In total, 99 papers were identified that fulfilled all inclusion criteria** (i.e., 78 unique papers were found on Scopus, 9 unique papers on Web of Science, and 12 overlapping articles).

Due to time constraints in this research project and the large number of studies found in the context of SSTs, the decision was made to include only journal papers ranked in the Academic Journal Guide 2015 by the Association of Business Schools. On the one hand, this reduced the number of papers to a more manageable number, and on the other hand, the value of the findings increased considerably because only peer-reviewed and ranked articles were used for further analysis. This revealed 53 articles (i.e., 35 unique papers on Scopus; 9 unique papers on Web of Science, and 9 overlapping papers), which were used for data extraction in the next step.

(5) Data extraction

These papers were coded with the following codes: title, authors, publication year, journal/conference, technology examined, country in which the research was conducted, model utilised, data collection methods, number of participants, data analysis, and relevant findings. A summary of the identified studies is provided in Table 2.6 on the following pages.

Table 2.6: Systematic Literature Review SSTs Acceptance Studies

No.	Author and Year of Publication	Title	Journal/ Conference	Technology Examined	Country	Model utilised	Data Collection Method	No. of Participants	Data Analysis	Relevant Findings
1	(Kim and Forsythe, 2008)	Adoption of virtual try-on technology for online apparel shopping	Journal of Interactive Marketing	virtual try-on technology	USA	TAM	Questionnaire	491	SEM	A and INO significantly (positive) influence BI. Variance explained BI: N/A
2	(Lu *et al.*, 2009)	Investigating passengers' intentions to use technology-based self check-in services	Transportation Research Part E	Kiosk check-in	Taiwan	TAM	Questionnaire	337	SEM	A, external stimuli, PBC, perceived service quality significantly (positive) influence BI; need for interaction and PR have significant (negative) effect on BI. Variance explained BI: 72.7%.
3	(Marler *et al.*, 2009)	Employee self-service technology acceptance: a comparison of pre-implementation and post-implementation relationship	Personnel Psychology	Human resource online platform	USA	Combined TAM	Questionnaire	119	SEM	A, SN, and perceived resources significantly (positive) influence BI. Variance explained BI: N/A
4	(Herrero Crespo and Rodriguez del Bosque, 2010)	The influence of the commercial features of the Internet on the adoption of e-commerce by consumers	Electronic Commerce Research and Application	Online-shopping	Spain	TPB	Questionnaire	998	SEM	A and SN significantly (positive) influence BI; PR significantly (negative) influence BI; PBC were insignificant on BI. Variance explained BI: 45.5%.

Table 2.6: Systematic Literature Review SSTs Acceptance Studies – Continued

No.	Author and Year of Publication	Title	Journal/ Conference	Technology Examined	Country	Model utilised	Data Collection Method	No. of Participants	Data Analysis	Relevant Findings
5	(Dimitriadis and Kyrezis, 2010)	Linking trust to use intention for technology-enabled bank channels: The role of trusting intentions	Psychology and Marketing	Online-banking	Greece	TAM	Questionnaire	763	SEM	Trust, PU, familiarity, stance to new technologies, and level of information significantly (positive) influence BI (internet banking); trust, PU, PEOU, INO, level of information significantly (positive) influence BI (phone banking). Variance explained BI: N/A
6	(Chiu Helena *et al.*, 2010)	Early versus potential adopters: Exploring the antecedents of use intention in the context of retail service innovations	International Journal of Retail and Distribution Management	Kiosk check-out (retailing)	China	UTAUT	Questionnaire	436	Multiple hierarchical regression	PE, EE, SI, FC significantly (positive) influence BI; Variance explained BI: 27.7%.
7	(Wessels and Drennan, 2010)	An investigation of consumer acceptance of m-banking	International Journal of Bank Marketing	m-banking	Australia	TAM	Questionnaire	314	Multiple hierarchical regression	PU, costs, compatibility, and attitude significantly (positive) influence BI. Variance explained BI: 83.8%.

Table 2.6: Systematic Literature Review SSTs Acceptance Studies – Continued

No.	Author and Year of Publication	Title	Journal/ Conference	Technology Examined	Country	Model utilised	Data Collection Method	No. of Participants	Data Analysis	Relevant Findings
8	(Çelik, 2011)	Influence of social norms, perceived playfulness and online shopping anxiety on customers' adoption of online retail shopping: An empirical study in the Turkish context	International Journal of Retail and Distribution Management	Online-shopping	Turkey	TAM	Questionnaire	278	SEM	PU, PEOU, perceived playfulness significantly (positive) influence BI. Variance explained BI: N/A
9	(Lin and Chang, 2011)	The role of technology readiness in self-service technology acceptance	Managing Service Quality	SSTs (general)	Taiwan	TAM	Questionnaire	410	SEM	PU, attitude, and technology readiness significantly (positive) influence BI. Variance explained BI: N/A
10	(Dimitriadis and Kyrezis, 2011)	The effect of trust, channel technology, and transaction type on the adoption of self-service bank channels	The Service Industries Journal	Online-/tele-banking	Greece	TAM	Questionnaire	762	SEM	Trust (trusting intention) significantly (positive) influence BI. Variance explained BI: N/A
11	(Yu, 2012)	Factors affecting individuals to adopt mobile banking: Empirical evidence from the UTAUT model	Journal of Electronic Commerce Research	m-banking	Taiwan	UTAUT	Questionnaire	441	SEM	PE, SI, and perceived credibility significantly (positive) influence BI; perceived financial costs significantly (negative) influence BI; EE insignificant on BI. Variance explained BI: 60.4%.

Table 2.6: Systematic Literature Review SSTs Acceptance Studies – Continued

No.	Author and Year of Publication	Title	Journal/ Conference	Technology Examined	Country	Model utilised	Data Collection Method	No. of Participants	Data Analysis	Relevant Findings
12	(Kaur and Gupta, 2012)	Consumers' Behavioral Intentions Toward Self-Service Technology in the Emerging Markets	Journal of Global Marketing	ATMs	India	TAM	Questionnaire	250	SEM	Attitude and service quality significantly (positive) influence BI. Variance explained BI: N/A
13	(Oghazi *et al.*, 2012)	Antecedents of Technology-based Self-Service Acceptance: A Proposed Model	Services Marketing Quarterly	Technology based Self-Services	Sweden	TAM	Questionnaire	288	SEM	PU, attitude, and enjoyment significantly (positive) influence BI. Variance explained BI: 73%.
14	(Yousafzai and Yani-de-Soriano, 2012)	Understanding customer-specific factors underpinning internet banking adoption	International Journal of Bank Marketing	Online-banking	UK	TAM	Questionnaire	435	SEM	PU significantly (positive) influences BI; PEOU insignificant on BI. Variance explained BI: 51%.
15	(Yang and Forney, 2013)	The moderating role of consumer technology anxiety in mobile shopping adoption: Differential effects of facilitating conditions and social influence	Journal of Electronic Commerce Research	Online-shopping	USA	UTAUT	Questionnaire	400	SEM	PE (utilitarian and hedonic), and SI significantly (positive) influence BI. Variance explained BI: N/A
16	(Ku and Chen, 2013)	Fitting facilities to self-service technology usage: Evidence from kiosks in Taiwan airport	Journal of Air Transport Management	Kiosk check-in at airports	Taiwan	TAM	Questionnaire	429	SEM	PU, FC, and process fit significantly (positive) influence BI; Variance explained BI: 46%.

Table 2.6: Systematic Literature Review SSTs Acceptance Studies – Continued

No.	Author and Year of Publication	Title	Journal/ Conference	Technology Examined	Country	Model utilised	Data Collection Method	No. of Participants	Data Analysis	Relevant Findings
17	(Lee *et al.*, 2014)	Empirical analysis of a self-service check-in implementation in Singapore Changi Airport	International Journal of Engineering Business Management	Kiosk check-in at airports	Singapore	TAM	Personal interviews	150	Regression Analysis	PU and A significantly (positive) influence BI; PR was insignificant on BI. Variance explained BI: N/A
18	(Wang *et al.*, 2014)	Virtually Compatible or Risk Business? Investigating Consumers' Proclivity Toward Online Banking	Journal of Marketing Channels	Online-banking	Taiwan	TAM	Questionnaire	594	SEM	A and perceived benefits/ compatibility significantly (positive) influence BI; PR significantly (negative) influences BI (PR studies as second-order factor). Variance explained BI: N/A
19	(Wu *et al.*, 2014)	A comprehensive examination of internet banking user behaviour: Evidence from customers yet to adopt, currently using and stopped using	Journal of Marketing Management	Online-banking	China	Combined TAM	Questionnaire	614	SEM	PU, PV, SN significantly (positive) influence BI (adoption intention); A, and PBC are insignificant on adoption intention. Variance explained BI: N/A
20	(Kim and Qu, 2014)	Travellers' behavioral intention towards hotel self-service kiosks usage	International Journal of Contemporary Hospitality Management	Self-check-in hotels	USA	TAM	Questionnaire	337	SEM	PU, A, and satisfaction significantly (positive) influence BI. Variance explained BI: N/A

Table 2.6: Systematic Literature Review SSTs Acceptance Studies – Continued

No.	Author and Year of Publication	Title	Journal/ Conference	Technology Examined	Country	Model utilised	Data Collection Method	No. of Participants	Data Analysis	Relevant Findings
21	(Morosan, 2014)	Toward an integrated model of adoption of mobile phones for purchasing ancillary services in air travel	International Journal of Contemporary Hospitality Management	Mobile shopping	USA	TAM	Questionnaire	556	SEM	A significantly (positive) influences BI. Variance explained BI: 84%.
22	(Lai, 2015)	Traveler Acceptance of an App-Based Mobile Tour Guide	International Journal of Hospitality & Tourism Research	App-based tour guide	China	UTAUT	Questionnaire	205	SEM	PE, EE, SI, FC, and informativeness significantly (positive) influence BI; entertainment was insignificant on BI. Variance explained BI: N/A
23	(Koenig-Lewis *et al.*, 2015b)	Enjoyment and social influence: Predicting mobile payment adoption	The Service Industries Journal	m-payment	France	TAM/ UTAUT	Questionnaire	316	SEM	PU, SI, and knowledge significantly (positive) influence BI; PR significantly (negative) influence BI; PEOU and perceived enjoyment are insignificant on BI. Variance explained BI: 62%.
24	(Kaushik and Rahman, 2015b)	Innovation adoption across self-service banking technologies in India	International Journal of Bank Marketing	Self-service banking technologies	India	TAM	Questionnaire	619	SEM	A significantly (positive) influences BI (in all three models); Variance explained BI: ATM: 49.8%; Phone banking: 19.2%; Kiosk: 39.2%.

Table 2.6: Systematic Literature Review SSTs Acceptance Studies – Continued

No.	Author and Year of Publication	Title	Journal/ Conference	Technology Examined	Country	Model utilised	Data Collection Method	No. of Participants	Data Analysis	Relevant Findings
25	(Al-Ajam and Md Nor, 2015)	Challenges of adoption of internet banking in Yemen	International Journal of Bank Marketing	Online-banking	Yemen	TPB	Questionnaire	1,286	SEM	A, SN, technology readiness significantly (positive) influence BI; Variance explained BI: 63.8%.
26	(Kapoor *et al.*, 2015)	Empirical Examination of the Role of Three Sets of Innovation Attributes for determining Adoption of IRCTC Mobile Ticketing Service	Information Systems Frontiers	Online-ticketing	India	DOI	Questionnaire	375	Linear and logistic regression analysis	Relative advantage, compatibility, triability, observability, cost, communicability, voluntariness, image, result demonstrability, and visibility significantly (positive) influence BI; Risk significantly (negative) influences BI; Complexity and social approval are insignificant on BI. Variance explained BI: 43%.
27	(Kaushik and Rahman, 2015a)	An alternative model of self-service retail technology adoption	Journal of Services Marketing	SSTs retail	India	TAM	Questionnaire	651	SEM	PU, SN, and A significantly (positive) influence BI. Variance explained BI: N/A
28	(López-Bonilla and López-Bonilla, 2015)	Self-consciousness profiles in the acceptance of airline e-ticketing services	Anatolia – An International Journal of Tourism and Hospitality Research	e-ticket booking	Spain	TAM	Questionnaire	819	SEM	PU, and A significantly (positive) influence BI. Variance explained BI: N/A

Table 2.6: Systematic Literature Review SSTs Acceptance Studies – Continued

No.	Author and Year of Publication	Title	Journal/ Conference	Technology Examined	Country	Model utilised	Data Collection Method	No. of Participants	Data Analysis	Relevant Findings
29	(Slade *et al.*, 2015)	Modeling Consumers' Adoption Intentions of Remote Mobile Payments in the United Kingdom: Extending UTAUT with Innovativeness, Risk, and Trust	Psychology and Marketing	m-payments	UK	UTAUT	Questionnaire	268	SEM	PE, SI, and INO significantly (positive) influence BI; PR significantly (negative) influences BI; EE and trust were insignificant on BI. Variance explained BI: 67%.
30	(Mortimer *et al.*, 2015)	Investigating the factors influencing the adoption of m-banking: a cross cultural study	International Journal of Bank Marketing	m-banking	Thailand / Australia	TAM	Questionnaire	175 (Thailand); 173 (Australia)	SEM	PU significantly (positive) influences BI (Tai sample and Australian), whereas PEOU did not in Australian sample. Need for interaction is not significant on BI (for both samples). PR is significant (negative) in both samples, SI is significant in Australia but not in Thailand. Variance explained BI: 59.3% Australia / 23.8% Thailand.

Table 2.6: Systematic Literature Review SSTs Acceptance Studies – Continued

No.	Author and Year of Publication	Title	Journal/ Conference	Technology Examined	Country	Model utilised	Data Collection Method	No. of Participants	Data Analysis	Relevant Findings
31	(Chiu and Hofer, 2015)	Service Innovation and usage intention: A cross market analysis	Journal of Service Management	SSTs retailing	Taiwan/ Austria	UTAUT	Questionnaire	387 (Taiwan); 353 (Austria)	Hierarchical Regression Analysis	PE significantly (positive) influences BI (both samples); EE significantly (positive) influences BI (in Taiwan sample), EE insignificant (in Austria sample); SI significantly (positive) influence BI (both samples), FC significantly (positive) influences BI (in Taiwan sample); FC insignificant (in Austria sample). Variance explained BI Austria: 15.3%; Variance explained BI Taiwan: 27.6%.
32	(Yeap *et al.*, 2016)	Factors propelling the adoption of m-learning among students in higher education	Electronic Markets	m-learning	Malaysia	TPB	Questionnaire	900	SEM	SN, PBC, and A significantly (positive) influence BI. Variance explained BI: 71.6%.
33	(Demoulin and Djelassi, 2016)	An integrated model of self-service technology (SST) usage in a retail context	Journal of Retail and Distribution Management	SSTs retailing	France	TAM3	Questionnaire	293	SEM/ logistic regression	PU, PEOU, PBC, and enjoyment significantly (positive) influence BI; need for interaction significantly (negative) influences BI; Variance explained BI: 59.9%.

Table 2.6: Systematic Literature Review SSTs Acceptance Studies – Continued

No.	Author and Year of Publication	Title	Journal/ Conference	Technology Examined	Country	Model utilised	Data Collection Method	No. of Participants	Data Analysis	Relevant Findings
34	(Alalwan *et al.*, 2016b)	Customers' Intention and Adoption of Telebanking in Jordan	Information Systems Management	Tele-banking	Jordan	UTAUT2	Questionnaire	323	SEM	PE, EE, HM, PV significantly (positive) influence BI; EE and SI were insignificant on BI. Variance explained BI: 75%.
35	(Alalwan *et al.*, 2016a)	Consumer adoption of mobile banking in Jordan: Examining the role of usefulness, ease of use, perceived risk and self-efficacy	Journal of Enterprise Information Management	m-banking	Jordan	TAM	Questionnaire	343	SEM	PU and PEOU significantly (positive) influence BI; PR significantly (negative) influences BI. Variance explained BI: 58%.
36	(Oh *et al.*, 2016)	Attitudinal and Situational Determinants of Self-Service Technology Use	Journal of Hospitality and Tourism Research	Self-check-in hotels	USA	TAM	Questionnaire	240	SEM	PU, PEOU, trust and waiting line significantly (positive) influence BI; service complexity and anxiety significantly (negative) influence BI. Variance explained BI: N/A
37	(Hur *et al.*, 2017)	Understanding usage intention in innovative mobile app service: Comparison between millennial and mature consumers	Consumers in Human Behavior	Fashion-shopping app	Korea	TAM	Questionnaire	1,288	SEM	PU and perceived playfulness significantly (positive) influence BI; PEOU is insignificant on BI. Variance explained BI: N/A

Table 2.6: Systematic Literature Review SSTs Acceptance Studies – Continued

No.	Author and Year of Publication	Title	Journal/ Conference	Technology Examined	Country	Model utilised	Data Collection Method	No. of Participants	Data Analysis	Relevant Findings
38	(Alalwan *et al.*, 2017)	Factors influencing adoption of mobile banking by Jordanian bank customers: Extending UTAUT2 with trust	International Journal of Information Management	m-banking	Jordan	UTAUT2	Questionnaire	343	SEM	PE, EE, HM, PV, and trust significantly (positive) influence BI; SI is insignificant on BI. Variance explained BI: 65%.
39	(Liébana-Cabanillas and Alonso-Dos-Santos, 2017)	Factors that determine the adoption of Facebook commerce: The moderating effect of age	Journal of Engineering and Technology Management	Online-commerce	Spain	TAM	Questionnaire	205	SEM	Perceived value, SN and PU significantly (positive) influence BI; social image, e-word-of-mouth were insignificant on BI; Variance explained BI: 85%.
40	(Leon, 2018)	Service mobile apps: a millennial generation perspective	Industrial Management & Data Systems	Mobile-apps	USA	TAM	Questionnaire	625	SEM	PU, PEOU and information quality significantly (positive) influence BI. Variance explained BI: 60.6%.
41	(Farah *et al.*, 2018)	Mobile-banking adoption: empirical evidence from the banking sector in Pakistan	International Journal of Bank Marketing	m-banking	Pakistan	UTAUT2	Questionnaire	368	SEM	PE, EE, SI, HM, perceived value significantly (positive) influence BI; trust and perceived risk are insignificant on BI. Variance explained BI: N/A

Table 2.6: Systematic Literature Review SSTs Acceptance Studies – Continued

No.	Author and Year of Publication	Title	Journal/ Conference	Technology Examined	Country	Model utilised	Data Collection Method	No. of Participants	Data Analysis	Relevant Findings
42	(Kaushik and Kumar, 2018)	Investigating consumers' adoption of SSTs – a case study representing India's hospitality industry	Journal of Vacation Marketing	SSTs hospitality	India	TAM	Questionnaire	648	SEM	PU significantly (positive) influence BI; need for interaction significantly (negative) influence BI. Variance explained BI: N/A
43	(Hota and Mishra, 2018)	Development and validation of a multivendor ATM adoption model in India	International Journal of Bank Marketing	ATMs	India	TAM	Questionnaire	372	SEM	Attitude, awareness, perception, and personal control significantly (positive) influence BI; personal control and perception are second-order factors. Variance explained BI: N/A
44	(Yahia *et al.*, 2018)	Investigating the drivers for social commerce in social media platforms: Importance of trust, social support and the platform perceived usage	Journal of Retailing and Consumer Services	social-commerce	Gulf-countries	UTAUT2	Questionnaire	205	SEM	PEOU, HM, FC, H, and trust of vendor significantly (positive) influence BI. Variance explained BI: N/A
45	(Su *et al.*, 2018)	How users' Internet experience affects the adoption of mobile payment: a mediation model	Technology Analysis and Strategic Management	m-payment	China	TAM/DOI	Questionnaire	922	SEM	PU, PEOU, perceived compatibility experience, significantly (positive) influence BI; Perceived risk and privacy concerns significantly (negative) influence BI. Variance explained BI: N/A.

Table 2.6: Systematic Literature Review SSTs Acceptance Studies – Continued

No.	Author and Year of Publication	Title	Journal/ Conference	Technology Examined	Country	Model utilised	Data Collection Method	No. of Participants	Data Analysis	Relevant Findings
46	(Saprikis *et al.*, 2018)	Mobile shopping consumers' behavior: An exploratory study and review	Journal of Theoretical and Applied Electronic Commerce Research	Mobile-shopping	Greece	TAM/DOI	Questionnaire	473	SEM	PU, relationship drivers, enjoyment, and innovativeness significantly (positive) influence BI; PEOU, anxiety, skilfulness, trust are insignificant on BI. Variance explained BI: 80%.
47	(Kazancoglu and Kursunluoglu Yarimoglu, 2018)	How food retailing changed in Turkey: spread of self-service technologies	British Food Journal	Self-check-outs supermarkets	Turkey	TAM	Questionnaire	500	SEM	PU and PEOU significantly (positive) influence BI; Anxiety significantly (negative) influence BI; need for interaction, situational factors, PR are insignificant on BI. Variance explained BI: N/A
48	(Yuen *et al.*, 2018)	An investigation of customers' intention to use self-collection services for last-mile delivery	Transport Policy	Self-collection services last-mile delivery	Singapore	DOI	Questionnaire	164	Hierarchical regression	Compatibility, relative advantage, and triability significantly (positive) influence BI; Complexity and observability are insignificant on BI. Variance explained BI: 42.1%.

Table 2.6: Systematic Literature Review SSTs Acceptance Studies – Continued

No.	Author and Year of Publication	Title	Journal/ Conference	Technology Examined	Country	Model utilised	Data Collection Method	No. of Participants	Data Analysis	Relevant Findings
49	(Wang *et al.*, 2018a)	An innovation diffusion perspective of e-consumers initial adoption of self-collection service via automated parcel station	International Journal of Logistics Management	Self-collection services last-mile delivery	Singapore	DOI	Questionnaire	170	SEM	A, and perceived relative advantage significantly (positive) influence BI. Variance explained BI: 68.4%.
50	(Alalwan *et al.*, 2018b)	Examining factors influencing Jordanian customers' intentions and adoption of internet banking: Extending UTAUT2 with risk	Journal of Retailing and Consumer Services	Online-banking	Jordan	UTAUT2	Questionnaire	348	SEM	PE, EE, PV, and HM significantly (positive) influence BI; SI is insignificant on BI. Variance explained BI: 64%.
51	(Owusu Kwateng *et al.*, 2018)	Acceptance and use of mobile banking: an application of UTAUT2	Journal of Enterprise and Information Management	m-banking	Ghana	UTAUT2	Questionnaire	300	SEM	H, PV, and trust significantly (positive) influence BI; PE, EE, SI, and HM are insignificant on BI. Variance explained BI: 35%.
52	(Giovanis *et al.*, 2018)	Adoption of mobile self-service retail banking technologies: The role of technology, social, channel and personal factors	Journal of Retail and Distribution Management	m-banking	Greece	UTAUT	Questionnaire	513	SEM	PE, EE, SI, and trust significantly (positive) influence BI; PR significantly (negative) influences BI. Variance explained BI: 60.1%.

Table 2.6: Systematic Literature Review SSTs Acceptance Studies – Continued

No.	Author and Year of Publication	Title	Journal/ Conference	Technology Examined	Country	Model utilised	Data Collection Method	No. of Participants	Data Analysis	Relevant Findings
53	(Roy *et al.*, 2018)	Predictors of customer acceptance of and resistance to smart technologies in the retail sector	Journal of Retailing and Consumer Services	Smart technologies in retailing	Australia	TAM	Questionnaire	361	SEM	PU and A significantly (positive) influence BI. Variance explained BI: N/A

(6) Synthesis

Most articles utilised TAM (n = 27) as their baseline model to investigate behavioural intention, which still shows the high applicability and dominance of TAM. This is followed by UTAUT/UTAUT2 (n = 13), TAM extensions, or combinations with other theories (n = 7), TPB (n = 3), and DOI (n = 3). Furthermore, most articles were published in the year 2018 (n = 14), followed by the years 2015 (n = 10), 2016 (n = 5), 2014 (n = 5), 2012 (n = 4), 2010 (n = 4), 2017 (n = 3), 2011 (n = 3), 2013 (n = 2), 2009 (n = 2), and 2008 (n = 1). The fact that more than 50 percent of the studies (n = 34) were published in the last four years shows the growing interest in SSTs acceptance research, which is linked to the larger number of SSTs available nowadays compared to 10 years ago.

It is worth mentioning that almost 50 percent (n = 22) of the studies investigated SSTs in the context of the banking industry (i.e., ATMs, online banking, mobile banking, mobile payment, etc.), which also reflects the journals used. For instance, most papers were published in the International Journal of Bank Marketing (n = 7), followed by the International Journal of Retail and Distribution Management (n = 4), and the Journal of Retailing and Consumer Services (n = 3). The remaining papers were published in a variety of different journals, indicating the broad range of fields affected by SSTs.

Regarding the methods used, all articles used questionnaires (i.e., field or online) as the primary data collection method. The studies took place not only in Europe (i.e., France, Greece, Spain, Sweden, Austria, UK; n = 13) but also in the USA (n = 5), Asian-Pacific (Australia, China, India, Korea, Malaysia, Singapore, and Taiwan; n = 25), the Middle East (Gulf countries, Jordan, Pakistan, Yemen; n = 9), and Africa (Ghana; n = 1). Interestingly, no study took place in Germany, which shows the need to investigate SSTs acceptance in the German culture. Considering the data analysis technique, the majority of studies applied structural equation modelling (n = 47), followed by regression analysis (i.e., simple, multiple, hierarchical; n = 6). In terms of the authors in the field of SSTs, four papers were published by Alalwan, two by Chiu, two by Kaushik, whereas the rest of the authors only published one paper.

After the studies have been presented in detail, a further synthesis of the constructs applied to investigate behavioural intention in the context of SSTs will be undertaken. This is necessary to clearly identify the constructs that have been used in the context of SSTs in the last ten years.

2.6.3.2 Construct Analysis of SSTs Acceptance Studies

In this subchapter, the identified papers are analysed in detail on the factors that were used to determine user acceptance (i.e., behavioural intention). Constructs that have been part of one of the existing technology acceptance theories and are conceptually overlapping, for instance, performance expectancy (UTAUT) and usefulness (TAM), are merged under the labels of UTAUT/UTAUT2, which have been applied in this research study and comprises the most advanced research model in technology acceptance research to date.

In addition to the original constructs studied in one of the technology acceptance theories, 47 external constructs were identified, which were used to determine behavioural intention: information quality, perceived process fit, perceived value, social image, perceived risk, electronic word-of-mouth, trust in technology, trust in vendor, need for interaction, awareness, attitude, familiarity, stance to new technology, level of information, service quality, perceived resources, perception, personal control, perceived compatibility, privacy concerns, experience, skilfulness, enjoyment, anxiety, innovativeness, relationship drivers, situational factors, perceived playfulness, service complexity, waiting line, informativeness, entertainment, knowledge, technology readiness, observability, communicability, service approval, voluntariness, image, result demonstrability, visibility, social approval, satisfaction, perceived credibility, perceived financial costs, perceived service quality, and triability.

With focus on the UTAUT model, Venkatesh *et al.* (2012) noted that the addition of additional constructs has mainly been on an ad hoc basis and that the works have not necessarily attempted to systematically choose complementary constructs to what is already captured in UTAUT. Furthermore, they argue that only complementary constructs can help expand the generalisability and scope of the model. Thus, a detailed analysis of the constructs (i.e., items and/or definitions) was undertaken to conceptually identify new constructs. This analysis revealed that several studies used various labels for the same construct. If possible, these were subsumed under the UTAUT2 labels:

First, enjoyment (Oghazi *et al.*, 2012; Demoulin and Djelassi, 2016; Saprikis *et al.*, 2018; Koenig-Lewis *et al.*, 2015b), playfulness (Hur *et al.*, 2017), and entertainment (Lai, 2015) are all used to describe the status of fun, enjoyment, or pleasure derived from using a technology and therefore are conceptually similar to hedonic motivation in UTAUT2. Therefore, they will be subsumed under “hedonic motivation” in this study.

Second, service complexity (Oh *et al.*, 2016), which describes the overall perception a consumer has about a particular self-service technology, is conceptually similar to effort expectancy in UTAUT2. Therefore, service complexity is subsumed under the label of “effort expectancy” in this thesis.

Third, perceived resources (Marler *et al.*, 2009), which describes external facilitating conditions; knowledge (Koenig-Lewis *et al.*, 2015b), which describes the internal facilitating conditions; skilfulness (Saprikis *et al.*, 2018), which describes the ability to fulfil a task; and compatibility (Wessels and Drennan, 2010; Kapoor *et al.*, 2015; Su *et al.*, 2018; Yuen *et al.*, 2018), which describes the compatibility of the technology with the lifestyle, values, and needs, are conceptually similar. All of these constructs are operationalised to remove barriers to use a certain technology. Therefore, they are overlapping with facilitating conditions in UTAUT2. These constructs are labelled “facilitating conditions” in this thesis.

Fourth, image (Kapoor *et al.*, 2015) and social image (Liébana-Cabanillas and Alonso-Dos-Santos, 2017) both describe the fact that by using the technology, ones’ status or image improves within a social system. These constructs are conceptually similar to social influence within the UTAUT2. Here, Venkatesh *et al.* (2003) also subsumed image under the term “social influence”. Therefore, within this thesis these constructs are summarised under the label “social influence”.

Fifth, innovativeness (Dimitriadis and Kyrezis, 2010; Slade *et al.*, 2015; Saprikis *et al.*, 2018; Giovanis *et al.*, 2018) is part of the technology readiness construct (Lin and Chang, 2011; Al-Ajam and Md Nor, 2015), and therefore these constructs overlap significantly. Due to the fact that innovativeness has most often been studied in the reviewed articles and has also been found to be the most important factor in technology readiness (Al-Ajam and Md Nor, 2015), these terms will be merged under the label “innovativeness” in this thesis.

Sixth, familiarity (Dimitriadis and Kyrezis, 2010), which refers to the experience of a person with certain technologies, is conceptually similar to experience (Su *et al.*, 2018). In this thesis these constructs will be labelled under the term “familiarity”.

Finally, it is worth mentioning that there are still constructs like social approval (Kapoor *et al.*, 2015) overlapping with social influence, visibility (Kapoor *et al.*, 2015) overlapping with observability, or information quality (Leon, 2018) overlapping with level of information (Dimitriadis and Kyrezis, 2010), which, despite their overlapping edges, are treated as unique constructs in this thesis. This is the case because the authors clearly stated the uniqueness of these constructs despite their similarity to other constructs.

Overall, this construct analysis revealed 34 conceptually new external constructs that have been studied to determine behavioural intention in the area of SSTs acceptance research. Table 2.7 provides a detailed overview of the constructs that were already studied in UTAUT2 and Table 2.8 provides a detailed overview of the external constructs studied in the context of SSTs. Both tables are presented on the following pages.

Table 2.7: Constructs Analysis SSTs Acceptance Studies – UTAUT2 Constructs

No.	Independent UTAUT2 Constructs	Frequency			References
		total	Significant	Insignificant	
1	Performance Expectancy (PE)	40	40	0	**Significant:** (Wessels and Drennan, 2010; Dimitriadis and Kyrezis, 2010; Chiu Helena *et al.*, 2010; Lin and Chang, 2011; Çelik, 2011; Yu, 2012; Yousafzai and Yani-de-Soriano, 2012; Oghazi *et al.*, 2012; Yang and Forney, 2013; Ku and Chen, 2013; Wu *et al.*, 2014; Lee *et al.*, 2014; Kim and Qu, 2014; Slade *et al.*, 2015; Mortimer *et al.*, 2015; López-Bonilla and López-Bonilla, 2015; Lai, 2015; Koenig-Lewis *et al.*, 2015b; Kaushik and Rahman, 2015a; Kapoor *et al.*, 2015; Chiu and Hofer, 2015; Oh *et al.*, 2016; Demoulin and Djelassi, 2016; Alalwan *et al.*, 2016b; Alalwan *et al.*, 2016a; Liébana-Cabanillas and Alonso-Dos-Santos, 2017; Hur *et al.*, 2017; Alalwan *et al.*, 2017; Yuen *et al.*, 2018; Wang *et al.*, 2018a; Su *et al.*, 2018; Saprikis *et al.*, 2018; Roy *et al.*, 2018; Leon, 2018; Owusu Kwateng *et al.*, 2018; Kazancoglu and Kursunluoglu Yarimoglu, 2018; Kaushik and Kumar, 2018; Farah *et al.*, 2018; Giovanis *et al.*, 2018; Alalwan *et al.*, 2018b)
2	Effort Expectancy (EE)	27	18	9	**Significant:** (Chiu Helena *et al.*, 2010; Çelik, 2011; Yousafzai and Yani-de-Soriano, 2012; Mortimer *et al.*, 2015; Lai, 2015; Chiu and Hofer, 2015; Oh *et al.*, 2016; Demoulin and Djelassi, 2016; Alalwan *et al.*, 2016a; Alalwan *et al.*, 2017; Yahia *et al.*, 2018; Su *et al.*, 2018; Leon, 2018; Kazancoglu and Kursunluoglu Yarimoglu, 2018; Farah *et al.*, 2018; Giovanis *et al.*, 2018; Alalwan *et al.*, 2018b; Owusu Kwateng *et al.*, 2018) **Insignificant:** (Yu, 2012; Slade *et al.*, 2015; Koenig-Lewis *et al.*, 2015b; Kapoor *et al.*, 2015; Chiu and Hofer, 2015; Alalwan *et al.*, 2016b; Hur *et al.*, 2017; Yuen *et al.*, 2018; Saprikis *et al.*, 2018)
3	Social Influence (SI)	22	19	3	**Significant:** (Marler *et al.*, 2009; Herrero Crespo and Rodriguez del Bosque, 2010; Chiu Helena *et al.*, 2010; Yu, 2012; Yang and Forney, 2013; Wu *et al.*, 2014; Slade *et al.*, 2015; Mortimer *et al.*, 2015; Lai, 2015; Koenig-Lewis *et al.*, 2015b; Kaushik and Rahman, 2015a; Chiu and Hofer, 2015; Al-Ajam and Md Nor, 2015; Yeap *et al.*, 2016; Liébana-Cabanillas and Alonso-Dos-Santos, 2017; Owusu Kwateng *et al.*, 2018; Farah *et al.*, 2018; Giovanis *et al.*, 2018; Kapoor *et al.*, 2015) **Insignificant:** (Alalwan *et al.*, 2017; Alalwan *et al.*, 2016b; Alalwan *et al.*, 2018b)

Table 2.7: Constructs Analysis SSTs Acceptance Studies – UTAUT2 Constructs – Continued

No.	Independent UTAUT2 Constructs	Frequency			References
		Total	Significant	Insignificant	
4	Facilitating Conditions (FC)	21	16	5	**Significant:** (Lu *et al.*, 2009; Chiu Helena *et al.*, 2010; Ku and Chen, 2013; Lai, 2015; Chiu and Hofer, 2015; Yeap *et al.*, 2016; Demoulin and Djelassi, 2016; Alalwan *et al.*, 2016b; Yahia *et al.*, 2018; Owusu Kwateng *et al.*, 2018; Marler *et al.*, 2009; Koenig-Lewis *et al.*, 2015b; Wessels and Drennan, 2010; Kapoor *et al.*, 2015; Su *et al.*, 2018; Yuen *et al.*, 2018) **Insignificant:** (Herrero Crespo and Rodriguez del Bosque, 2010; Wu *et al.*, 2014; Chiu and Hofer, 2015; Farah *et al.*, 2018; Saprikis *et al.*, 2018)
5	Hedonic Motivation (HM)	12	10	2	**Significant:** (Alalwan *et al.*, 2016b; Alalwan *et al.*, 2017; Yahia *et al.*, 2018; Owusu Kwateng *et al.*, 2018; Farah *et al.*, 2018; Alalwan *et al.*, 2018b; Oghazi *et al.*, 2012; Demoulin and Djelassi, 2016; Saprikis *et al.*, 2018; Hur *et al.*, 2017) **Insignificant:** (Koenig-Lewis *et al.*, 2015b; Lai, 2015)
6	Habit (H)	2	2	0	**Significant:** (Yahia *et al.*, 2018; Owusu Kwateng *et al.*, 2018)
7	Price Value (PV)	4	4	0	**Significant:** (Alalwan *et al.*, 2016a; Alalwan *et al.*, 2017; Owusu Kwateng *et al.*, 2018; Alalwan *et al.*, 2018b)

Table 2.8: Constructs Analysis SSTs Acceptance Studies – External Constructs

No.	Independent <u>External</u> Constructs	Frequency			References
		Total	Significant	Insignificant	
1	Attitude (A)	18	17	1	**Significant:** (Kim and Forsythe, 2008; Marler *et al.*, 2009; Lu *et al.*, 2009; Herrero Crespo and Rodriguez del Bosque, 2010; Lin and Chang, 2011; Oghazi *et al.*, 2012; Kaur and Gupta, 2012; Morosan, 2014; Lee *et al.*, 2014; Kim and Qu, 2014; López-Bonilla and López-Bonilla, 2015; Kaushik and Rahman, 2015b, 2015a; Al-Ajam and Md Nor, 2015; Yeap *et al.*, 2016; Roy *et al.*, 2018; Hota and Mishra, 2018) **Insignificant:** (Wu *et al.*, 2014)
2	Perceived Risk (PR)	14	11	3	**Significant:** (Lu *et al.*, 2009; Herrero Crespo and Rodriguez del Bosque, 2010; Wang *et al.*, 2014; Slade *et al.*, 2015; Mortimer *et al.*, 2015; Kapoor *et al.*, 2015; Alalwan *et al.*, 2016a; Alalwan *et al.*, 2016b; Su *et al.*, 2018; Giovanis *et al.*, 2018; Alalwan *et al.*, 2018b) **Insignificant:** (Lee *et al.*, 2014; Kazancoglu and Kursunluoglu Yarimoglu, 2018; Farah *et al.*, 2018)
3	Trust in Technology (TT)	11	9	2	**Significant:** (Dimitriadis and Kyrezis, 2011, 2010; Kaushik and Rahman, 2015a; Oh *et al.*, 2016; Liébana-Cabanillas and Alonso-Dos-Santos, 2017; Alalwan *et al.*, 2017; Saprikis *et al.*, 2018; Owusu Kwateng *et al.*, 2018; Giovanis *et al.*, 2018) **Insignificant:** (Slade *et al.*, 2015; Farah *et al.*, 2018)
4	Innovativeness (INO)	7	7	0	**Significant:** (Kim and Forsythe, 2008; Dimitriadis and Kyrezis, 2010; Slade *et al.*, 2015; Saprikis *et al.*, 2018; Giovanis *et al.*, 2018; Al-Ajam and Md Nor, 2015; Lin and Chang, 2011)
5	Need for Interaction	5	3	2	**Significant:** (Lu *et al.*, 2009; Demoulin and Djelassi, 2016; Kaushik and Kumar, 2018) **Insignificant:** (Mortimer *et al.*, 2015; Kazancoglu and Kursunluoglu Yarimoglu, 2018)

Table 2.8: Constructs Analysis SSTs Acceptance Studies – External Constructs – Continued

No.	Independent External Constructs	Frequency			References
		Total	Significant	Insignificant	
6	Perceived financial costs	3	3	0	**Significant:** (Wessels and Drennan, 2010; Yu, 2012; Kapoor *et al.*, 2015)
7	Perceived Value	3	3	0	**Significant:** (Wu *et al.*, 2014; Liébana-Cabanillas and Alonso-Dos-Santos, 2017; Farah *et al.*, 2018)
8	Trust in Vendor	2	2	0	**Significant:** (Yahia *et al.*, 2018; Owusu Kwateng *et al.*, 2018)
9	Familiarity	2	2	0	**Significant:** (Dimitriadis and Kyrezis, 2010; Su *et al.*, 2018)
10	Perceived Service Quality	2	2	0	**Significant:** (Lu *et al.*, 2009; Kaur and Gupta, 2012)
11	Anxiety	4	2	2	**Significant:** (Oh *et al.*, 2016; Kazancoglu and Kursunluoglu Yarimoglu, 2018) **Insignificant:** (Kim and Forsythe, 2008; Saprikis *et al.*, 2018)
12	Communica-bility	2	2	0	**Significant:** (Wang *et al.*, 2014; Kapoor *et al.*, 2015)
13	Information Quality	1	1	0	**Significant:** (Leon, 2018)
14	Service Process Fit	1	1	0	**Significant:** (Ku and Chen, 2013)
15	Awareness	1	1	0	**Significant:** (Hota and Mishra, 2018)

Table 2.8: Constructs Analysis SSTs Acceptance Studies – External Constructs – Continued

No.	Independent **External** Constructs	Frequency			References
		Total	Significant	Insignificant	
16	Stance to New Technology	1	1	0	**Significant:** (Dimitriadis and Kyrezis, 2010)
17	Level of Information	1	1	0	**Significant:** (Dimitriadis and Kyrezis, 2010)
18	Perception	1	1	0	**Significant:** (Hota and Mishra, 2018)
19	Privacy Concerns	1	1	0	**Significant:** (Su *et al.*, 2018)
20	Relationship Driver	1	1	0	**Significant:** (Saprikis *et al.*, 2018)
21	Waiting Line	1	1	0	**Significant:** (Oh *et al.*, 2016)
22	Informativeness	1	1	0	**Significant:** (Lai, 2015)
23	Observability	2	1	1	**Significant:** (Kapoor *et al.*, 2015) **Insignificant:** (Yuen *et al.*, 2018)
24	Service Approval	1	1	0	**Significant:** (Kapoor *et al.*, 2015)
25	Voluntariness	1	1	0	**Significant:** (Kapoor *et al.*, 2015)

Table 2.8: Constructs Analysis SSTs Acceptance Studies – External Constructs – Continued

No.	**Independent <u>External</u> Constructs**	**Frequency**			**References**
		Total	Significant	insignificant	
26	Result Demonstrability	1	1	0	**Significant:** (Kapoor *et al.*, 2015)
27	Visibility	1	1	0	**Significant:** (Kapoor *et al.*, 2015)
28	Satisfaction	1	1	0	**Significant:** (Kim and Qu, 2014)
29	Perceived Credibility	1	1	0	**Significant:** (Yu, 2012)
30	Triability	1	1	0	**Significant:** (Yuen *et al.*, 2018)
31	Personal Control	1	1	0	**Significant:** (Hota and Mishra, 2018)
32	Electronic Word of Mouth	1	0	1	**Insignificant:** (Liébana-Cabanillas and Alonso-Dos-Santos, 2017)
33	Situation Factors	1	0	1	**Insignificant:** (Kazancoglu and Kursunluoglu Yarimoglu, 2018)
34	Social Approval	1	0	1	**Insignificant:** (Kapoor *et al.*, 2015)

Considering the findings of the construct analysis in the research field of SSTs, *attitude, perceived risk, trust in technology, and innovativeness* were most often included to investigate SSTs and also most often found significant on behavioural intention. Therefore, for the context of SSTs, it is assumed that these constructs are the most critical factors alongside the general acceptance constructs regularly provided in the acceptance models. Nevertheless, it is important to mention at this stage that attitude is used in many cases as a mediator as in the original theory of reasoned action (Ajzen and Fishbein, 1975) and theory of planned behaviour (Ajzen, 1985, 1991). For instance, attitude was used for mediating the effects of perceived usefulness or perceived ease of use (Marler *et al.*, 2009; Kim and Forsythe, 2008; Morosan, 2014). Moreover, even the effect of perceived risk and trust in technology were proposed to be mediated by attitude (Kaushik and Rahman, 2015b; Morosan, 2014). However, this study follows the stream of authors who argue that attitude is not a significant predictor of behavioural intention and external constructs influence behavioural intention directly, which was found in several previous studies (Davis *et al.*, 1989; Taylor and Todd, 1995c; Venkatesh *et al.*, 2003; Venkatesh *et al.*, 2012). Therefore, attitude, at this stage, is not considered as a potential framework extension construct.

In the next subchapter, the second related research field, i.e., autonomous vehicles (AVs), will be presented in detail. It will start with a brief overview of public opinion surveys before it turns to the systematic review of AVs acceptance studies.

2.6.4 User Acceptance of Autonomous Vehicles

Autonomous vehicles (AVs) are defined as self-driving vehicles that fulfil their driving tasks without human intervention (Piao *et al.*, 2016; Hulse *et al.*, 2018). Vehicles that are equipped with advanced driver assistant systems are considered semi-autonomous vehicles in this thesis. AVs are still in their infancy and the main focus of research has been on technical aspects or the feasibility of AVs as well as the impacts on safety and congestion (Urmson *et al.*, 2008). However, the focus on user-centred aspects like acceptance and utilisation is still limited. In this regard, Becker and Axhausen (2017) conducted a meta-analysis on surveys investigating the public opinion and perceptions on autonomous vehicles (see Table 2.9).

Table 2.9: Public Opinion Studies of AVs adopted from Becker and Axhausen (2017)

Reference	Method	Country	No. of respondents
(J.D. Power, 2012)	N/A	USA	17,400
(Silberg *et al.*, 2013)	Focus groups	USA	32
(Continental, 2013, 2014)	N/A	Germany, USA, China, Japan	N/A
(Payre *et al.*, 2014)	Interview/paper-based/online survey	France	5/45/421
(Howard and Dai, 2014)	Paper-based survey	USA	107
(Rödel *et al.*, 2014)	Online survey	Austria	336
(Deloitte, 2014)	N/A	19 countries	23,000
(IPSOS Mori, 2014)	Interviews	UK	1,001
(Seapin Software, 2014)	Online survey	USA	2,039
(Schoettle and Sivak, 2014b)	Online survey	USA, UK, Australia	1,533
(Schoettle and Sivak, 2015)	Online survey	USA	505
(Kyriakidis *et al.*, 2015)	Online survey	109 countries	4,886
(Bansal and Kockelman, 2016)	Online survey	USA	2,167
(Bansal *et al.*, 2016)	Online survey	USA	347

The main findings of public opinion surveys on AVs can be summarised as (1) system specific characteristics, (2) individual characteristics (e.g., socio-demographic characteristics and mobility characteristics), and (3) contextual characteristics (Nordhoff *et al.*, 2016). System-specific characteristics, for instance, involve findings that AVs are believed to reduce crashes, lead to fewer emissions and less fuel consumption (Schoettle and Sivak, 2014a), and can be used when under medication or alcohol (Payre *et al.*, 2014). Individual characteristics, for instance, involve the findings that men are on average more willing to adopt, use, and buy AVs than women (Payre *et al.*, 2014; Kyriakidis *et al.*, 2015), and elderly people generally have a lower willingness to pay for such systems (Kyriakidis *et al.*, 2015; J.D. Power, 2012) Finally, the contextual characteristics, for example, comprise the findings that people would prefer to use autonomous vehicles in monotonous and stressful situations (Continental, 2013, 2014).

However, these public opinion surveys did not follow any theoretical model to explain user acceptance of AVs (Zmud *et al.*, 2016; Zmud and Sener, 2017). Therefore, the knowledge of users' intention to actually use AVs in the future is still very limited (Panagiotopoulos and Dimitrakopoulos, 2018). In this context, Buckley *et al.* (2018, p. 202) argue that using "a theory provides a grounded framework from which to develop future efforts and using an established theory reduces the potential for a haphazard approach to understanding a phenomenon." Therefore, by utilising psychological theory (e.g., UTAUT) in the context of AVs, the investigation moves beyond the use of individual characteristics (e.g., age, gender) that cannot be amended, and as such provides modifiable variables for change (Buckley *et al.*, 2018). Therefore, as within the area of SSTs, a systematic literature review was undertaken to identify relevant acceptance studies, which utilised one of the existing technology acceptance theories in the context of AVs. The review followed the same steps as for the systematic review of SSTs acceptance studies in the previous subchapter.

2.6.4.1 Systematic Review of AVs Acceptance Studies

(1) Purpose of the Literature Review

The systematic literature review of AVs acceptance studies was conducted in November 2018, with the aim to create an overview of the various constructs studied in the field of AVs acceptance. However, as stated before, the review aims to provide a snapshot of the current state of acceptance research conducted in the area of AVs. It does not, however, pretend to cover the sum of all literature available. It rather aims to offer an informative and focused evaluation of purposefully selected literature.

(2) Identification/Literature Search

The same databases were used as for the systematic review of SSTs (i.e., Scopus and Web of Science). Since this systematic review focuses on autonomous vehicles, this term is used as a search term in combination with related terms that were used intermingled and interchangeable in the public opinion survey presented in the previous subchapter (i.e., automated vehicle and self-driving vehicle). Besides the change of the keywords in the first bracket, the systematic review included the same keywords as those within the search for SSTs acceptance studies. As a result, the following search string was developed and applied:

(“autonomous vehicle” OR “automated vehicle*” OR “self-driving vehicle*” OR AV*) AND (adoption OR acceptance OR “user acceptance” OR “technology acceptance” OR “technology adoption” OR consumer) AND (“unified theory of acceptance and use of technology” OR utaut OR utaut2 OR “technology acceptance model” OR tam OR tam2 OR tam3 OR “theory of reasoned action” OR tra OR “theory of planned behavio*” OR tpb OR “diffusion of innovation” OR “innovation diffusion theory” OR doi OR idt OR “social cognitive theory” OR sct OR “combined tam” OR c-tam OR ”combined tam-tpb” OR “motivational model” OR mm OR “model of pc-utilization” OR mpcu)*

The initial search on Scopus and Web of Science encompassed *“all fields”* for the first bracket *(“autonomous vehicle*” OR “automated vehicle*” OR “self-driving vehicle*” OR AV*)* to be able to capture as many papers as possible that have investigated these vehicles in the context of technology acceptance theories. The rest of the search string was limited to title, abstract, or keywords to increase the likelihood to identify papers that have actually investigated user acceptance and utilised one of the technology acceptance theories. As within the search of SSTs studies, the timespan was limited to the last 10 years (2008 – 2018) as well as to English publications. Overall, this search strategy yielded **a total of 31 papers on Scopus and 30 papers on Web of Science,** indicating that little research exists on the acceptance of AVs within the existing technology acceptance theories domain.

(3) Screening

The identified papers were checked for accessibility in the first step. This revealed 24 papers on Scopus and 25 papers on Web of Science (i.e., 49 accessible papers). Furthermore, the papers identified in both databases were compared based on their title to identify any overlaps. In total, 7 papers overlapped, leaving 42 individual papers (i.e., 17 unique papers on Scopus, 18 unique papers on Web of Science, and 7 overlapping papers). As a next step, the titles and the abstracts of the identified and accessible papers were screened based on two criteria. First, it was checked whether the paper actually investigated autonomous vehicles or any related area (e.g., semi-autonomous vehicles/advanced driver support systems). The screening process revealed 25 articles that actually investigated AVs as the main object (i.e., 10 unique AVs papers on Scopus, 8 unique AVs papers on Web of Science, and 7 overlapping AVs papers). Second, it was checked whether these articles utilised one of the main technology acceptance theories as a baseline model in their research to investigate technology acceptance. This process revealed a total of 20 papers that actually investigated AVs technology and utilised a technology acceptance theory (i.e., 9 unique papers on Scopus, 4 unique papers on Web of Science, and 7 overlapping papers).

(4) Eligibility

Those papers identified in the first screening process (i.e., title and abstract screening) were then fully reviewed (i.e., full-text) based on three further screening criteria. First, it was checked whether the main methodology was quantitative in nature and investigated the constructs and their relationships empirically. As a result, 16 papers were identified (i.e., 7 unique papers on Scopus, 4 unique papers on Web of Science, and 5 overlapping papers). Second, only studies that analysed the relationships between their proposed constructs and behavioural intention were selected, revealing 14 papers (7 unique papers on Scopus, 3 unique papers on Web of Science, and 4 overlapping papers). Third, only studies that provided statistical evidence (e.g., regression coefficients) for the impact of the constructs on behavioural intention were selected for data synthesis. As a result, all studies provided this information. Additionally, the detailed review identified two papers that used the same data (Zmud *et al.*, 2016; Zmud and Sener, 2017); therefore, only one paper was included for further analysis. In total, 13 articles were identified that fulfilled all inclusion criteria (Choi and Ji, 2015; Madigan *et al.*, 2016; Zmud *et al.*, 2016; Angelis *et al.*, 2017; Rahman *et al.*, 2017; Moták *et al.*, 2017; Leicht *et al.*, 2018; Madigan *et al.*, 2017; Chen and Yan, 2018; Panagiotopoulos and Dimitrakopoulos, 2018; Buckley *et al.*, 2018; Xu *et al.*, 2018; Rahman *et al.*, 2018).

In this regard, it is worth mentioning that many of the papers found through the initial search cross-referenced the other papers from the initial search, which proves that the identified papers are the leading articles in the field of AVs acceptance research when applying an acceptance model.

Since the number of studies identified through the database search was limited, an additional backwards search was conducted in the field of AVs. In doing so, the references of the identified papers were screened regarding the following keywords: “autonomous vehicle*” OR “automated vehicle*” OR “self-driving vehicle*”.

Additionally, since the initial search also identified papers that investigated semi-autonomous vehicles (i.e., investigation of advanced driver support systems/assistance systems), these terms were also included into the backwards search. As with the initial search only papers published between 2008 – 2018 were considered. In this step 65 potential papers were identified through the backwards search. However, 13 articles were excluded because they cross-referenced the papers already identified, which left 52 potential articles. Out of these, 18 papers overlapped; thus, revealing 34 individual papers. These papers were further checked for accessibility. As a result, 29 papers could be downloaded. Following this step, the abstracts were screened to determine whether the study actually investigated AVs or semi-AVs as the main objective and whether a technology acceptance theory had been utilised. As a result, three additional studies could be identified, and a full screen was undertaken (i.e., main methodology: quantitative; studying the relationship to behavioural intention; statistical evidence). All three papers fulfilled the inclusion criteria and were therefore also selected for construct analysis in the next step (Adell, 2010; Kervick *et al.*, 2015; Lee *et al.*, 2017).

In total, applying this search strategy combined with the backwards search, 16 papers were identified in the field of AVs acceptance research that utilised one of the main technology acceptance theories and supplied empirical evidence as well as investigated the impact of the constructs on behavioural intention. This implies that little research has been conducted in the field of user acceptance of autonomous vehicles by utilising one of the existing technology acceptance theories. Therefore, the decision was made to incorporate all papers found (journal and conference papers) into the data extraction stage.

(5) Data extraction

These papers were coded with the following codes: title, authors, publication year, journal/conference, technology examined, country in which the research was conducted, framework utilised, data collection methods, number of participants, data analysis, and main findings. A summary of the identified studies is provided in Table 2.10 on the following pages.

Table 2.10: Systematic Literature Review of AVs Acceptance Studies

No.	Author and Year of Publication	Title	Journal/Conference	Technology Examined	Country	Model Utilised	Data Collection Method	No. of Participants	Data Analysis	Relevant Findings
1	(Adell, 2010)	Acceptance of Driver Support Systems	European conference on human centred design for intelligent transport systems	assistance systems	Spain and Italy	UTAUT	Questionnaire	38	Linear regression analysis	PE and SI significantly influenced BI; EE was insignificant on BI; Variance explained BI: 20%.
2	(Kervick *et al.*, 2015)	Testing a structural model of young driver willingness to uptake smartphone driver support systems	Accident Analysis and Prevention	Assistance systems	Ireland	UTAUT	Questionnaire	333	SEM	Perceived gains (i.e., perceived usefulness) and SI significantly influenced BI; perceived risk and PEOU were insignificant on BI; Variance explained BI: 72%.
3	(Choi and Ji, 2015)	Investigating the Importance of Trust on Adopting an Autonomous Vehicle	International Journal of Human-Computer Interaction	Autonomous cars	South Korea	TAM	Questionnaire	552	SEM	PU, trust, locus of control significantly influenced BI; Perceived risk was insignificant on BI; Variance explained BI: 67%.
4	(Madigan *et al.*, 2016)	Acceptance of Automated Road Transport Systems (ARTS): an adoption of the UTAUT model	Transportation Research Procedia	Autonomous shuttles	France and Switzer-land	UTAUT	Questionnaire	349	Hierarchical multiple regression analysis	PE, EE, SI significantly influenced BI. Moderating variables were insignificant. Variance explained BI 22%.

Table 2.10: Systematic Literature Review of AVs Acceptance Studies – Continued

No.	Author and Year of Publication	Title	Journal/Conference	Technology Examined	Country	Model Utilised	Data Collection Method	No. of Participants	Data Analysis	Relevant Findings
5	(Zmud *et al.*, 2016)	Self-Driving Vehicles - Determinants of Adoption and Conditions of Usage	Journal of the Transportation Research Board	Autonomous Cars	USA	UTAUT/ CTAM	Questionnaire	556	Spearman's correlation	PE, EE, SI, technology use, technology acceptance, perceived safety, anxiety, A are significantly related to BI; desire of control was insignificant on BI; Moderating variables had no strong effect. Variance explained BI: N/A
6	(Madigan *et al.*, 2017)	What influences the decision to use automated public transport? Using UTAUT to understand public acceptance of automated road transport systems.	Transportation Research Part F	Autonomous shuttles	Greece	UTAUT2	Questionnaire	315	Hierarchical multiple regression analysis	PE, SI, FC, HM significantly influenced BI; EE was insignificant on BI. Moderating variables were insignificant. Variance explained BI: 58.6%.
7	(Angelis *et al.*, 2017)	Negative attitudes towards cyclists influence the acceptance of an in-vehicle cyclist detection system	Transportation Research Part F	Assistance systems	Italy	TPB	Questionnaire	355	SEM	PU, trust, A influenced BI significantly. Perceived ease of use was insignificant on BI. Variance explained BI: N/A

Table 2.10: Systematic Literature Review of AVs Acceptance Studies – Continued

No.	Author and Year of Publication	Title	Journal/Conference	Technology Examined	Country	Model Utilised	Data Collection Method	No. of Participants	Data Analysis	Relevant Findings
8	(Rahman *et al.*, 2017)	Assessing the utility of TAM, TPB, and UTAUT for advanced driver assistance systems	Accident Analysis and Prevention	Assistant Systems	USA	UTAUT	Questionnaire	430	Multiple linear regression analysis	PE, EE, SI significantly influenced BI; moderating variables insignificant; Variance explained BI: 71%.
9	(Moták *et al.*, 2017)	Antecedent variables of intentions to use an autonomous shuttle: Moving beyond TAM and TPB?	Revue européenne depsychologie appliquée	Autonomous shuttles	France	TAM/TPB	Questionnaire	162	Regression analysis	PU, PBC, A, confidence, experience, group norm, universalism influences BI significantly. Variance explained BI: 53%.
10	(Lee *et al.*, 2017)	Age differences in acceptance of self-driving cars: a survey of perceptions and attitudes	International Conference on Human Aspects of IT for the Aged Population	Autonomous cars	USA	TAM	Questionnaire	1,765	Regression analysis	PU, PEOU, affordability, emotional benefit, social support, lifestyle fit and conceptual fit influence BI significantly; accessibility, technical support, reliability and interoperability were insignificant. Variance explained BI: 60%.
11	(Leicht *et al.*, 2018)	Consumer innovativeness and intentioned autonomous car adoption	Journal of High Technology Management Research	Autonomous cars	France	UTAUT	Questionnaire	241	SEM	PE, EE, SI significantly influence BI; moderating variable (i.e., innovativeness) was significant. Variance explained BI: N/A.

Table 2.10: Systematic Literature Review of AVs Acceptance Studies – Continued

No.	Author and Year of Publication	Title	Journal/Conference	Technology Examined	Country	Model Utilised	Data Collection Method	No. of Participants	Data Analysis	Relevant Findings
12	(Chen and Yan, 2018)	Interrelationships between influential factors and behavioural intention with regard to autonomous vehicles	International Journal of Sustainable Transportation	autonomous cars	Taiwan	TPB	Questionnaire	574	SEM	Attitude, subjective norm, perceived behavioural control and innovativeness significantly influence BI; Perceived risk and price sensitivity were insignificant on BI. Variance explained BI: 60.3%.
13	(Panagiotopoulos and Dimitrakopoulos, 2018)	An empirical investigation on consumers' intentions towards autonomous driving	Transportation Research Part C	autonomous cars	Greece	TAM	Questionnaire	483	Multiple regression analysis	PU, PEOU, trust and SI significantly influence BI; Variance explained BI: 43.7%.
14	(Buckley *et al.*, 2018)	Psychosocial factors associated with intended use of automated vehicles: A simulated driving study	Accident Analysis and Prevention	autonomous cars	USA	TPB/TAM	Questionnaire	74	Hierarchical regression	TPB: A, SN, and PBC significantly influence BI. TAM: PEOU significantly influence BI; PU was insignificant. Trust contributed variance to both models beyond TPB or TAM constructs. Variance explained BI: 44% (TAM); 49% (TPB).

Table 2.10: Systematic Literature Review of AVs Acceptance Studies – Continued

No.	Author and Year of Publication	Title	Journal/Conference	Technology Examined	Country	Model Utilised	Data Collection Method	No. of Participants	Data Analysis	Relevant Findings
15	(Xu *et al.*, 2018)	What drives people to accept automated vehicles? Findings from a field experiment	Transportation Research Part C	autonomous cars	China	TAM	Questionnaire	300	SEM	PU, PEOU, trust and perceived safety influences BI significantly; Variance explained BI: 55%.
16	(Rahman *et al.*, 2018)	Modelling driver acceptance of driver support systems	Accident Analysis and Prevention	assistance systems	USA	TAM	Questionnaire	387	Hierarchical regression analysis	A, perceived, endorsement, compatibility and affordability significantly influence BI; trust, SN, PEOU and PBC were not found to be significant; Variance explained in BI: 85%.

(6) Synthesis

Most articles utilised UTAUT (i.e., UTAUT, UTAUT2, and CTAM; n = 7) followed by TAM (n = 5), TPB (n = 2) and TPB/TAM (n = 2). Furthermore, most articles were published in the year of 2018 (n = 6), followed by the years 2017 (n = 5), 2016 (n = 2), 2015 (n = 2), and 2010 (n = 1), indicating an increased research interest and progress in the field of user acceptance of autonomous driving. Moreover, this is in line with the fact that in the earlier years, mainly advanced driver-assistance systems were investigated, whereas in the years 2017 and 2018 mainly fully autonomous vehicles were investigated.

Furthermore, most of the articles focused on autonomous cars or autonomous shuttles (n = 11), whereas 5 papers focused on advanced driver-assistance systems and as such on semi-autonomous driving functions. The journal focus is clearly on the field of transportation (i.e., Journal of Transportation Research Board, Transportation Research Part C and F, International Journal of Sustainable Transportation; n = 6), followed by psychology (i.e., Accident Analysis and Prevention, Revue européenne depsychologie appliquée; n = 5), innovation (Journal of High Technology Management Research; n = 1), and operations and technology management (i.e., International Journal of Human-Computer Interaction; n = 1). Two papers were published in a conference proceeding with focus on transportation (i.e., European Conference on Human Centred Design for Intelligent Transport Systems, Transportation Research Procedia), and one paper was published in the International Conference on Human Aspects of IT for the Aged Population. All papers found in this systematic review were peer-reviewed, which increases the value of the findings in the underlying field. Additionally, according to the ABS Journal Ranking Guide 2015, seven papers were published in high-class journals (i.e., Accident Analysis and Prevention, Transportation Research Part C, Journal of High Technology Research).

Regarding the methods used, all articles used questionnaires as the primary data collection method. The studies took place not only in Europe (i.e., Italy, Spain, France, Greece, Ireland and Switzerland; n = 8) but also in the USA (n = 5) and Asia (South Korea, Taiwan and China; n = 3). Considering the data analysis technique, the majority used regression analysis (i.e., hierarchical regression, linear and multiple regression; n = 9), followed by SEM (n = 6) and Spearman's correlation analysis (n = 1). In terms of authors in the field of AVs, two have published two papers (Madigan *et al.*, 2016;

Madigan *et al.*, 2017; Rahman *et al.*, 2018; Rahman *et al.*, 2017), whereas the others have published only one article.

In the next step, the constructs used in these studies will be further accessed to identify the constructs most regularly incorporated into one of the existing technology acceptance theories in the context of AVs.

2.6.4.2 Construct Analysis of AVs Acceptance Studies

Since various models have been used that contain different labels for similar constructs, within this thesis, if possible, these constructs are subsumed under the label of UTAUT2 constructs. Despite the fact that only one study utilised UTAUT2, price value and habit were not studied at all. Madigan *et al.* (2017) argue that it was not possible to address price value and habit in their study because the transportation offered (i.e., Automated Road Transport Systems (ARTS)) was free of cost and only temporarily available. Thus, participants could not develop any habitual patterns.

In addition to the variables studied in UTAUT/UTAUT2/C-TAM, TAM, or TPB, 28 external variables were identified, which were used to determine behavioural intention (i.e., perceived accuracy, affordability, endorsement, technical support, accessibility, confidence, universalism (environmental values), group norm, emotional benefits, experience, locus of control, sensation seeking, innovativeness, perceived risk, general technology acceptance, technology use, perceived safety, anxiety, attitudes toward behaviour/technology, negative attitudes towards cyclists, desire for control, conceptual fit, lifestyle fit, interoperability, social support, reliability, compatibility and trust in technology). Furthermore, three external variables were studied to determine trust (i.e., system transparency, technical competence, and situation management). A detailed analysis of the constructs (i.e., items and/or definitions) revealed that some studies used various labels for the same construct.

First, technical support (Lee *et al.*, 2017), which describes the fact that someone believes that support is available, and locus of control (Choi and Ji, 2015), which relates to the extent to which an individual believes to be in control of external events (similar to perceived behavioural control in TPB), are conceptually similar to facilitating conditions in UTAUT/UTAUT2. Thus, these constructs are subsumed under “facilitating conditions” in this thesis.

Second, social support (Lee *et al.*, 2017), which describes the degree to which family and friends will approve of using self-driving vehicles, is conceptually similar to social influence in UTAUT/ UTAUT2 and is therefore merged under “social influence” in this study.

Third, Moták *et al.* (2017) studied “positive affective attitude”, which they define as “pleasure” derived from using autonomous shuttles, which is conceptually similar to hedonic motivation in UTAUT/UTAUT2. As such, it is labelled “hedonic motivation” in this study.

Fourth, the personality scales “technology acceptance” (e.g., “it is important to keep up with new technology”) and “technology use” (smartphone usage, text messaging, Facebook usage, and smartphone transportation apps) (Zmud *et al.*, 2016) mirror the innovativeness of an individual. People who state that it is important to keep up with the latest technology and use regular technology are those who are in general more innovative. Thus, these personality scales are conceptually similar to innovativeness and therefore are subsumed under “innovativeness” in this thesis.

Overall, this construct analysis revealed 23 conceptually new external constructs that have been studied, determining behavioural intention in the area of AVs acceptance research. Table 2.11 provides a detailed overview of the UTAUT2 constructs and Table 2.12 studied, which were used to determine behavioural intention and displays the significance.

Table 2.11: Constructs Analysis AVs Acceptance Studies – UTAUT2 Constructs

No.	Independent UTAUT2 Constructs	Frequency			References
		Total	Significant	Insignificant	
1	Performance Expectancy (PE)	15	14	1	**Significant:** (Adell, 2010; Kervick *et al.*, 2015; Madigan *et al.*, 2016; Zmud *et al.*, 2016; Madigan *et al.*, 2017; Angelis *et al.*, 2017; Rahman *et al.*, 2017; Moták *et al.*, 2017; Lee *et al.*, 2017; Choi and Ji, 2015; Panagiotopoulos and Dimitrakopoulos, 2018; Xu *et al.*, 2018; Rahman *et al.*, 2018) **Insignificant:** (Buckley *et al.*, 2018)
2	Effort Expectancy (EE)	14	9	5	**Significant:** (Choi and Ji, 2015; Madigan *et al.*, 2016; Zmud *et al.*, 2016; Rahman *et al.*, 2017; Lee *et al.*, 2017; Leicht *et al.*, 2018; Panagiotopoulos and Dimitrakopoulos, 2018; Buckley *et al.*, 2018; Xu *et al.*, 2018) **Insignificant:** (Adell, 2010; Kervick *et al.*, 2015; Madigan *et al.*, 2017; Angelis *et al.*, 2017; Rahman *et al.*, 2018)
3	Social Influence (SI)	12	11	1	**Significant:** (Adell, 2010; Kervick *et al.*, 2015; Madigan *et al.*, 2016; Zmud *et al.*, 2016; Madigan *et al.*, 2017; Rahman *et al.*, 2017; Lee *et al.*, 2017; Leicht *et al.*, 2018; Chen and Yan, 2018; Panagiotopoulos and Dimitrakopoulos, 2018; Buckley *et al.*, 2018) **Insignificant:** (Rahman *et al.*, 2018)
4	Facilitating Conditions (FC)	6	4	2	**Significant:** (Madigan *et al.*, 2017; Moták *et al.*, 2017; Chen and Yan, 2018; Buckley *et al.*, 2018; Choi and Ji, 2015) **Insignificant:** (Rahman *et al.*, 2018; Lee *et al.*, 2017)
5	Hedonic Motivation (HM)	1	1	0	**Significant:** (Madigan *et al.*, 2017; Moták *et al.*, 2017)

Table 2.12: Constructs Analysis AVs Acceptance Studies – External Constructs

No.	Independent <u>External</u> Constructs	Frequency			References
		Total	Significant	Insignificant	
1	Trust in technology	6	5	1	**Significant:** (Choi and Ji, 2015; Angelis *et al.*, 2017; Panagiotopoulos and Dimitrakopoulos, 2018; Buckley *et al.*, 2018; Xu *et al.*, 2018) **Insignificant:** (Rahman *et al.*, 2018)
2	Attitude	5	4	1	**Significant:** (Zmud *et al.*, 2016; Chen and Yan, 2018; Buckley *et al.*, 2018; Rahman *et al.*, 2018) **Insignificant:** (Kervick *et al.*, 2015)
3	Perceived risk	3	0	3	**Insignificant:** (Kervick *et al.*, 2015; Choi and Ji, 2015; Chen and Yan, 2018)
4	Innovative-ness	2	2	0	**Significant:** (Zmud *et al.*, 2016; Chen and Yan, 2018)
5	Affordability	2	2	0	**Significant:** (Lee *et al.*, 2017; Rahman *et al.*, 2018)
6	Perceived safety	2	2	0	**Significant:** (Zmud *et al.*, 2016; Xu *et al.*, 2018)
7	Perceived accuracy	1	0	1	**Insignificant:** (Kervick *et al.*, 2015)
8	Anxiety	1	1	0	**Significant:** (Zmud *et al.*, 2016)
9	Endorsement	1	1	0	**Significant:** (Rahman *et al.*, 2018)
10	Accessibility	1	0	1	**Insignificant:** (Lee *et al.*, 2017)
11	Confidence	1	1	0	**Significant:** (Moták *et al.*, 2017)

Table 2.12: Constructs Analysis AVs Acceptance Studies – External Constructs – Continued

No.	**Independent External Constructs**	**Frequency**			**References**
		Total	Significant	Insignificant	
12	Universalism	1	1	0	**Significant:** (Moták *et al.*, 2017)
13	Emotional Benefit	1	1	0	**Significant:** (Lee *et al.*, 2017)
14	Experience	1	1	0	**Significant:** (Moták *et al.*, 2017)
15	Sensation seeking	1	0	1	**Insignificant:** (Choi and Ji, 2015)
16	Desire for control	1	0	1	**Insignificant:** (Zmud *et al.*, 2016)
17	Conceptual fit	1	1	0	**Significant:** (Lee *et al.*, 2017)
18	Lifestyle fit	1	1	0	**Significant:** (Lee *et al.*, 2017)
19	Inter-operability	1	0	1	**Insignificant:** (Lee *et al.*, 2017)
20	Social support	1	1	0	**Significant:** (Lee *et al.*, 2017)
21	Reliability	1	0	1	**Insignificant:** (Lee *et al.*, 2017)
22	Compatibility	1	1	0	**Significant:** (Rahman *et al.*, 2018)
23	Negative attitudes towards cyclists	1	1	0	**Significant:** (Angelis *et al.*, 2017)

It is worth mentioning that most studies reviewed adopted the original technology acceptance theories to the specific context investigated (e.g., assistant systems, autonomous cars). In more detail, some studies excluded constructs like habit or price value due to the novelty of the technology (Madigan *et al.*, 2017), whereas others added additional constructs like trust in technology (Choi and Ji, 2015). Studies that did not adapt the theories could explain a significantly lower portion of the variance in behavioural intention (Adell, 2010; Madigan *et al.*, 2016), which shows the need to tailor the theories used to predict technology acceptance to a specific research field. Overall, the findings of the construct analysis in the research field of AVs show that trust in technology, attitude, perceived risk, innovativeness, and affordability were most often included to investigate acceptance of autonomous vehicles (i.e., cars, shuttles, and assistant systems).

In the following subchapter, the theoretical findings from the systematic literature reviews in the areas of ADVs, SSTs, and AVs will be summarised, consolidated, and discussed.

2.6.5 Summary, Consolidation, and Discussion of Theoretical Findings

ADVs are considered a self-service technology in last-mile delivery and comprise two main characteristics: driving autonomously and dropping off parcels without human – human interaction. However, only a relatively small number of studies was identified in an extensive online search that specifically investigated the acceptance of ADVs. All studies found were descriptive in nature and investigated user acceptance of ADVs dichotomously (yes/no) without focusing on the behavioural determinants and the relationships in intention formation. Besides the investigation of acceptance on a yes/no scale, Braun and Buckstegen (2017) found that risk might be an important construct in user acceptance of ADVs. Their findings revealed that 62 percent of the participants believe that delivery with robots or drones is “rather risky” or “definitely risky” (N = 2,023). Due to the limited number of papers identified, two databases (i.e., Scopus and Web of Science) were also used to identify additional papers in this specific field. However, this revealed only one relevant study (Marsden *et al.*, 2018). Nevertheless, this study found that people perceived ADVs as environmentally friendly and innovative but at the same time associate ADVs as dangerous and risky, which is also in line with the findings by Braun and Buckstegen (2017). Thus, this indicates that the perception of risk might be considered as an important factor in determining user acceptance of ADVs.

Little research has been conducted in the area of user acceptance of ADVs, and no study has utilised one of the existing technology acceptance models. Therefore, broader literature reviews were undertaken in related and overlapping research fields, namely, SSTs and AVs. This seemed plausible since ADVs comprise characteristics from both research areas (i.e., driving autonomously and serving as SSTs during parcel drop-off). The findings of the systematic reviews gave great insight into the relevant constructs in acceptance formation. Interestingly, in both research fields, **trust in technology, perceived risk, innovativeness, and attitude** were studied most often as external constructs. Thus, these constructs and the findings will be contrasted and discussed in more detail in the following.

First, trust in technology was found to be significant in nine SSTs studies as well as five AVs studies, whereas in only one AVs study and two SSTs studies trust in technology was identified as insignificant. Following these findings, it seems plausible that trust in technology might also be a relevant driver in user acceptance formation in the context of ADVs. This is supported by the fact that trust is considered inherently important for new SSTs because these systems lack personal interaction (Farah *et al.*, 2018), which is also the case for ADVs in last-mile delivery. Therefore, trust in technology will be included as an additional external construct in this study.

Second, innovativeness was found to be significant in seven studies in the context of SSTs and in two studies in the context of AVs. Following these findings, it seems obvious in both research fields (i.e., AVs and SSTs) that the higher the innovativeness of people the higher the acceptance during the introduction stage. Thus, it is believed that people who are more innovative will also be more likely to use ADVs. Alongside these findings, it has also been argued that individual characteristics in technology acceptance research, despite its importance, has been limited (Dwivedi *et al.*, 2019). Therefore, innovativeness will also be incorporated as an additional external construct in this study.

Third, the findings for perceived risks are rather mixed. On the one hand, perceived risk was identified as significant in eleven studies in the context of SSTs and found insignificant in only three SSTs studies, indicating the importance of perceived risk in a self-service context. On the other hand, in the context of AVs, no study could prove the significance of perceived risk, which is surprising given the potential risks that are involved in driving an autonomous vehicle (e.g., safety risk). However, in the context of AVs, the perspective of the investigation of potential risks might be different compared to the context of SSTs, meaning two studies were able to identify that perceived safety, which is also an uncertainty related construct and conceptually similar to perceived risk (i.e., opposite perspective) was statistically significant on behavioural intention (Zmud *et al.*, 2016; Xu *et al.*, 2018). This shows that safety is considered important in driving an autonomous vehicle. Additionally, considering the findings from the context of ADVs, perceived risk is determined to be important in ADVs acceptance formation (Marsden *et al.*, 2018; Braun and Buckstegen, 2017). Moreover, perceived risk has been studied frequently alongside UTAUT2 (Alalwan et al., 2018b) and is unlike the original constructs a detractor in the adoption process (Slade *et al.*, 2015). Detractors are important because consumers tend to consider not only the incentives but also the threats of using a certain technology (Cowart *et al.*, 2008). Therefore, in the context of ADVs, it is believed that perceived risk plays an important role, not only during the autonomous driving of ADVs on public roads but also during the parcel drop-off process. Thus, perceived risk will be incorporated as an additional external construct in this study.

Fourth, attitude was identified as the most important external construct in the context of SSTs. In more detail, it was identified to be statistically significant in seventeen studies. Additionally, it was also found to be statistically significant in four AVs studies. However, in the SSTs context, attitude was often studied as a mediator. For instance, attitude was used for mediating the effects of perceived usefulness and perceived ease of use (Marler *et al.*, 2009; Kim and Forsythe, 2008), or even the effects of perceived risk and trust in technology were proposed to be mediated by attitude (Kaushik and Rahman, 2015b; Morosan, 2014), whereas in the AVs context, attitude was applied as an additional external construct alongside others. Despite the fact that the mediating effect of attitude is in line with the theoretical structure of models like TRA or the TPB (Ajzen and Fishbein, 1975, 1980; Ajzen, 1991, 1985), it is, however, contradictory to the findings of other studies reviewed in this thesis, where direct effects on behavioural intention were identified (see construct analyses of SSTs and AVs studies for examples). Moreover, even in the early beginning of the technology acceptance research, empirical evidence of direct relationships between beliefs and behavioural intention was found (Davis *et al.*, 1989; Bagozzi and Phillips, 1982; Taylor and Todd, 1995c). This is consistent with further developments of technology acceptance research models like UTAUT and UTAUT2, which do not consider attitude as a mediating construct (Venkatesh *et al.*, 2003; Venkatesh *et al.*, 2012). Considering this theoretical foundation, attitude will not be included into the research framework in this study.

In summary, taking into consideration the findings of all three research areas (ADVs, SSTs, and AVs) **perceived risk, trust in technology,** as well as **innovativeness** are believed to be important in the context of user acceptance of ADVs in last-mile delivery in Germany and therefore are incorporated as external constructs into the research framework. Moreover, incorporating only the constructs that are important in both related research fields also preserves the parsimoniousness in the framework extension process. These constructs will be further reviewed and defined in chapter 3, where the hypothesis for each construct will also be stated.

2.7 Selection and Justification of the Research Model

To date, in the context of user acceptance of ADVs, no theoretical model has been applied to investigate the behavioural components and relationships to determine user acceptance. However, the systematic literature reviews of related and overlapping research fields showed that various theories and models have been applied in the contexts of AVs as well as SSTs. For instance, Kapoor *et al.* (2015) investigated the acceptance of mobile ticketing services by applying the Theory of Diffusion and Innovation (DOI); Slade *et al.* (2015) investigated mobile payments by utilising the Unified Theory of Acceptance and Use of Technology (UTAUT); Herrero Crespo and Rodriguez del Bosque (2010) examined the acceptance of e-commerce by employing the Theory of Planned Behaviour; and Madigan *et al.* (2017) investigated the acceptance of autonomous shuttles through the application of UTAUT2. Some of these models are highly parsimonious (e.g., TAM), whereas others are more extensive and cover a variety of constructs that determine user acceptance behaviour (e.g., UTAUT2).

Taking together the findings of the systematic literature reviews in the areas of SSTs and AVs, the Technology Acceptance Model (TAM) has been used extensively as a baseline model to examine user technology acceptance in these domains. However, despite the fact that TAM is considered a robust and reliable model, TAM has been criticised for its comprehensiveness as well as its deterministic approach and providing little information on individual characteristics (Agarwal and Prasad, 1998). Furthermore, TAM neglects social influence; however, especially when it comes to innovations, these are important (Rogers, 1983, p. 215). Moreover, TAM and other models in the information systems domain are only able to explain around 40 percent of the variance in behavioural intention (Venkatesh *et al.*, 2003), which shows the need for further investigations in the domain of technology acceptance. However, the variety of models and theories available to study technology acceptance led to a theoretical confusion in regard to the decision of which model fits the study best. Based on the theoretical confusion as well as the aim in mind to increase the explanatory power of the model, Venkatesh *et al.* (2003) developed the UTAUT model, which is stated to be comprehensive and parsimonious at the same time (Venkatesh *et al.*, 2003).

At present, UTAUT is considered the newest and most comprehensive model in the technology acceptance area, since it integrates most of the relevant pre-existing theories and models in the domain of technology acceptance into one unified theory (see chapter 2.4.9). As such, it includes findings and knowledge from various disciplines (e.g., social psychology, information systems), which broadens the focus and the applicability of the model. Overall, it is argued that UTAUT summarises what is known and as such provides a good ground for future research (Venkatesh *et al.*, 2003). Since UTAUT has been validated throughout a variety of technologies and disciplines (Williams *et al.*, 2011), it is believed to be the most powerful model to explain and predict technology acceptance.

Since UTAUT was explicitly developed for an organisational context, it still neglects constructs that are relevant in a consumer context. Thus, Venkatesh *et al.* (2012) extended the UTAUT model based on an extensive literature review with constructs that were proven to be important in a consumer context, namely, price value, habit, and hedonic motivation (see chapter 2.4.9). Compared to the original model, the extension enabled a higher explanation of the variance in behavioural intention as well as behaviour in a consumer context (Venkatesh *et al.*, 2012). This proves the importance of specific consumer-related constructs when studying consumer acceptance of new technologies. Furthermore, UTAUT2 is relatively new and has not reached a relative level of maturity compared to other technology acceptance theories and models (Slade *et al.*, 2013), which gives room for further theory development. Nevertheless, UTAUT2 has been proven to be statistically significant in the related research areas – SSTs (Alalwan *et al.*, 2016b; Alalwan *et al.*, 2017; Yahia *et al.*, 2018; Owusu Kwateng *et al.*, 2018; Farah *et al.*, 2018; Alalwan *et al.*, 2018b) and AVs (Madigan *et al.*, 2017).

Despite these facts, UTAUT2 has not been utilised enormously, even though it is considered the most comprehensive and parsimonious research model in the information systems domain, including various determinants that influence an individual to accept new technology with particular focus on end-users (Tamilmani *et al.*, 2018b). Therefore, it was considered theoretically and practically useful to utilise the UTAUT2 model as the theoretical basis in this research and incorporate and synthesise the findings of the systematic literature reviews in the areas of SSTs and AVs. As such, this approach follows the approach conducted by Venkatesh *et al.* (2003) and Venkatesh *et al.* (2012).

2.8 Originality of Research and Research Gaps

The development of ADVs is becoming more and more prevalent. ADVs are believed to have the potential to revolutionise last-mile delivery in a way that is more sustainable, more cost-efficient, and more customer-centred (Marsden *et al.*, 2018; Schröder *et al.*, 2018). However, without user acceptance, the technological development and introduction of ADVs as a delivery option in last-mile logistics can be a substantial waste of resources. Therefore, it is imperative to understand the customer perspective in this regard.

Based on the literature reviews conducted in this thesis, it can be concluded that little research exists on the end-customer acceptance of logistics innovations and in particular on the acceptance of ADVs in the context of last-mile delivery, despite its importance to the success of the innovation (Wang *et al.*, 2018a, 2018b). More specifically, very little attention has been devoted to the behavioural components of users that determine user acceptance in the logistical domain. However, last-mile delivery is a customer-oriented service that has a strong behavioural element (Collins, 2015). Hence, it is imperative to identify the factors that determine the acceptance of ADVs as a delivery option to be able to design, develop, and promote ADVs as an alternative to its conventional delivery option (i.e., van delivery). Following this, there is a major gap in the logistics innovation literature regarding the factors that contribute to the user acceptance of ADVs as a last-mile delivery option. Thus, the research question "What are the factors that affect user acceptance of autonomous delivery vehicles in last-mile delivery in Germany?" has not yet received sufficient attention in the literature and further research needs to be done to attain a comprehensive understanding of user acceptance in this particular field.

Moreover, in the context of logistics innovations, it has even been found that theory-based research is limited (Grawe, 2009). As such, this study is among the first that conceptualises the consumers' adoption behaviour of a specific last-mile logistics innovation (i.e., ADVs) and by doing so enriches the sparse literature of logistics innovations with the consumer behavioural element. In more detail, within this study an established behavioural theory (i.e., UTAUT2) is applied and adapted to the context of logistics innovations in particular to the specific context of ADVs, which is currently lacking in the literature of logistics innovations (Wang *et al.*, 2018a, 2018b). As such, this study not only extends the theorisation of logistics innovations with focus on end-consumers (i.e., recipients) (Wang *et al.*, 2018b), but also offers additional theoretical insights as well as empirical evidence for the UTAUT2 model, which has not been applied to the logistics context and the last-mile delivery context in particular. In this vein, it has been argued that it is highly timely to more closely investigate the constructs that determine consumer acceptance of innovations in the broader logistics literature (Wang *et al.*, 2018b).

Utilising an existing and previously validated psychological theory (e.g., TPB, TAM, UTAUT or UTAUT2) to investigate the responses of emerging technologies has been proven a valuable approach for examining emerging technologies in general (Buckley *et al.*, 2018), and also in the area of transportation and autonomous vehicles (e.g., Choi and Ji, 2015; Madigan *et al.*, 2016; Madigan *et al.*, 2017; Moták *et al.*, 2017; Lee *et al.*, 2017; Leicht *et al.*, 2018; Chen and Yan, 2018; Panagiotopoulos and Dimitrakopoulos, 2018; Buckley *et al.*, 2018; Xu *et al.*, 2018). Moreover, using an established theory also reduces the potential for a haphazard approach for understanding this phenomena (Buckley *et al.*, 2018). Thus, it is justified to utilise a UTAUT2 derived in the field of information systems in the field of last-mile logistics.

In doing so, it not only extends the theorisation of logistics innovations with focus on end-consumers (i.e., recipients), which is currently lacking in the literature (Wang *et al.*, 2018b), but also offers additional theoretical insights as well as empirical evidence for the UTAUT2 model, which has not been applied to the logistics context and the last-mile delivery context in particular. In this vein, it has been argued that it is highly timely to more closely investigate the constructs that determine consumer acceptance of innovations in the broader logistics literature (Wang *et al.*, 2018b).

Furthermore, all logistics innovations studies identified that are theory-based in nature and investigate a logistics innovation for last-mile delivery were conducted in the Asia-Pacific area (i.e., China, Singapore). However, no study so far has investigated the consumer's behavioural intention of last-mile delivery innovations in a western context – not to mention in Germany. Therefore, this is the first study that investigates logistics innovations in a western context and more specifically in Germany.

In summary, this research is an important effort to understand user acceptance of ADVs. This study is the first that conceptualises and validates consumers' intentions towards ADVs in last-mile delivery in the cultural background of Germany by adopting the UTAUT2 model to a logistical domain and more specifically to the domain of ADVs in last-mile delivery. As such, it is the first study that has a strong emphasis on the behavioural components regarding ADVs in last-mile delivery, which is important for successfully developing and implementing ADVs as a last-mile delivery option. Therefore, the findings will not only highly contribute to the academic literature but will also have several benefits for logistics service providers and other practitioners who are involved in developing and implementing ADVs as a last-mile delivery solution (see subchapter 8.3).

2.9 Conclusion

This chapter has presented, reviewed and discussed the literature on technology acceptance. It presented not only a definition of user acceptance of technology in the context of ADVs and defined ADVs for this research study, but also discussed it the literature on the models and theories used to explain and predict technology acceptance. In particular, the eight models that were synthesised in the UTAUT model were discussed. Moreover, this chapter presented previous acceptance research in the areas of AVs, SSTs, as well as ADVs. As a result, trust in technology, perceived risk, and innovativeness were identified as important external constructs for the context of user acceptance of ADVs. Furthermore, it was found that only descriptive research on user acceptance of ADVs as well as no theory-based investigations of user acceptance in last-mile logistics with a cultural focus on Germany exist. This gap will be filled within this thesis by adapting the UTAUT2 model to the context of ADVs for last-mile delivery in Germany.

Chapter 3: Theoretical Framework and Hypotheses Development

3.1 Introduction

After reviewing the literature on user acceptance of AVs, SSTs, as well as ADVs, this chapter will present the theoretical framework that was used to study user acceptance of ADVs in last-mile delivery in Germany. This includes the presentation of the original UTAUT2 constructs used, the modifications conducted to fit the framework to the context of ADVs, as well as the hypotheses that were derived. At the end of this chapter, the theoretical framework will be summarised, which includes the constructs, labels, and the questionnaire items used in this research study.

3.2 UTAUT2 Constructs

As presented in chapter 2.4.9, the original UTAUT2 model consists of seven independent constructs (i.e., performance expectancy, effort expectancy, social influence, facilitating conditions, hedonic motivation, price value, and habit) that determine behavioural intention directly or use behaviour indirectly (Venkatesh *et al.*, 2012). Furthermore, UTAUT2 proposed three moderating variables (i.e., experience, age, and gender). Within this study the UTAUT2 model will be used as the core model to investigate user acceptance of ADVs and will follow the original UTAUT2 model by Venkatesh *et al.* (2012) as closely as possible to accomplish this. Although UTAUT2 was explicitly developed for the consumer context, it is necessary in this study to modify the model to the specific context of ADVs in order to answer the research question and fulfil the research objectives comprehensively. Within this subchapter, two aspects are covered. First, compared to the original UTAUT2, behavioural intention is presented as the main dependent construct in this study. Second, the independent constructs originally from UTAUT2 that are used in this study will be presented, including the hypotheses derived.

3.2.1 Behavioural Intention as the Main Dependent Construct

There are various definitions of user acceptance (see subchapter 2.3.). Although the original UTAUT as well as the UTAUT2 model focus on explaining behavioural intention as well as use behaviour to fully describe user acceptance, this study excludes use behaviour and focuses only on behavioural intention. Thus, as stated in subchapter 2.3, behavioural intention is defined as user acceptance of ADVs in this study. Even though this procedure of ignoring the actual behaviour to investigate user acceptance has been stated to be a major limitation by some authors in technology acceptance research (Lee *et al.*, 2003; Bagozzi, 2007), the decision to study behavioural intention as the main dependent construct (i.e., user acceptance) in this study relies on both theoretical and practical reasons.

First, from a theoretical perspective, the association between intention and actual behaviour can be described by the cognitive dissonance theory (Festinger, 2009). Within this theory it is argued that discrepancies between behavioural intentions and the actual behaviour cause a psychological tension (i.e., cognitive dissonance). Since individuals want to minimise these psychological tensions, they often tend to bring in line their behaviour with their intentions. Concurrently, several studies have found that behavioural intention is the key predictor of use behaviour. As such, it totally mediates the effects of other constructs on use behaviour (Ajzen and Fishbein, 1980; Taylor and Todd, 1995b; Ajzen, 1991; Venkatesh and Davis, 2000; Pavlou, 2003; Neufeld *et al.*, 2007). This mediating effect has also been supported in a meta-analytical review of TRA studies by Sheppard *et al.* (1988). Even though Dillon and Morris (1996) acknowledge the fact that the actual behaviour might be slightly different from their intentions, they postulate that behavioural intention is the best predictor of user acceptance. In the context of UTAUT2 studies, dismissing the use behaviour construct is a common practice because it is often not possible to investigate use behaviour of evolving technologies (Tamilmani *et al.*, 2018b).

Second, and this is in line with the aforementioned reason for not including use behaviour in previous UTAUT2 studies, it is practically not possible to investigate use behaviour of ADVs at this point of time. This is due to the fact that ADVs are still in the developing and testing stage and hence are not introduced as a regular delivery option yet. In other words, ADVs are still evolving and it is not possible to measure use behaviour of this delivery technology. According to Tamilmani *et al*. (2017), in such cases behavioural intention is considered a good indicator of future technology use. Therefore, most of the UTAUT2 studies investigated behavioural intention as the main dependent construct instead of the actual behaviour (Tamilmani *et al.*, 2018b), which is also true for studies in the context of AVs as well as SSTs (see chapter 2.6).

Third, besides the fact that it is not possible at this stage to investigate the actual behaviour, from a practical viewpoint it is highly recommended to start investigating user acceptance very early in the developmental process to be able to make corrections and adjustments (Kollmann, 1998). This is especially true for the design of the vehicle. Many key decisions on the design are usually made in the beginning of the development process and therefore integrating findings on user acceptance in this phase increases the flexibility to change and modify. Additionally, only a small fraction of development costs have been incurred so far (Davis, 1993). Thus, it is recommended that the analysis of user acceptance should take place before the market introduction, which could also reduce the risk of user rejection (Davis, 1993).

Taking into consideration the aforementioned reasons, it is justified to use behavioural intention instead of the actual behaviour as the main dependent construct to investigate user acceptance of ADVs in this study.

3.2.2 Independent UTAUT2 Constructs

Within this study, five out of the seven independent UTAUT2 constructs are used. One construct was excluded (see chapter 3.3.1) and one was modified (see chapter 3.3.1.1) to fit the original model to the context of ADVs. Additionally, to answer the research question in this study, it is also not necessary to study the moderating variables proposed in UTAUT2, which even decrease the complexity of the proposed theoretical framework. In the following, the five independent constructs deriving from the original UTAUT2 (i.e., performance expectancy, effort expectancy, social influence, facilitating conditions, and hedonic motivation) are described in detail. This includes not only the theoretical roots of these constructs but also a clear adoption to the research context of ADVs. After each section the hypothesis will be stated.

3.2.2.1 Performance Expectancy

Performance expectancy (PE) has its theoretical roots in various acceptance models, which use a variety constructs to describe the usefulness of a technology (Venkatesh *et al.*, 2003). These include the Technology Acceptance Model (TAM/TAM2 and Combined TAM) by using perceived usefulness (Davis *et al.*, 1989), the Motivational Theory (MM) by using extrinsic motivation (Davis *et al.*, 1992), the Social Cognitive Theory (SCT) by using outcome expectancy (Compeau and Higgins, 1995, 1999), the Model of PC Utilisation (MPCU) by using job-fit (Thompson *et al.*, 1991), and the Theory of Diffusion and Innovation (DOI) by using relative advantage (Rogers, 1983, 2003). Although the models and their constructs have evolved in various disciplines, the similarities have been acknowledged in previous research (e.g., Davis *et al.*, 1989; Thompson *et al.*, 1991; Compeau and Higgins, 1995). On this basis, Venkatesh *et al.* (2003) subsumed the constructs under the term ***"performance expectancy"***.

In UTAUT2, which was explicitly developed for investigating technology acceptance in a consumer context, performance expectancy has been defined as "the degree to which using a technology [i.e., ADVs] will provide benefits to consumers in performing certain activities" (Venkatesh *et al.*, 2012, p. 159). In other words, consumers are more likely to accept new technology if they believe it is more advantageous and useful in their daily life (Alalwan *et al.*, 2017). In the original UTAUT model, performance expectancy has been found to be the most important construct in predicting behavioural intention (Venkatesh *et al.*, 2003). Similarly, Tamilmani *et al.* (2018b) also found in their systematic review of UTAUT2 studies that performance expectancy is the best predictor of behavioural intention. Furthermore, the importance and statistical power of performance expectancy has been proven in several consumer studies related to this research in the context of SSTs (e.g., Slade *et al.*, 2015; Alalwan *et al.*, 2016b; Giovanis *et al.*, 2018; Mehta *et al.*, 2019; Raza *et al.*, 2019; Tarhini *et al.*, 2019) as well as in the context of AVs (e.g., Adell, 2010; Madigan *et al.*, 2016; Madigan *et al.*, 2017).

Within this research context, the use of ADVs as a delivery option is believed to be more consumer-orientated and therefore more useful over its traditional alternative. This is the case because the delivery with ADVs will be more flexible, more convenient, and highly transparent for the recipient, which have been proven to be highly important in last-mile delivery (Deutsche Post AG, 2012). For instance, the recipient can not only set the time and place for the delivery via a mobile app, but also is he/she able to change the delivery time and place, which increases the flexibility of the daily planning for the recipients. As such, the recipient has total control over the delivery process. Therefore, no deliveries will be missed due to the absence of the recipient. As a matter of fact, the recipient does not need to actively collect the parcel at a parcel shop or parcel locker, which was the case by using the traditional delivery option when they were not at home. He/she also does not need to wait at home, which decreases the opportunity costs of the recipients (e.g., waiting time). This, again, increases the convenience for the recipient. Considering all advantages of ADVs, the following hypothesis derives:

Hypothesis 1: Performance expectancy positively influences behavioural intention to use ADVs.

3.2.2.2 Effort Expectancy

Effort expectancy has its theoretical roots in three theories used to examine technology acceptance: the technology acceptance model (TAM) by using perceived ease of use (Davis *et al.*, 1989), the model of pc utilisation (MPCU) by using ease of use (Thompson *et al.*, 1991), as well as the theory of diffusion and innovation (DOI) by using complexity (Rogers, 1983, 2003). Even though the theories used different theoretical concepts to describe ease of use of a technology, the similarities have been acknowledged in previous research (e.g., Davis *et al.*, 1989; Moore and Benbasat, 1991; Thompson *et al.*, 1991). Thus, Venkatesh *et al.* (2003) subsumed the constructs under the construct of ***"effort expectancy"***.

Effort expectancy is defined as "the degree of ease associated with consumers' use of technology [i.e., ADVs]" (Venkatesh *et al.*, 2012, p. 159). It was found to be significant in the working environment (Venkatesh *et al.*, 2003) as well as in the consumer context (Venkatesh *et al.*, 2012). However, the results in the consumer context of SSTs and AVs are somewhat mixed. For instance, Slade *et al.* (2015) investigated the acceptance of mobile payments (i.e., SSTs) by utilising UTAUT and found an insignificant effect on behavioural intention. They argue that the insignificance is likely due to the ubiquity of mobile phone technology. However, in a similar context of SSTs technologies, Alalwan *et al.* (2017) found a significant effect of effort expectancy on behavioural intention by investigating the acceptance of mobile banking. They conclude, therefore, that customers seem to be concerned about the difficulty. In the context of autonomous vehicles – in this case autonomous shuttles – Madigan *et al.* (2017) did not find a significant effect of effort expectancy on behavioural intention. They postulate that this finding is likely to be related to the fact that autonomous shuttles are similar to general public transportation and therefore passengers do not require any new skills or expertise. Rahman *et al.* (2017), however, investigated semi-autonomous driving functions and found a significant effect of effort expectancy on behavioural intention, which shows the need of ease for driver support systems to be accepted.

In this thesis, it is believed that using ADVs as a delivery option is more complex and therefore requires more effort to get the parcels delivered compared to traditional delivery practices. First, complexity arises when the recipients interact with the delivery service provider via the mobile app to set the date and time for delivery. In the traditional delivery process recipients do not need to interact with the delivery service provider until the final delivery (i.e., parcel drop-off). Second, the interaction with the ADV itself comprises more effort because the recipients have to connect their smartphones via Bluetooth to the vehicle before they are able to collect the parcel. As a result, the higher flexibility and convenience through ADVs for last-mile delivery comes with higher effort for the recipient. Whilst some users might perceive the extra effort as only marginal, other users might feel it burdensome and hence form unfavourable intentions towards using ADVs as a delivery option. In this context, consumers who perceived the use of ADVs as likely to be burdensome and complex are likely to be more resistant or sceptical of ADVs. Following these arguments, the following hypothesis derives:

Hypothesis 2: Effort expectancy positively influences behavioural intention to use ADVs.

3.2.2.3 Social Influence

Social factors have been investigated in various acceptance models. For instance, social influence is represented as subjective norm in TRA, TAM2, TPB, and the combined TAM (Ajzen, 1985, 1991; Venkatesh and Davis, 2000; Taylor and Todd, 1995a; Taylor and Todd, 1995b), as social factors in MPCU (Thompson *et al.*, 1991), and as image in DOI (Rogers, 1983, 2003). Even though the constructs are named differently, the similarities were acknowledged in previous research. For instance, Thompson *et al.* (1991) utilised the term “social norms”, and acknowledge its similarity to subjective norm, which was used within the TRA. Additionally, Venkatesh *et al.* (2003, p. 451) postulates that "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." Therefore, as with the other constructs, Venkatesh *et al.* (2003) tried to solve the theoretical confusion with different terms by subsuming these constructs under the term ***"social influence"***.

Social influence (SI) is defined as "the extent to which consumers perceive that important others (e.g., family and friends) believe they should use a particular technology [i.e., ADVs]" (Venkatesh *et al.*, 2012, p. 159). It has been found significant in an organisational context (Venkatesh *et al.*, 2003). Interestingly, Venkatesh *et al.* (2003) found that the effect of social influence on behavioural intention is significant only in mandatory contexts, whereas in situations where the behaviour is voluntary it might not. According to Venkatesh and Davis (2000) the effect of social influence on behavioural intention in a voluntary context is operated by influencing the perceptions about a certain technology (i.e., internalisation and identification), whereas in a mandatory environment this effect might be triggered by compliance (i.e., intention to comply with the social influence). As such, in a consumer context, which is mainly voluntarily, social influence was believed to be insignificant (Venkatesh *et al.*, 2003). However, in a later study, Venkatesh *et al.* (2012) were able to also find a significant effect in a consumer context were the behaviour is mainly voluntary by developing the UTAUT2. This finding is in line with various other consumer studies. For instance, it seems to be clear that social influence is considered as an important determinant not only in the context of user acceptance of AVs (e.g., Adell, 2010; Madigan *et al.*, 2016; Madigan *et al.*, 2017; Leicht *et al.*, 2018; Rahman *et al.*, 2017) but also in various SSTs contexts (e.g., Yu, 2012; Slade *et al.*, 2015; Giovanis *et al.*, 2018; Alalwan *et al.*, 2018a).

The underlying assumption in this study is that users will consult with their social network before using ADVs. In the case that referent others (e.g., family or friends) are in favour of ADVs, the intention that people use this delivery service might be higher, even though they might not be in favour of using it at first. In other words, the intention to use ADVs can be influenced by the perceived social pressure. Thus, social influence is hypothesised to play a significant role in user acceptance of ADVs. Therefore, the following hypothesis derives:

Hypothesis 3: Social influence positively influences behavioural intention to use ADVs.

3.2.2.4 Facilitating Conditions

The term "facilitating conditions" derives from three previously used concepts in technology acceptance research, namely, perceived behavioural control in TPB (Ajzen, 1991) and the combined TAM (Taylor and Todd, 2001); as facilitating conditions in the Model of PC Utilisation (MPCU) (Thompson *et al.*, 1991); as well as compatibility in the Model of DOI (Rogers, 1983, 2003). All of these constructs have one particular similarity: they are "operationalised to include aspect of technological and/or organisational environment that are designed to remove barriers to use" (Venkatesh *et al.*, 2003, p. 453). Therefore, Venkatesh *et al.* (2003) subsumed the constructs under the term ***"facilitating conditions".***

In UTAUT2, facilitating conditions are defined as "consumers' perceptions of the resources and support available to perform a behavio[u]r" (Venkatesh *et al.*, 2012, p. 159). In this study, this would be the interaction between the human and the technology (i.e., ADVs). In the original UTAUT model, facilitating conditions are hypothesised to influence technology use directly. This is because facilitating conditions serve as the alternative for actual behavioural control in an organisational context (Ajzen, 1991). This is linked to the fact that within an organisation facilitating conditions (e.g., training or support) are freely available to nearly all users, which is not the case in the environment of private consumers (Venkatesh *et al.*, 2012). In a consumer context, however, the availability of facilitating conditions varies significantly across the technology generations and mobile devices, to name a few (Venkatesh *et al.*, 2012). Thus, facilitating conditions perform more like perceived behavioural control in the TPB in a consumer context, and therefore it influences both behavioural intention as well as behaviour (Ajzen, 1991; Venkatesh *et al.*, 2012). Thus, a consumer who has access to a favourable set of facilitating conditions, which can be internal or external (e.g., personal assessments about knowledge), is more likely to have higher intention to use a technology (Venkatesh *et al.*, 2012).

This assumption is in line with the consumer literature reviewed in this thesis. Venkatesh *et al.* (2012) were able to find a significant effect in the original UTAUT2 by investigating mobile internet. Furthermore, not only in the context of AVs (e.g., Madigan *et al.*, 2017) but also in the SSTs contexts (e.g., Alalwan *et al.*, 2016b; Owusu Kwateng *et al.*, 2018; Tarhini *et al.*, 2019), facilitating conditions have played a major role in determining behavioural intention. Additionally, and in line with the above discussion, several consumer studies applied perceived behavioural control in their empirical studies and also found a significant relationship to behavioural intention (e.g., Chen and Yan, 2018; Buckley *et al.*, 2018).

In this study, it is assumed that users have different levels of access to information and other resources that might facilitate their use of ADVs, for instance, personal knowledge (e.g., smartphone usage, online shopping experience, etc.), help hotlines, peers, or the internet. Furthermore, some individuals will be more interested in the system and therefore might invest more time in understanding the features of ADVs by researching and consulting with various sources. In general, consumers with lower levels of facilitating conditions will have lower intentions to new technology – in this case ADVs (Venkatesh *et al.*, 2003). Following the above arguments, the following hypothesis derives:

Hypothesis 4: Facilitating conditions positively influence behavioural intention to use ADVs.

3.2.2.5 Hedonic Motivation

In the beginning of the technology acceptance research, hedonic factors (i.e., affect factors) did not play a major role in technology acceptance models despite their potential role (Kulviwat *et al.*, 2007). Most theories and models have focused only on cognition (Kulviwat *et al.*, 2007). However, it had been suggested in previous research that consumers not only adopt technologies because of their usefulness but also because of the sources of enjoyment (Koenig-Lewis *et al.*, 2015b). Therefore, it has been argued that hedonic motivation plays an pivotal role in technology acceptance (Brown and Venkatesh, 2005). Its importance has been shown in the consumer behaviour (e.g., Childers *et al.*, 2001) as well as in the information systems context (e.g., van der Heijden, 2004).

Hedonic motivation has often been conceptualised as perceived enjoyment in previous research (e.g., Koenig-Lewis *et al.*, 2015b; Saprikis *et al.*, 2018). In UTAUT2, hedonic motivation is a new construct incorporated explicitly because of its importance in the consumer context (Venkatesh *et al.*, 2012). In doing so, Venkatesh *et al.* (2012) included intrinsic utilities/motivations (i.e., fun, entertainment, and playfulness) alongside extrinsic utilities/motivations (i.e., performance expectancy). In UTAUT2, hedonic motivation is defined as "the fun or pleasure derived from using a technology [i.e., ADVs]" (Venkatesh *et al.*, 2012, p. 161).

Hedonic motivation has been proven to be more important than performance expectancy in a consumer context (Venkatesh *et al.*, 2012). Despite its potential, not many studies included the construct as an additional external construct in technology acceptance models (Alalwan *et al.*, 2016a; Alalwan *et al.*, 2017; Yahia *et al.*, 2018; Owusu Kwateng *et al.*, 2018; Farah *et al.*, 2018; Alalwan *et al.*, 2018b; Madigan *et al.*, 2017; Tarhini *et al.*, 2019). In the context of autonomous vehicles, Madigan *et al.* (2017) identified hedonic motivation even as the most important construct to determine behavioural intention. Conceptually similar, enjoyment was also included as an additional external factor in the SSTs context (Oghazi *et al.*, 2012; Koenig-Lewis *et al.*, 2015b; Demoulin and Djelassi, 2016; Saprikis *et al.*, 2018). Among those, Koenig-Lewis *et al.* (2015b) was the only one that could not find a significant effect on behavioural intention; however, they found a significant indirect effect through perceived usefulness.

Since this study tries to follow the original UTAUT2 model as closely as possible, hedonic motivation conceptualised as enjoyment in this study. As such, it is believed to be influential in predicting behavioural intention in the context of ADVs. Thus, people who believe that the use of ADVs is fun, enjoyable and/or entertaining are believed to be more open-minded towards those delivery systems. Therefore, their intention to use ADVs as a delivery option will be higher. Following the above arguments, the following hypothesis derives:

Hypothesis 5: Hedonic motivation positively influences behavioural intention to use ADVs.

3.3 Framework Modifications, Exclusions and Extensions

After presenting the five original constructs used in UTAUT2 and their underlying hypotheses, this subchapter focuses on the modifications and extensions that needed to be made to fit the research framework to the context of ADVs for last-mile delivery. The aim of this subchapter is to describe and present in detail the modifications made and is divided in two parts: first, the focus is on the modifications and exclusions of constructs originally included in UTAUT2; second, the constructs that were identified to be important in SSTs as well as AVs studies in the systematic literature reviews will be presented in detail, including their underlying hypotheses.

3.3.1 Modification and Exclusion of Constructs

This subchapter includes the first part of the modifications and extensions procedures in this study: the modifications and exclusions of constructs. In more detail, price value is modified to price sensitivity, and habit, which was originally studied by UTAUT2, was excluded from the research framework. Again, it is worth mentioning that within this study no moderating variables (i.e., experience, gender, age) will be studied. This is based on the research question, which only looks at the constructs (i.e., factors) that are important in user acceptance formation of ADVs. However, age and gender are used as control variables in this study to strengthen the robustness of the theoretical research framework (see subchapter 6.4.2 for more details).

3.3.1.1 Price Sensitivity

Price has historically always been a major factor affecting the choices of consumers (Armstrong *et al.*, 2009). In comparison to other technology acceptance models and theories reviewed, the UTAUT2 model is the first that incorporates the factor price/costs (Venkatesh *et al.*, 2012). Venkatesh *et al.* (2012, p. 158) argue that “unlike workplace contexts, users are responsible for the costs and such costs, besides being important, can dominate consumer adoption decisions.” Since the original UTAUT model only considered time and effort, incorporating price/costs expands the focus of the model (Venkatesh *et al.*, 2012). By introducing a price construct, they followed previous research investigating the consumers' cognitive trade-offs between the perceived benefits of the technology and the monetary costs for using them (Dodds *et al.*, 1991) and introduced the new construct as ***"price value"*** (Venkatesh *et al.*, 2012). Hence, price value is considered as positive when the benefits are perceived to be greater than the monetary costs. They proposed price value to influence behavioural intention and were able to provide support for this relationship (Venkatesh *et al.*, 2012).

Even though price value has received some attention in previous marketing literature (e.g., Zeithaml, 1988) as well as in information systems literature (e.g., Alalwan *et al.*, 2017), overall the construct has been omitted by several UTAUT2 studies. However, most of the studies did not provide any reason for omitting it (Tamilmani *et al.*, 2018a). In this study, price value is not a suitable construct because consumers need to be aware of the price as well as the technology and its benefits beforehand. In other words, consumers need to decide whether the service is reasonably priced or not (Tsai and LaRose, 2015). However, this decision cannot be drawn without information on the price and the quality of a product or service. Missing this information is often the reason why UTAUT2 studies drop price value (e.g., Madigan *et al.*, 2016). Since ADVs are still in the developmental stage and only few prototypes are tested in public (e.g., Starship Technology robots in Hamburg or the ADV developed by Heilbronn University of Applied Sciences in Heilbronn), it is not possible for potential users to decide whether the price is worth the service they will receive. Thus, using the construct price value would rather end in speculative assumptions of potential users rather than valuable knowledge.

However, as users are responsible for emerging costs in the consumer context, price/costs are believed to be important in investigating private user acceptance for last-mile delivery solutions (Schröder *et al.*, 2018). This is especially true for Germany, where consumers are in general more concerned about the price and price changes (i.e., price sensitivity) compared to other countries like the United States, France, or the United Kingdom (OC & C Strategy Consultants, 2012). It is important to consider that Germans are in general not willing to pay much for home delivery (Statista, 2018c, 2018b). Therefore, most Germans are highly price-sensitive and will seek lower prices for their deliveries. This supports the decision to include a construct related to price in this study. In this study, ***"price sensitivity"*** is incorporated as an independent construct determining behavioural intention.

Price sensitivity is defined as "the way in which buyers react to prices and to price changes (Goldsmith *et al.*, 2005, p. 501) for home delivery. Specifically, it is how customers feel about the price for an offering (Goldsmith and Newell, 1997). In comparison to price value, price sensitivity is more related to consumers' willingness to pay for a specific product or service (Tsai and LaRose, 2015). Thus, this construct can already be investigated before the broad market introduction of ADVs as a delivery option. Although price sensitivity has been investigated and proven influential in previous acceptance studies (Goldsmith *et al.*, 2005; Goldsmith and Newell, 1997), it is one of the less-researched areas, especially in the field of technology acceptance and adoption (Tsai and LaRose, 2015; Natarajan *et al.*, 2017; Goldsmith and Newell, 1997). Price sensitivity has been incorporated into the Theory of Planned Behaviour by Chen and Yan (2018), who investigated the acceptance of autonomous vehicles. However, their findings could not support the significance of price sensitivity on behavioural intention, whereas Tsai and LaRose (2015) investigated broadband internet adoption by utilising the social cognitive theory as a foundation and found a significant negative effect of price sensitivity on broadband intention.

With the new delivery concept of ADVs, experts state that the cost of the last-mile delivery process which, is causing disproportionally high transport costs for the transportation provider at the moment (Liu *et al.*, 2019a), will drop up to 40 percent with the introduction of automated delivery systems (Joerss *et al.*, 2016). To date, however, it is not clear whether the decrease of costs will actually appear or whether these costs will also lead to a decrease of actual delivery costs for the final customer (i.e., recipient). Since the new delivery concept (i.e., ADVs) includes many additional advantages for the user (i.e. higher flexibility, more transparency over the delivery process, etc.), it could also be the case that logistics service providers introduce this kind of delivery as a premium service. Thus, it is possible that extra payments will be required that increase the total delivery costs, as in the case of same-day or same-hour delivery (Joerss *et al.*, 2016). This is assumed in this study. Thus, the price for ADV services will be higher than conventional delivery, especially in the beginning of the market introduction. Therefore, the following hypothesis derives:

Hypothesis 6: Price sensitivity negatively influences behavioural intention to use ADVs.

3.3.1.2 Habit

Across disciplines, habit is defined in two distinct ways. On the one hand, habit has been conceptualised "as the extent to which people tend to perform behaviors (use IS) automatically because of learning" (Limayem *et al.*, 2007, p. 705). On the other hand, it is conceptualised as prior use or past behaviour (Kim and Malhotra, 2005). Indeed, it was found that a higher level of experience in usage leads to habitual use of technology (Venkatesh *et al.*, 2012). Even though habit has been proven in previous consumer studies (e.g., Yahia *et al.*, 2018; Owusu Kwateng *et al.*, 2018), it is not possible to investigate habit in a reasonable way in this study. Following the above definitions, to examine the role of habit, users should have already gained rich experience and accumulative knowledge in using ADVs. However, ADVs as a delivery option are not widely available on the market. Currently there are only some trial tests (e.g., Hamburg, Dusseldorf, and Heilbronn). Thus, participants in this study have very likely not tried or used ADVs or even heard about this delivery system before. In other words, respondents of this study have very limited or – probably in most cases – no experience at all with ADVs. As a matter of fact, they could not develop any habitual behaviour at this point of time.

The decision to exclude habit is supported by other studies that investigated innovative technologies in the very beginning of the diffusion process and excluded habit (e.g., Alalwan *et al.*, 2016b; Alalwan *et al.*, 2017; Madigan *et al.*, 2017). Additionally, Tamilmani *et al.* (2019a) found in their review of UTAUT2 studies that habit has often been omitted due to the novelty of the technology investigated. Taking together the findings and arguments, it is reasonable to omit habit in this study. However, at a later stage, after ADVs are introduced as a regular delivery option, it might be worth investigating habit as a determinant of user acceptance of ADVs.

3.3.2 Framework Extensions

Although the UTAUT as a synthesised theory and its further development the UTAUT2 claim that the variables are sufficient to predict behavioural intention as well as the actual behaviour in the workplace or the consumer domain, respectively, most of the reviewed studies in the context of AVs and SSTs used further extensions to predict the acceptance in a specific domain adequately, which is in line with the findings by Tamilmani *et al.* (2017) and Dwivedi *et al.* (2019). The aim in this study is to identify the most important constructs in the context of user acceptance of ADVs. However, it is believed that to obtain a complete understanding of the user acceptance of ADVs, more constructs like the original ones proposed by Venkatesh *et al.* (2012) need to be incorporated into UTAUT2, which might sacrifice the parsimonious nature of the research framework to a small extent. However, it is argued that parsimony is not desirable by itself. In more detail, it is only desirable to the extent to which it still facilitates understanding (Venkatesh *et al.*, 2003). Thus, the balance between parsimoniousness on the one hand, and the level of explanatory power on the other hand, needs to be considered in the framework extension process in this study.

Therefore, it was decided in this thesis to include only the constructs that are most often studied and proven influential in the related research areas (i.e., SSTs and AVs). The findings of the systematic literature reviews showed that perceived risk, trust in technology, and innovativeness are considered important in various cases and contexts and therefore are included in this thesis as additional external constructs. To guarantee that the framework will still be operationally consistent, it was further checked whether those constructs overlap with existing UTAUT2 constructs. This is in line with the assertion that it is highly important that the incorporation of new variables are compatible with the existing variables in the model (Ajzen and Fishbein, 1980). In doing so, the construct definitions and/or their underlying items were compared to the existing UTAUT2 constructs. As a result, no overlap with existing constructs could be found, which is not surprising given that trust in technology, perceived risk, and innovativeness are the variables that have been most incorporated into UTAUT/UTAUT2 research (Tamilmani *et al.*, 2017, 2018b). Thus, UTAUT2 in this study is extended with ***perceived risk, trust in technology***, as well as ***innovativeness***. These constructs will be further reviewed, defined, and explained in more detail in the following sections.

3.3.2.1 Perceived Risk

Perceived risk has been studied in consumer adoption literature for many years (Bauer, 1960; Dowling and Staelin, 1994). Generally, it comprises two components: (1) the perceived uncertainty of outcomes as well as (2) the perceived importance of negative consequences, which are associated with the potential outcomes (Bauer, 1960). Taking this conceptualisation into consideration, Featherman and Pavlou (2003, p. 454) define perceived risk in a self-service context as "the potential for loss in the pursuit of a desired outcome of using an e-service [i.e., ADVs as a delivery option]."

It has been indicated by previous studies that consumers form beliefs about a product or service before using it (Giovanis *et al.*, 2018; Featherman and Hajli, 2016), which is concurrent with the theory of reasoned action (Ajzen and Fishbein, 1975). This evaluation might also include risk beliefs, which are used to assess the risk of using a new service or product and immediately influence their behavioural intention to use this service (Giovanis *et al.*, 2018; Featherman and Hajli, 2016). Indeed, many new technological services are considered inherently risky (Slade *et al.*, 2015). For instance, in the domain of e-commerce, concerns about the security and privacy have been identified, which is mainly due to the spatial and temporal separation of the seller and buyer as well as the vulnerability, which results from the wireless communications infrastructure (Kim *et al.*, 2009; Shin, 2010). In the context of online banking, perceived risk has been considered important due to the high uncertainty, intangibility, heterogeneity, as well as vagueness (Alalwan *et al.*, 2016b).

Despite its importance in technology acceptance research, perceived risk has been overlooked by previous technology acceptance models including the UTAUT/UTAUT2 model (Koenig-Lewis *et al.*, 2015a; Tamilmani *et al.*, 2018b). However, it is one of the most frequently studied constructs alongside UTAUT2 (Tamilmani *et al.*, 2018b) and has been integrated into several other technology acceptance theories. For instance, Curran and Meuter (2005) and Featherman and Hajli (2016) included perceived risk into the original technology acceptance model (TAM); Slade *et al.* (2015) incorporated perceived risk into UTAUT, and Herrero Crespo and Rodriguez del Bosque (2010) incorporated perceived risk into the theory of reasoned action (TRA). Unlike the original constructs studied in UTAUT, perceived risk is a detractor in the adoption process (Slade *et al.*, 2015). Detractors are important since consumers tend to consider not only the incentives but also the threats in their acceptance decision (Cowart *et al.*, 2008).

The findings of the systematic literature reviews in the areas of SSTs and AVs in this thesis show that perceived risk is considered important. For instance, Lu *et al.* (2009) investigated self-check-in services and found that perceived risk plays an important role; Herrero Crespo and Rodriguez del Bosque (2010) explored the acceptance of e-commerce and could prove the significance of perceived risk, and Slade *et al.* (2015) investigated mobile payments and were able to support the importance of perceived risk. Even though, perceived risk could not be proven in an AVs context (Kervick *et al.*, 2015; Choi and Ji, 2015; Chen and Yan, 2018), perceived safety, which is conceptually similar to perceived risk has been proven to be important (e.g., Zmud *et al.*, 2016; Xu *et al.*, 2018). In addition to the findings of the systematic literature reviews, Marsden *et al.* (2018) as well as Braun and Buckstegen (2017) also found that risk might play an important role in acceptance formation in the specific context of ADVs in last-mile delivery.

In the context of ADVs, some potential risks might occur given their characteristics, which lead to negative losses or consequences of individuals. For instance, technology failure may occur due to technical or human error during parcel drop-off. In such a case, customers' perceptions of malfunctioning of an SSTs lowers the intention to use the technology (Curran and Meuter, 2005). Another example of a potential risk source might be the risk of potential accidents on public roads. Once a user has doubts about the safety of a technology, they try to avoid it (König and Neumayr, 2017), and therefore the intention to use ADVs might be lowered. Taking into consideration the findings of the descriptive studies in the context of ADVs, the findings in the areas of SSTs and AVs research, as well as the potential risk sources in the ADVs area, perceived risk (i.e., overall perceived risk), which, in this study, is referred to as "the potential for loss in the pursuit of a desired outcome" of using ADVs as a delivery option (Featherman and Pavlou, 2003, p. 454), plays an important role in user acceptance of ADVs. Thus, the following hypothesis derives:

H7a: Overall perceived risk negatively influences behavioural intention to use ADVs.

Even though perceived risk has very often been treated as a unitary construct and found to be influential on behavioural intention (e.g., Slade *et al.*, 2015; Kapoor *et al.*, 2015; Mortimer *et al.*, 2015; Alalwan *et al.*, 2016b), perceived risk has been argued to be multidimensional (Jacoby and Kaplan, 1972; Featherman and Hajli, 2016; Featherman and Pavlou, 2003). Since the risk facets may vary independently of one another, studying perceived risk as a general and abstract construct might not reveal the important facets considered as risky when using a technology or a technological service (Mandrik and Bao, 2005). In this regard, Cunningham (1967) was the first who typified perceived risk into six dimensions: (1) performance, (2) financial, (3) safety, (4) opportunity/time, (5) social, and (6) psychological loss. Similarly, in the context of self-services, Featherman and Pavlou (2003) recommended to use the six risk dimensions proposed by Cunningham (1967). However, they also recommended to replace safety risk (i.e., threats to consumers health) with privacy risk (i.e., likelihood of threats to the privacy) due to the absence of safety risk involved in e-commerce transactions.

In the context of ADVs it is believed that two risk facets are dominant due to the two major characteristics of ADVs. First, perceived performance risk, which is defined as "the consumer assessment of potential performance problems, malfunctioning [and] transaction processing errors […], and therefore not performing as expected" (Featherman and Hajli, 2016, p. 253) during the final parcel drop-off process (e.g., parcel locker does not perform accurately, Bluetooth connection fails, etc.), is proposed to determine overall perceived risk in the context of ADVs. In general, Curran and Meuter (2005) state that if consumers believe that self-services include the potential of malfunctioning they will search for alternatives. Therefore, if consumers believe that the parcel drop-off might malfunction, they will very likely not adopt it as a delivery option. This is in line with the finding by Hwang and Choe (2019), who stated that performance risk is one of the most important risk facets for automated drone delivery in the context of last-mile delivery.

Second, perceived safety risk, which is defined as the potential threat to health (i.e., harmful or injurious) of a human being (Jacoby and Kaplan, 1972) due to malfunctioning of the autonomous driving function, is proposed to play a major role in determining the overall perceived risk of ADVs. This is because ADVs are self-driving vehicles (i.e., without driver) and therefore people might see a higher potential risk of accidents. This is in line with the findings by Braun and Buckstegen (2017), who found that more than 50 percent of consumers in Germany believe that autonomous vehicles used for delivery (i.e., ADVs and aerial drones) are dangerous when participating in public traffic, as well as the findings by Marsden *et al.* (2018), who found that people do not like ADVs because of the potential risk of accidents. Following these arguments, the following hypotheses derive:

H7b: Perceived performance risk positively influences overall perceived risk.

H7c: Perceived safety risk positively influences overall perceived risk.

3.3.2.2 Trust in Technology

In every situation in which uncertainty exists or undesirable outcomes are possible, trust is considered to be important (Luhmann, 2017). In behavioural as well as information systems literature, most researchers refer to the definition of trust proposed by Mayer *et al.* (1995, p. 712) as “the willingness to be vulnerable to the actions of another party.” Following this definition, trust comprises three facets: ability, benevolence, and integrity. Ability is defined as having the skills and knowledge to proceed a task. Benevolence is defined as the extent to which a trustor wants to do good to the trustee. Integrity “involves the trustor’s perception that the trustee adheres to a set of principles that the trustor finds acceptable” (Mayer *et al.*, 1995, p. 719). Trust has mostly been evaluated by measuring interpersonal relationships (i.e., trust in people) in the information systems domain (McKnight *et al.*, 2011). For instance, trust has been investigated regarding internet vendors (McKnight *et al.*, 2002; Gefen *et al.*, 2003) and has been found to influence Web consumers’ beliefs and behaviour (Clarke, 1999). Overall, the literature confirms that trust in another actor as well as trust in an agent of another actor influences behavioural decisions of an individual (McKnight *et al.*, 2011).

However, as within the studies of AVs as well as SSTs, in this study it is more important to rely on the technology (i.e., ADVs) rather than a third party. Therefore, it is of highest interest to investigate trust in technology. This is based on the fact that the overall delivery process of last-mile with ADVs depends mostly on a human – technology interaction (i.e., app usage, direct interaction with the vehicle during parcel drop-off) and not on human – human interaction, which was the case in the traditional delivery process. Therefore, trust in this study focuses only on the attributes of ADVs, which is consistent with other constructs used in UTAUT2 that also focus on the attributes of technology (e.g., performance expectancy or effort expectancy).

Similar to the interpersonal context, trust in technology has been defined as “the general tendency to be willing to depend on technology [i.e., ADVs]” (McKnight *et al.*, 2011, p. 7). However, compared to the interpersonal context, comparatively little research exists on trust in technology (McKnight *et al.*, 2011). In particular, in the context of self-services (i.e., automated services), it has been argued to be of special importance due to the lack of personal interaction involved (Farah *et al.*, 2018). Considering the findings from the systematic literature reviews, trust in technology has been investigated and was found to be significant in both related research areas: AVs and SSTs. For instance, trust in technology with focus on AVs technologies has been investigated and identified as a significant predictor of behavioural intention in several of the reviewed consumer acceptance studies (e.g., Choi and Ji, 2015; Angelis *et al.*, 2017; Panagiotopoulos and Dimitrakopoulos, 2018; Buckley *et al.*, 2018). In the context of SSTs, several studies could also find a significant effect (e.g., Dimitriadis and Kyrezis, 2010; Kaushik and Rahman, 2015a; Oh *et al.*, 2016; Alalwan *et al.*, 2017; Tarhini *et al.*, 2019). In addition to that, trust in technology has been found in a systematic review of UTAUT2 studies to be one of the most external variables incorporated (Tamilmani *et al.*, 2017, 2018b).

Taking into consideration the positive results of trust in SSTs and AVs studies, the implicit uncertainty of the human – technology interaction of ADVs through the changing delivery process (i.e., lack of personal interaction due to the substitution of the delivery person), as well as the fact that people tend to rely more on automation they trust (Lee and Moray, 1992; Ghazizadeh *et al.*, 2012; Shahrdar *et al.*, 2018), trust in technology is proposed to be a necessary precondition for the acceptance of ADVs and therefore it is believed to be highly influential on behavioural intention to use ADVs. In this study, this is referred to as "overall trust in technology" (TT_O) and is defined as the general tendency to be willing to depend on ADVs as a delivery option. Thus, the following hypothesis derives:

H8a: Overall trust in technology positively influences behavioural intention to use ADVs.

Despite the fact that most studies refer to the three-dimensional definition of trust by Mayer *et al.* (1995), it is worth mentioning that all studies reviewed in the systematic reviews did not explicitly differentiate between these three aspects of trust in developing their models (i.e., using only one construct "trust in technology"). Some studies, however, tried to follow the three-dimensional definition by incorporating all three aspects into one construct (e.g., Alalwan *et al.*, 2017). However, this abstract level of trust has been criticised and researchers have called for a more detailed view on trust to generate a better understanding (Leimeister *et al.*, 2005).

In this regard, several researchers have proposed a more detailed view on trust in technology. For instance, McKnight *et al.* (2011) have conceptualised trust in technology by presenting three facets, which are based on the interpersonal facets by Mayer *et al.* (1995): functionality (i.e., possession of the needed functionality to do a required task;

similar to ability), helpfulness (i.e., able to provide effective help when needed; similar to benevolence), and reliability (operate reliably or consistently; similar to integrity). In the context of automation, Lee and Moray (1992) proposed three dimensions of trust: performance, process, and purpose. Performance comprises characteristics like ability, reliability, as well as predictability. By contrast, process is stated to be the degree to which the automation's algorithms are suitable for the underlying situation as well as able to realise the user's goals, whereas purpose focuses on the degree the automation is used in the context it was designed for. In the context of AVs, Choi and Ji (2015) have conceptualised trust as system transparency, technical competence, as well as situation management. System transparency is defined as the degree the operating of AVs can be predicted and understood by users. Technical competence is defined as the degree of perceived performance of AVs by the user. Situation management is stated to be the belief that the user can recover control in desired situations (Choi and Ji, 2015).

The various facets of trust in technology identified in the literature are conceptually similar and can be summarised as follows: one facet of trust in technology refers to the belief that a system can be predicted or understood; another facet refers to the belief that a system performs its tasks in an accurate and correct manner; and the last facet refers to the belief that the system offers effective, responsive, and adequate assistance (Choi and Ji, 2015).

To be able to increase the insights of trust in technology in the ADVs context, trust has been studied in more detail in this study. In the context of ADVs, the belief that the vehicle performs its tasks accurately and correctly is considered the most important aspect. This is because it has been shown in the domain of autonomous vehicles that the perceived performance (i.e., technical competence/reliability) of the technology is the main driver of trust in technology (e.g., Kaur and Rampersad, 2018; Choi and Ji, 2015). Thus, it is proposed that the expectations of the ADVs' performance will increase trust. Since ADVs combine the features from SSTs (i.e., autonomous parcel drop-off) as well as AVs (i.e., autonomously driving) in one technology, trust in the performance of the technology is investigated from two angles. First, the degree to which users believe that ADVs "operate reliably and consistently without failing" (McKnight *et al.*, 2011, p. 4) (i.e., no accidents, etc.) on public roads is investigated. In this study, this facet of trust is referred to as "street performance" (TT_S). Second, as soon as the ADV arrives at the final destination, the parcel drop-off process, i.e., opening the locker, which includes connecting the smartphone via Bluetooth to the vehicle and collecting the parcel, needs to work accurately and correctly. In other words, the degree to which users believe that ADVs "operate reliably and consistently without failing" (McKnight *et al.*, 2011, p. 4) during parcel drop-off is investigated. In this study, this is referred to "parcel drop-off performance" (TT_P). These two facets of trust in technology are proposed to determine "overall trust in technology" (TT_O) in the context of user acceptance of ADVs. Thus, the following hypotheses derive:

H8b: Parcel drop-off performance positively influences overall trust in technology.

H8c: Street performance positively influences overall trust in technology.

Besides the influence of trust on behavioural intention, trust has also been proven as a major determinant of perceived risk in a service-based setting (e.g., Koenig-Lewis *et al.*, 2010; Slade *et al.*, 2015) as well as in the context of autonomous vehicles (Choi and Ji, 2015). Indeed, perceived risk has been found as a major construct linked to trust, especially when it comes to the use of an automated system (e.g., Pavlou, 2003; Slade *et al.*, 2015). Here, evidence is provided that trust on automation influences behavioural intention indirectly through perceived risk. Trust in technology is believed to reduce perceived risk, which depends on the user's expectation of negative situations. In other words, trust reduces the high perceptions of risk because it helps to overcome uncertainty and anxiety in regard to the behaviour as well as its possible outcomes (McKnight *et al.*, 2002). Following these arguments, in the context of ADVs, if users trust the ADV then they believe that the vehicle will perform as expected (i.e., ADVs drive accurately on public roads; ADVs perform accurately during parcel drop-off), therefore reducing the overall perception of risk of a negative situation. Thus, the following hypothesis derives:

H8d: Overall trust in technology negatively influences overall perceived risk.

3.3.2.3 Innovativeness

Innovativeness has received much attention in previous consumer behaviour research (Agarwal and Prasad, 1998; Rogers, 1983, 2003; Midgley and Dowling, 1978; Parasuraman, 2000; Hirschman, 1980). Depending on the domain of research, various definitions of innovativeness occur. For instance, Rogers and Shoemaker (1971) define innovativeness in the domain of innovation diffusion as the extent to which a member of a social system adopts new ideas relatively in the beginning of the diffusion process compared to other members of his/her social system. According to Midgley and Dowling (1978, p. 236), innovativeness in the marketing domain refers to "the degree to which an individual is receptive to new ideas and makes innovation decisions independently of the communicated experience of others." In the domain of information systems, Agarwal and Prasad (1998, p. 206) define innovativeness as "the willingness to try out any new information technology." Following these definitions, innovativeness can be summarised as the extent to which people are open in experiencing and experimenting with something new. In this research study, the definition by Agarwal and Prasad (1998) is adopted. As such, innovativeness is defined as the willingness to try out ADVs as a delivery option.

Despite the fact that innovativeness has been asserted as a key construct in a consumer's willingness to adopt a new technology (Agarwal and Prasad, 1998; Rogers, 1983, 2003; Midgley and Dowling, 1978), it has not been incorporated in one of the major technology acceptance theories or models (Agarwal and Prasad, 1998; Slade *et al.*, 2015). Even the UTAUT or the UTAUT2, which claim to be the most comprehensive models, fail to recognise the importance of an individual innovativeness in the adoption process (Slade *et al.*, 2015; Dwivedi *et al.*, 2019). Despite the failure to include innovativeness in previous acceptance models, many studies incorporated innovativeness to understand individual differences in the acceptance of technology (e.g., Chen and Yan, 2018; Kim and Forsythe, 2008; Dimitriadis and Kyrezis, 2010; Saprikis *et al.*, 2018; Giovanis *et al.*, 2018; Slade *et al.*, 2015).

For instance, in the context of SSTs, Slade *et al.* (2015) investigated remote mobile payments and Giovanis *et al.* (2018) investigated self-service retail banking technology and have proven the influence of innovativeness on behavioural intention. In the context of AVs, Chen and Yan (2018) found a significant effect of innovativeness on behavioural intention. Additionally, within a logistical background, Chen *et al.* (2018) investigated self-service parcel delivery services (i.e., automated parcel lockers) as an alternative to conventional home delivery and found that innovativeness has a strong positive relationship to behavioural intention. Additionally, Tamilmani *et al.* (2018b) also found in their systematic review of UTAUT2 studies that innovativeness is one of the most often studied external constructs alongside UTAUT2.

In the context of ADVs, innovativeness is believed to play an important role. This is because ADVs offer a new way of parcel delivery that is different to existing delivery options. This is mainly because of the large amount of technology as well as the technology interaction involved in the delivery process. Additionally, people need to have a mobile device (e.g., smartphone or tablet-pc) to be able to use this delivery service. Thus, people are believed to be more innovative as such. Taking into consideration the positive previous findings as well as the high dependency on technology involved in the delivery process by ADVs, the level of innovativeness by the user is believed to play an important role in the adoption process. Thus, the following hypothesis derives:

H9: Innovativeness positively influences behavioural intention to use ADVs.

3.3.3 Summary of Hypotheses and Construct Definitions

After reviewing, discussing, and defining the research constructs, Table 3.1 on the following page summarises all constructs and their underlying hypotheses and adopted definitions used within this research project.

Table 3.1: Summary of Research Constructs and Their Definitions

Constructs	H	Adopted Definitions to the Context of ADVs	References
Performance Expectancy (PE)	H1	"the degree to which using [ADVs] will provide benefits to consumers"	(Venkatesh *et al.*, 2012, p. 159)
Effort Expectancy (EE)	H2	"the degree of ease associated with consumers' use of [ADVs]."	(Venkatesh *et al.*, 2012, p. 159)
Social Influence (SI)	H3	"the extent to which consumers perceive that important others (e.g. family and friends) believe the should use [ADVs]" as a delivery option.	(Venkatesh *et al.*, 2012, p. 159)
Facilitating Conditions (FC)	H4	"consumers' perceptions of the resources and support available" to use ADVs as a delivery option.	(Venkatesh *et al.*, 2012, p. 159)
Hedonic Motivation (HM)	H5	"the fun or pleasure derived from using [ADVs]."	(Venkatesh *et al.*, 2012, p. 161)
Price Sensitivity (PS)	H6	"the way in which buyers react to prices and to price changes" for home delivery.	(Goldsmith *et al.*, 2005, p. 501)
Overall Perceived Risk (PR_O)	H7a	Overall "potential for loss in the pursuit of a desired outcome" of using ADVs as a delivery option.	(Featherman and Pavlou, 2003, p. 454)
Perceived Performance Risk (PR_PR)	H7b	"Consumer assessment of potential performance problems, malfunctioning [and] transaction processing errors [of ADVs], and therefore not performing as expected."	(Featherman and Hajli, 2016, p. 253)
Perceived Safety Risk (PR_SR)	H7c	Potential to be "harmful or injurious to your health" because of malfunctioning of the autonomous driving function.	(Jacoby and Kaplan, 1972, p. 11)
Overall Trust in Technology (TT_O)	H8a	"the general tendency to be willing to depend on [ADVs]"	(McKnight *et al.*, 2011, p. 7)
Street Performance (TT_S)	H8b	The degree to which ADVs "operate reliably or consistently without failing" on public roads.	(McKnight *et al.*, 2011, p. 4)
Parcel Drop-off Performance (TT_P)	H8c	The degree to which ADVs "operate reliably or consistently without failing" during parcel drop-off.	(McKnight *et al.*, 2011, p. 124)
Relationship between TT_O and PR_O	H8d	Overall trust in technology (TT_O) reduced overall perceived risk (PR_O) in the context of ADVs.	(e.g., Koenig-Lewis *et al.*, 2010; Slade *et al.*, 2015)
Innovativeness (I)	H9	"the willingness of an individual to try out" ADVs as a delivery option.	(Agarwal and Prasad, 1998, p. 206)
Behavioural Intention (BI)	Main dependent construct	"the degree to which an individual intends to use [ADVs as a delivery option], when available, and incorporates it into his/her [everyday life]."	(Adell, 2010, p. 477)

3.4 Research Framework and Operationalisation of Constructs

The last two chapters were directed towards fulfilling the first two objectives of this thesis. A theoretical research framework has been developed based on previous literature, which shows the determinants and their relations to behavioural intention (i.e., user acceptance) in the context of ADVs. The most appropriate external constructs identified in the literature of AVs as well as the literature of SSTs have been added to the UTAUT2. Thus, both related research perspectives – SSTs and AVs – were considered in developing the acceptance framework for ADVs. Additionally, the limited findings from the ADVs studies were also taken into consideration (Kapser and Abdelrahman, 2019). The final theoretical framework, including its underlying hypotheses, is presented in Figure 3.1. The references used to define these constructs and their items are presented in Table 3.2 on the following pages.

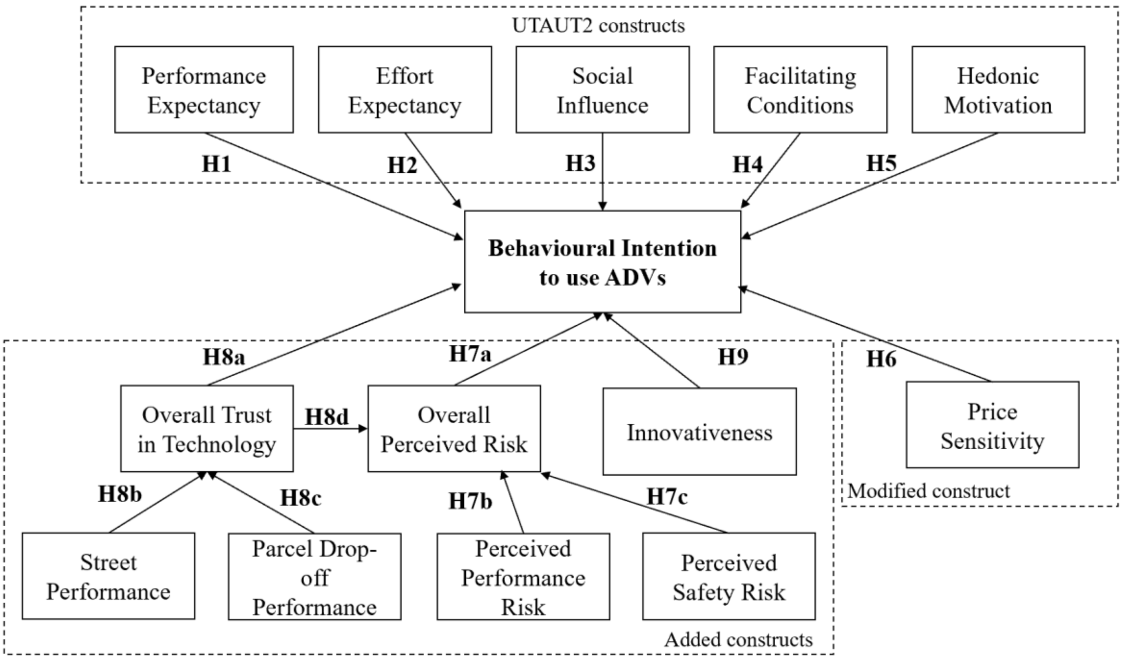

Figure 3.1: Developed Theoretical Research Framework

The operationalisation of the constructs is based on previous research to raise the consistency in the research field of technology acceptance as well as to preserve content validity (Straub *et al.*, 2004). However, the items were to some extent adapted to the context of ADVs. As stated before, this study tries to follow the original UTAUT2 model as closely as possible, therefore the research items used by Venkatesh et al. (2012) were applied for the following constructs: performance expectancy, effort expectancy, social influence, facilitating conditions, and hedonic motivations. Additionally, the questionnaire items for the additional incorporated constructs (i.e., overall trust in technology, street performance, parcel drop-off performance, overall perceived risk, perceived performance risk, perceived safety risk, innovativeness, as well as price sensitivity) showed not only high reliability but also demonstrated high convergent as well as discriminant validity in previous research studies. All questionnaire items were investigated on a Likert scale from (1) strongly disagree to (7) strongly agree. An exception is the construct of price sensitivity, where some reversed items were applied. For the reverse coded items, it is investigated in the opposite way. Since this research was conducted in Germany, the German translation of the questionnaire items can be found in Appendix B: Survey Questionnaire – German Version. The constructs with their labels, the adapted questionnaire items, as well as the references are presented in Table 3.2.

Table 3.2: Constructs and Questionnaire Items

Construct	Adapted Items	References
Performance Expectancy (PE)	▪ I would find autonomous delivery vehicles useful in my daily life. ▪ Using autonomous delivery vehicles would help me accomplish things more quickly. ▪ Using autonomous delivery vehicles would increase my productivity. ▪ Using autonomous delivery vehicles would increase my flexibility in my daily life.	(Venkatesh *et al.*, 2012)
Effort Expectancy (EE)	▪ Learning how to use autonomous delivery vehicles would be easy for me. ▪ My interaction with the autonomous delivery vehicle via the mobile app would be clear and understandable. ▪ I would find autonomous delivery vehicles easy to use. ▪ It would be easy for me to become skilful at using autonomous delivery vehicles.	(Venkatesh *et al.*, 2012)
Social Influence (SI)	▪ People who are important to me would think that I should use autonomous delivery vehicles. ▪ People who influence my behaviour would think that I should use autonomous delivery vehicles. ▪ People whose opinion I value would prefer that I use autonomous delivery vehicles.	(Venkatesh *et al.*, 2012)

Table 3.2: Constructs and Questionnaire Items – Continued

Construct	Adapted Items	References
Facilitating Conditions (FC)	▪ I have the resources necessary to use autonomous delivery vehicles (i.e., mobile device). ▪ I have the knowledge necessary to use autonomous delivery vehicles. ▪ Autonomous delivery vehicles are compatible with other technologies I use (e.g., smartphone). ▪ I could get help from others when I have difficulties using autonomous delivery vehicles.	(Venkatesh *et al.*, 2012)
Hedonic Motivation (HM)	▪ Using autonomous delivery vehicles would be fun. ▪ Using autonomous delivery vehicles would be enjoyable. ▪ Using autonomous delivery vehicles would be very entertaining.	(Venkatesh *et al.*, 2012)
Price Sensitivity (PS)	▪ I would not mind paying more to try out autonomous delivery vehicles as a delivery option *(reverse)*. ▪ I would not mind spending a lot of money for getting my orders delivered by autonomous delivery vehicles *(reverse)*. ▪ I would be less willing to pay for autonomous delivery vehicles as a delivery option if I thought it to be high in price. ▪ If I knew that autonomous delivery vehicles as a delivery option were likely to be more expensive than conventional delivery options, that would not matter to me *(reverse)*. ▪ A really great delivery option would be worth paying a lot of money for.	(Goldsmith *et al.*, 2005)
Overall Perceived Risk (PR_O)	▪ Overall, using autonomous delivery vehicles as a delivery option would be risky. ▪ Overall, autonomous delivery vehicles as a delivery option would be dangerous to use. ▪ Using autonomous delivery vehicles as a delivery option would expose me to an overall risk.	(Featherman and Pavlou, 2003)
Perceived Performance Risk (PR_PR)	▪ Autonomous delivery vehicles might not perform well and create problems during parcel drop-off (e.g., locker cannot be opened, failure of Bluetooth connection, etc.). ▪ Autonomous delivery vehicles might not work properly during parcel drop-off. ▪ The chances that something would be wrong with the performance of autonomous delivery vehicles during parcel drop-off would be high.	(Featherman and Pavlou, 2003)
Perceived Safety Risk (PR_SR)	▪ Autonomously driving delivery vehicles on public roads would be risky. ▪ Autonomously driving delivery vehicles on public roads would be dangerous. ▪ Autonomously driving delivery vehicles would add great uncertainty to public roads.	(Featherman and Pavlou, 2003)

Table 3.2: Constructs and Questionnaire Items – Continued

Construct	Adapted Items	References
Overall Trust in Technology (TT_O)	▪ Overall, I would trust autonomous delivery vehicles to be reliable. ▪ Overall, I would trust autonomous delivery vehicles to be dependable. ▪ Overall, I would trust autonomous delivery vehicles.	(Choi and Ji, 2015)
Street Performance (TT_S)	▪ I believe that the operation of autonomous delivery vehicles would be free of error when driving on public roads. ▪ I believe that I could depend and rely on autonomous delivery vehicles when driving on public roads. ▪ I believe that autonomous delivery vehicles would perform consistently under a variety of circumstances when driving on public roads.	(Choi and Ji, 2015)
Parcel Drop-off Performance (TT_P)	▪ I believe that the interaction with autonomous delivery vehicles during parcel drop-off would be free of error. ▪ I believe that I could depend and rely on autonomous delivery vehicles during parcel drop-off. ▪ I believe that autonomous delivery vehicles would perform consistently under a variety of circumstances during parcel drop-off.	(Choi and Ji, 2015)
Innovativeness (INO)	▪ If I heard about a new technology, I would look for ways to experiment with it. ▪ Among my peers, I am usually the first to explore new technologies. ▪ I like to experiment with new technology.	(Agarwal and Prasad, 1998)
Behavioural Intention (BI)	▪ I intend to use autonomous delivery vehicles as a delivery option in the future. ▪ I would always try to use autonomous delivery vehicles as a delivery option in my daily life when available in the future. ▪ I plan to use autonomous delivery vehicles frequently when available in the future.	(Venkatesh *et al.*, 2012)

3.5 Conclusion

This chapter presented the developed theoretical research framework, which was used to investigate user acceptance of ADVs in this thesis. All original UTAUT2 constructs used in this study were presented in detail and the hypotheses were clearly stated. Additionally, the modifications, exclusions, as well as extensions of the UTAUT2 model were presented with a clear reasoning. As a result, within this chapter it was possible to develop the theoretical research framework, including the questionnaire to verify it. As such, the first and second research objectives of this thesis were fulfilled comprehensively.

Chapter 4: Methodology

4.1 Introduction

This chapter aims to explain the underlying research methodology applied in this research project to fulfil the research objectives and answer the research question empirically. The chapter will start with the presentation of the research philosophy as well as the applied research approach. It will continue with the research design. This includes the research strategy, the data collection method (i.e., questionnaire design and development, pre-testing, translation procedures), the sampling strategy (i.e., sampling process, quotas, and sample size), as well as the data analysis procedures (i.e., descriptive and inferential statistics). Each methodological decision will be presented with a clear reasoning. At the end of this chapter, the ethical considerations will be presented.

4.2 Research Philosophy

Research philosophy refers to the development of knowledge as well as the nature of that knowledge in a particular research domain (Saunders *et al.*, 2009). The philosophical commitment not only includes important assumptions about the way researchers view the world but also underpins these assumptions with particular research strategies chosen and their underlying methods (Johnson and Clark, 2006). The philosophical choice is, therefore, influenced by the researcher's practical view of the relationship between knowledge and the process of knowledge development (Saunders *et al.*, 2009). However, it needs to be considered that "the important issue is not so much whether our research should be philosophically informed, but it is how well we are able to reflect upon our philosophical choices and defend them in relation to the alternatives we could have adopted" (Saunders *et al.*, 2009, p. 108).

In business and management research, two main research philosophies are regularly utilised – positivism and interpretivism – with others lying on a continuum between these two extremes (Bryman and Bell, 2015; Carson *et al.*, 2001; Saunders *et al.*, 2009; Collis and Hussey, 2014). These philosophies will be presented in the following sections. This will be followed by a brief comparison of these paradigms in Table 4.1, based on ontology (i.e., reality), epistemology (i.e., knowledge), axiology (i.e., values) as well as the data collection techniques and the decision and justification to use positivism in this research.

Positivism, on the one hand, is defined as “an organised method for combining deductive logic with precise empirical observations of individual behaviour in order to discover and confirm a set of probabilistic causal laws that can be used to predict general patterns of human activity” (Neuman, 2010, p. 97). The key aspect of positivism is the use of quantifiable variables and extrapolation of the findings from the sample to draw inferences for a specific phenomenon to a specified population (Neuman, 2010). The process of positivists starts with studying the literature to establish a theory and develop hypotheses (Collis and Hussey, 2014). Thus, the focus in this paradigm is on description, the explanation of relationships, and determining facts (Carson *et al.*, 2001; Neuman, 2010). Since positivists are descriptive, they make a clear distinction between observable facts and value judgements. In other words, research is undertaken in a value-free and objective way (Saunders *et al.*, 2009). The positivist paradigm has a tendency of using a large amount of quantitative data and statistical analysis (Saunders *et al.*, 2009; Collis and Hussey, 2014).

Interpretivism, on the other hand, is considered the opposite side of the philosophical continuum (Carson *et al.*, 2001; Collis and Hussey, 2014). Compared to positivism, the social reality is highly subjective since it is shaped by perceptions (Collis and Hussey, 2014; Neuman, 2010). Interpretivism seeks to understand the differences between humans as social actors (Saunders *et al.*, 2009). The focus in this philosophical paradigm lies on exploring the complexity of human sense-making and understanding the behaviour of humans from the respondent’s own perspective (Collis and Hussey, 2014). Overall, “it includes a consideration of multiple realities, different actors’ perspectives, researcher involvement, taking account of the contexts of the phenomena under study, and the contextual understanding and interpretation of data“ (Carson *et al.*, 2001, p. 6). The interpretivist paradigm has a tendency of using small amounts of qualitative data (Collis and Hussey, 2014; Saunders *et al.*, 2009).

A comparison between these two main philosophical paradigms based on ontology, epistemology, axiology, as well as the data collection techniques is presented in Table 4.1 on the following page.

Table 4.1: Comparison of Research Philosophies adopted from Saunders et al. (2009, p. 119)

	Positivism	**Interpretivism**
Ontology: *the researcher's view of the nature of reality or being*	External, objective and independent of social actors.	Socially constructed, subjective, may change, multiple.
Epistemology*: the researcher's view regarding what constitutes acceptable knowledge*	Only observable phenomena can provide credible data, facts. Focus on causality and law like generalisations, reducing phenomena to simplest elements.	Subjective meanings and social phenomena. Focus upon the details of situation, a reality behind these details, subjective meanings motivating actions.
Axiology: *the researcher's view of the role of values in research*	Research is undertaken in a value-free way, the researcher is independent of the data and maintains an objective stance.	Research is value bound, the researcher is part of what is being researched, cannot be separated and so will be subjective.
Data collections techniques	Highly structured, large samples, measurement, quantitative, but can also be qualitative.	Small samples, in-depth investigations, qualitative.

The decision to use one philosophical paradigm over the other is a significant task. As presented above, the reason for this is that the decision is driven by several concerns like the researcher's own beliefs about the way to study humans and their behaviours, the research questions and objectives, the rigour of the research, the problem understanding, the generalisability of the results, as well as the usefulness of the findings. In this research it is argued that the most applicable philosophical paradigm is positivism. The justification of using the positivism paradigm is presented in the following.

First, the aim of this research is to identify and confirm the constructs that affect user acceptance of ADVs in last-mile delivery in Germany by utilising the UTAUT2 model. Reviewing the literature showed that there are many studies available that applied technology acceptance theories in contexts closely linked to this research study (i.e., SSTs and AVs contexts). However, none of these studies used UTAUT/UTAUT2 in the context of ADVs and none were conducted in the cultural context of Germany. Using the positivism paradigm allows testing, evaluating, and confirming or rejecting the hypotheses derived from existing theory in a new context (Neuman, 2010). In more detail, the established relationships of UTAUT2 as well as a few new relationships hypothesised in the UTAUT2 literature will be used to better understand and describe the user perspective regarding the acceptance of ADVs in the context of last-mile delivery. In other words, using the positivism paradigm will help to investigate whether existing knowledge on UTAUT/UTAUT2 is transferable to the context of ADVs as well as to the cultural context of Germany. Therefore, within this research, a confirmatory (i.e., positivism) rather than an exploratory research approach (i.e., interpretivism) is most useful.

Second, this study aims to make generalisations and draw inferences to a wider population (i.e., German population). However, this is only possible when a large amount of quantitative data is gathered and analysed in an efficient and statistical manner. Thus, using the positivism paradigm allows the collection of quantitative data from a large sample in a highly structured and efficient way. The data interpretation follows clear statistical procedures (i.e., structural equation modelling in this study), which increases the reliability of the findings compared to the interpretivism paradigm (Collis and Hussey, 2014).

Third, through the general literature review on theories and models of technology acceptance and also the extant literature reviews in the areas of user acceptance of AVs as well as SSTs, it seems that positivism is the dominant paradigm used to study user acceptance of new technologies. In fact, this conclusion is supported by the findings of the UTAUT meta-analysis conducted by Williams *et al.* (2009), which also concluded that the positivism paradigm is most often used and suitable in studying technology acceptance with the UTAUT model.

Finally, not only due the theoretical and practical considerations stated above but also in terms of monetary and time constraints, using the positivism paradigm is the most suitable research philosophy to answer the research question in this study in a justifiable manner.

4.3 Research Approach

A specific theory underlies each research project. “The extent to which you are clear about the theory at the beginning of your research raises an important question concerning the design of your research project” (Saunders *et al.*, 2009, p. 124). Therefore, it needs to be clear at the beginning whether the theory development takes place before or after collecting the data to design the right research strategy. The first procedure is called deductive, whereas the second one is called inductive (Saunders *et al.*, 2009; Collis and Hussey, 2014). Both will be explained in more detail in the following.

Deduction, in general, "owes much to what we would think of as scientific research" (Saunders *et al.*, 2009, p. 124). Deduction is a process by which the researcher generally arrives at a justified conclusion by generalisations of known facts. Overall, the deductive research approach includes several characteristics: (1) the explanation of causal relationships; (2) allows the testing of hypotheses; (3) the constructs need to be operationalised in a way to measure them quantitatively; and (4) with the deductive approach, generalisation can be drawn on a wider population (Saunders *et al.*, 2009). Linking the deductive approach to philosophy, it is more concerned with the positivistic paradigm (Saunders *et al*., 2009).

The inductive approach is the upside version of deduction. As noted, deduction emerged from natural sciences research. Social scientists, however, are sceptical of the cause – effect link made in natural science without considering the way humans interpret their social world (Saunders *et al.*, 2009), which is the strength of an inductive approach. Therefore, the induction is not concerned with theory testing but is concerned with theory building as its most important aim. With the inductive approach it is possible to interpret the in-depth meaning of data (Creswell, 2014). In Table 4.2, the key differences between deductive as well as inductive approaches are presented.

Table 4.2: Comparison of Research Approaches adopted from Saunders et al. (2009, p. 127)

Deductive	**Inductive**
Scientific principle	Gaining and understanding of the meanings human attach to events
Moving from theory to data	A close understanding of the research context
The need to explain causal relationships between variables	The collection of qualitative data
The collection of quantitative data	A more flexible structure to permit changes of research emphasis as the research progresses
A highly structured approach	A realisation that the researcher is part of the research process
Researcher independence of what is being researched	Less concerned with the need to generalise
The necessity to select samples of sufficient size in order to generalise	

Even though labelling research approaches can be misleading (Saunders *et al.*, 2009), taking into consideration the reasons for the chosen research philosophy (i.e., positivism) and the characteristics of the deductive approach mentioned above, within this research project it is most suitable to apply a deductive approach.

4.4 Research Design

Research design is defined as "a plan of the research project to investigate and obtain answers to research questions" (Cooper and Schindler, 2014, p. 125). Depending on the research purpose, the research design can generally be differentiated in exploratory (i.e., finding new insights), explanatory (i.e., studying established relationships, hypotheses testing), and descriptive research (i.e., portraying accurate profiles of persons, events, or situations) (Saunders *et al.*, 2009; Sekaran, 2003).

Drawing on the research question and the methodological choices made so far (i.e., positivism and deduction), the research design in this study is explanatory in nature. This is because this research tries to explain relationships rather than explore new insights or describe facts as its main purpose. In other words, this study aims to explain the relationships of the constructs that determine user acceptance of ADVs for last-mile delivery in the cultural context of Germany.

Within the research design (i.e., research plan), the techniques of research strategy, data collection methods (including the questionnaire design, translation, and pre-testing procedures), sources of data collection (i.e., sampling), as well the data analysis techniques are presented. This will also include constraints that might occur during the research (e.g., access to data, location, or monetary constraints) (Saunders *et al.*, 2009). Additionally, to the choice of a specific technique, the following subsections will always include a clear reasoning, which will be consistent with the research philosophy chosen.

4.4.1 Research Strategy

As with other methodological choices, the choice of the right research strategy depends on the research question, the objectives, as well as the feasibility of the research procedures. Thus, the research strategy (e.g., experiment, survey, case study, ethnography, grounded theory, etc.) should be suitable for its intended purpose and feasible from a practical standpoint (Saunders *et al.*, 2009; Johannesson and Perjons, 2014). In other words, every research strategy tries to fulfil a different task. For instance, case studies might be suitable for studying complex social relationships; however, it might be inappropriate for studying attitudes of a large population. Experiments might be suitable for identifying the cause of some events, whereas they are inappropriate for exploring an unknown topic (Johannesson and Perjons, 2014). In this research a survey strategy is applied because it suits the research objectives and question best. Therefore, other research strategies are out of scope and in the following only the survey strategy will be explained in more detail, including its general usability and advantages, which are used to justify the application in this research study.

The purpose of survey research is to map out some world. It "usually has a broad coverage and provides a helicopter view of some area of interest" (Johannesson and Perjons, 2014, p. 42). In survey research, theories are tested to be able to examine the relationships between variables theoretically (Rea and Parker, 2014). Survey research often includes data about participants' activities, beliefs, as well as their attitudes (Neuman, 2010; Johannesson and Perjons, 2014).

Survey research is a popular and common research strategy in business and management research and is most suitable for collecting data on narrow and well-defined topics (Saunders *et al.*, 2009; Johannesson and Perjons, 2014). It is possible with survey data to draw conclusions and generalise about an entire population by using data only from a portion of the population (Rea and Parker, 2014; Johannesson and Perjons, 2014). Within the survey strategy it is possible to collect a large amount of data within a short time-period to reasonable costs (Saunders *et al.*, 2009; Johannesson and Perjons, 2014). Furthermore, since the data of surveys is generally standardised, it is possible to easily compare the data statistically without making previous subjective interpretation necessary, which increases the generalisability of the findings (Saunders *et al.*, 2009). Moreover, the theoretical constructs identified in the literature of AVs and SSTs, which consist of perceptions, are abstract in nature and thus cannot be directly observed. However, using a survey strategy, the participants can state their self-reported perceptions (Neuman, 2010). Finally, the survey strategy in the field of technology acceptance is not only most commonly used in UTAUT/UTAUT2 studies, it has also proven to be a suitable research strategy in this area (Williams *et al.*, 2009). Considering all these advantages, the application of a survey strategy within this research is justified.

4.4.2 Data Collection Method

"While the research strategy provides useful support on a high level, it needs to be complemented with research methods that can guide the research work on a more detailed level" (Johannesson and Perjons, 2014, p. 39). Among other methods, examples are observations; semi-structured, in-depth and group interviews; focus groups; as well as questionnaires (Saunders *et al.*, 2009). Some of them are more regularly used in qualitative research, whilst others are more suitable for quantitative research. Since this research is based on a positivism paradigm that applies the deductive approach along with the survey strategy, questionnaires are the most suitable data collection method to fulfil the third research objective (i.e., empirically test the relationships) and answer the research question comprehensively. Thus, other data collection methods are out of scope for this research project.

In the following, the questionnaire design and the development process conducted in this study as well as the pretesting and translation procedures that were part of this study are presented and explained in more detail.

4.4.2.1 Questionnaires and Questionnaire Types

Questionnaires are among the most widely used data collection techniques (Saunders *et al.*, 2009) and are generally used to gather straightforward information (Johannesson and Perjons, 2014). Tashakkori and Teddlie (2003) emphasise the strengths of questionnaires as follows: suitable to measure attitudes and eliciting other content from study participants, cheap to administer (e.g., online questionnaire), have a moderately high measurement validity as well as reliability for a well-constructed and validated questionnaire, quick turnaround, can be used for probability samples, and ease of data analysis. Johannesson and Perjons (2014) add that the results of the questionnaire can be interpreted in the same way for all participants when standardised questions are used. Overall, Saunders *et al.* (2009) conclude that questionnaires are the best choice for targeting the administration of a large number of participants in a short period of time, which was the case in this research project.

There are many different types of questionnaires, all of which depend on how the questionnaire is administered as well as the amount of time spent with the respondents.

Additionally, the choice of the questionnaire type also depends on the sample size required for sufficient analysis, the number of questions, the types of questions you need to ask, as well as the importance of uncontaminated answers by the respondents, among others (Saunders *et al.*, 2009). Thus, the type of questionnaire chosen "will dictate how sure you can be that the respondent is the person whom you wish to answer the questions and thus the reliability of responses" (Saunders *et al.*, 2009, p. 363). In general, questionnaires can be differentiated in self-administered and interviewer-administered questionnaires (see Figure 4.1).

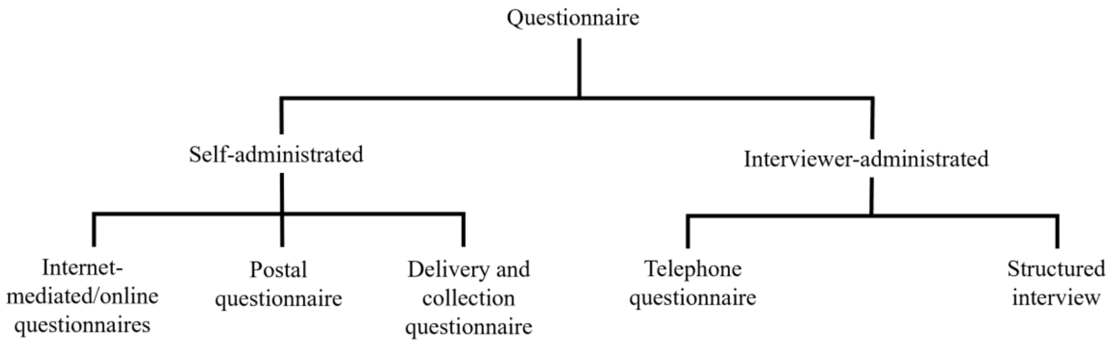

Figure 4.1: Types of Questionnaire adopted from Saunders et al. (2009, p. 363)

Within this research, self-administered, internet-mediated questionnaires (i.e., online-questionnaires) were used. This type of questionnaire was chosen not only because several other researchers have used it for investigating various technologies by using the UTAUT/UTAUT2 model (Williams *et al.*, 2015; Williams *et al.*, 2009) but mainly because of its multiple advantages. First, online questionnaires are usually a faster and cheaper option to gather data than postal or delivery and collection questionnaires. Therefore, it allows the researcher to instantly deliver the questionnaire to a large number of people at the same time (Rea and Parker, 2014). Second, self-administered online questionnaires are not only more convenient to distribute but also gives the respondents enough time to respond accurately. In doing so, respondents of self-administrated online questionnaires are more likely to answer in a honest and not in a socially desirable way (Dillman, 2007). Third, the researcher has the option to download the data directly to a software package (in this study, IBM SPSS25 and IBM AMOS25) and then pursue a powerful analysis (Rea and Parker, 2014), which minimises human error. In summary, considering the aforementioned characteristics and advantages of self-administrated online questionnaires, this type of questionnaire is the most suitable and practical one to answer the research question and fulfil the research objectives in the most efficient way.

In the following subsections, the questionnaire design and development process underlying this research will be explained in detail. This will include four steps: (1) designing and developing the English questionnaire, (2) pretesting and modifying the English questionnaire, (3) translating the English questionnaire into German, (4) pretesting and modifying the German questionnaire for data collection.

4.4.2.2 Questionnaire Design and Development

To be able to collect high-quality data, the questionnaire – as well as the questions asked – need to be developed carefully. As stated by Vaus (2014), designing a successful questionnaire is crucial because it will affect the response rate as well as the reliability and validity of the collected data. In this research, the fifteen practical principles by Johnson and Christensen (2008) presented in Table 4.3 on the following page were considered in constructing the survey questionnaire. However, it is worth mentioning again that the item-based questions were not self-developed, rather they were adopted from previous validated research and modified to the underlying research context. Therefore, some principles could not be totally complied with. For instance, some items used to investigate “price sensitivity” were quite long; nevertheless, they were used because they have been validated in previous research.

Table 4.3: Principles of Questionnaire Construction adopted from Johnson and Christensen (2008)

Principle 1	Make sure the questionnaire items match your research objectives.
Principle 2	Understand your research participants.
Principle 3	Use natural and familiar language.
Principle 4	Write items that are clear, precise, and relatively short.
Principle 5	Do not use “leading” or “loaded” questions.
Principle 6	Avoid double barrelled questions.
Principle 7	Avoid double negatives.
Principle 8	Determine whether an open-ended or closed-ended question is needed.
Principle 9	Use exclusive and exhaustive response categories for closed-ended questions.
Principle 10	Consider different types of response categories for item-based questions.
Principle 11	Use multiple items to measure abstract constructs.
Principle 12	Consider using multiple methods when measuring abstract construct.
Principle 13	Use caution if you reverse the wording in some of the items.
Principle 14	Develop a questionnaire that is easy for the participant to use.
Principle 15	Always pilot test your questionnaire.

The final questionnaire consists of five parts. The first part of the questionnaire was the cover letter, which contained the aims of this research and the contact details from the researcher for any further questions or queries regarding the research project. The second part of the questionnaire included the demographic characteristics (i.e., age, gender, nationality, household net-income, employment status) as well as some general questions on participants’ online shopping behaviour and app usage. The third part of the questionnaire was an information sheet. It was designed to give the respondents some basic information on ADVs. This included general information on ADVs like the size of the vehicles, driving speed, and some examples on the safety and security systems with which those vehicles are equipped. Additionally, two pictures of ADVs were presented so that the participants could more accurately imagine the use of ADVs. Furthermore, some examples of pilot tests of ADVs in Germany were given so that the respondents could further inform themselves in case they were interested in this kind of delivery system in more depth. Furthermore, the information sheet contained information on the interaction between the final recipient and the vehicle, for instance, setting the time and date via smartphone or using the app to open the locker of the vehicle. Finally, it contained the basic advantages, which are associated with using ADVs (e.g., higher flexibility, higher convenience, etc.). The fourth part of the questionnaire consisted the questions on the participants familiarity of ADVs as well as on the acceptance of ADVs by utilising the extension of UTAUT2. This part was developed based on the original UTAUT2 questionnaire by Venkatesh *et al.* (2012) as well as on several other studies reviewed in the areas of SSTs and AVs. The item-based questions were measured with a seven-point Likert scale ranging from 1 = "strongly disagree" to 7 = "strongly agree", which is in accordance to the original UTAUT2 questionnaire and also has the advantage that with a large number of possible response options, the ability to differentiate increases and therefore a more detailed picture can be drawn (Bortz and Döring, 2002). The only exception were the reversed items from "price sensitivity", which were investigated the other way around. Finally, part five of the questionnaire included one open question. This gave the respondents the opportunity to express their opinions and raise any thoughts in an open forum without any restrictions given by the researcher (Collis and Hussey, 2014). Overall, to keep it easy for the respondents, all questions asked them to tick only one answer, except for the final open-ended question.

4.4.2.3 English Questionnaire Pretesting and Modifying

Since intellectual exercise cannot substitute for actually testing a questionnaire instrument (Backstrom and Hursh, 1963), pretesting the questionnaire instrument is highly recommended (Sekaran, 2003; Hilton, 2017). Indeed, adequate pretesting of the questionnaire instrument should always be the starting point (Iacobucci and Churchill, 2010). Pretesting should include not only the assessment of the individual questions and the information provided in the questionnaire but also the logical sequence of the questionnaire instrument (Reynolds *et al.*, 1993). Hence, pretesting a questionnaire helps to ensure that the questions are understood, work as intended, have no issues with the wording of the measurements, and create a logical flow of the questions (Sekaran, 2003; Hilton, 2017).

In this study, most of the questions were used to measure the theoretically developed research framework and as such were based on previous validated items (Agarwal and Prasad, 1998; Featherman and Pavlou, 2003; Goldsmith *et al.*, 2005; Venkatesh *et al.*, 2012; Choi and Ji, 2015). However, the questionnaire items were slightly adapted in the wording to fit the underlying research context and the research question. Therefore, the questionnaire underwent another pre-test. This will be explained in more detail in the following.

Due to the advantage that the interviewer can observe the participant during the completion of the questionnaire, a vast majority of the literature suggests conducting the pre-test by personal interviews (Boyd *et al.*, 1991; Reynolds *et al.*, 1993). Hence, the pre-test of the English version of the questionnaire in this study was conducted in person. The sample size in pre-testing is commonly rather small (i.e., 5 – 10 participants) to test the questionnaire for its appropriateness and comprehension (Reynolds *et al.*, 1993; Sekaran, 2003).

The English questionnaire was handed out to four academics who were not involved in the research project as well as four participants that fit in the general population studied. All participants stated to be fluent in English before taking part in the English pre-test. The inclusion of academics in the pre-test was based on the fact that they are in general more likely to spot technical faults such as double questions and lopsided response categories (Green *et al.*, 1988).

To guarantee the inclusion of a variety of participants, age and gender were used as selection criteria; their age ranged from 25 – 64 years. The pre-test included three females and five males. All participants had at least a high school degree, whereas the highest education was a master's degree. Each respondent filled in the questionnaire individually. In other words, the respondents had no opportunity to discuss the answers with the other participants.

After each participant completed the questionnaire, the questionnaire was discussed sequentially with each participant individually. They were asked about their feedback on the simplicity and clarity of the questionnaire instrument. This procedure is also known as the debriefing method (Reynolds *et al.*, 1993). The feedback of the participants recommended some minor changes of the wording of some of the questionnaire items to increase the simplicity. Additionally, it was recommended to change the structure of the information sheet and include more information in order to obtain a better understanding of ADVs in a quicker way. As a final step of the questionnaire development, the feedback of the participants was completely incorporated into the English questionnaire and the instrument was discussed again with the participants individually to ensure that the changes were desirable (Reynolds *et al.*, 1993). As a result, no further recommendations were given. As a next step, the questionnaire was translated into German. The translation process is presented in the following subsection.

4.4.2.4 Questionnaire Translation into German

In this research, the back translation technique recommended by Brislin (1970) was conducted. Back translation is the most commonly used methodology in academic translation and among professional studies when investigating a subject in different cultural contexts (Douglas and Craig, 2007). In general, the process is as follows: first, the original research instrument (i.e., questionnaire) is translated into the language in which the study is going to be (in this case German); second, the translated version will be translated back into the original language (Brislin, 1970). In doing so, it verifies whether all aspects of the original translation are covered. In the following a step-by-step description for this study's translation process is presented.

The translation process in this study included the following steps. First, the original and pre-tested English questionnaire was sent to the first independent translator, who holds a PhD in psychology and has a professorship in social psychology. Since she lived and worked in the United States for several years, she is fluent in English. Second, after the first translator completely translated the original English questionnaire into German, it was sent to a second independent translator. She holds a state examination in anglistics. Before she started teaching English as a foreign language at grammar school in Germany, she lived and worked as an assistant teacher in the United Kingdom. Third, after the translation process was completed, I compared both English versions (original and backtranslation) of the questionnaire and checked it for any discrepancies, mistranslations, or problems in meaning. Since some minor translation discrepancies occurred in the back-translated English version, I discussed those with both translators. As a result, the translators concordantly agreed on some minor changes, which led to a minor refinement of the German questionnaire version. The final English questionnaire version is presented in Appendix A: Survey Questionnaire – English Version.

4.4.2.5 German Questionnaire Pretesting and Modifying

As with the English version of the questionnaire, the German questionnaire version was pre-tested. In doing so, the German questionnaire was sent to three academics and six participants who fit into the sample population via email. Like the English pre-test, the age range was 18 – 64 years. The highest education was a doctoral degree, whereas the lowest education level was secondary school education. They were asked to fill in the questionnaire in the same way as the participants for the English version. The only difference was that the pre-test was conducted via email and not in person due to time constraints of the participants. Participants were asked to fill in the questionnaire and provide feedback regarding the clarity and simplicity via email or telephone, depending on their preferences. The feedback from the participants included only a few changes in the wording of some item-based questions to decrease their complexity and enhance the understanding of the questions.

Before the changes were made, I discussed the proposed wording changes with the second translator to make sure that I did not change the meaning of the translation. Following this discussion, the feedback was completely incorporated into the questionnaire and discussed again with the participants. As a result, no additional recommendations were given at this stage, thus providing support for the clarity and simplicity of the German questionnaire instrument. As a final step, the online version of the final German questionnaire was created on the Qualtrics platform. The finalised German version of the questionnaire (paper-based) is presented in Appendix B: Survey Questionnaire – German Version. Additionally, the link to the online questionnaire on the Qualtrics platform is also presented in Appendix B.

4.4.3 Sampling

Sampling can basically be differentiated into probability (i.e., random/representative) and non-probability (non-random, judgmental) sampling (Saunders *et al.*, 2009; Bryman and Bell, 2015). “With probability samples the chance, or probability, of each case being selected from the population is known and is usually equal for all cases” (Saunders *et al.*, 2009, p. 213). This type of sampling is used when inferences on the whole population are to be drawn. However, to be able to use probability sampling the entire population needs to be known (sample frame), which is very often not the case. On the other hand, non-probability sampling describes the process where the participants do not have the same chances to be selected. Thus, it is argued that with non-probability samples it is generally not possible to draw inferences from the data and generalise to the whole population (Saunders *et al.*, 2009; Bryman and Bell, 2015).

Deciding to use probability or non-probability depends on particular reasons, but mainly, however, on the research question and the objectives. In this research project, probability sampling would have been the most appropriate sampling strategy to answer the research question in a fully representative manner because it would ensure that each German citizen had an equal chance to participate, allowing for generalisation to the entire German population. In market research and political opinion polls, random digit dial (RDD) telephone surveys were formerly used to investigate people’s opinions and attitudes in a representative manner because almost everyone used to have a landline telephone, which was considered the sample frame (Glasser and Metzger, 1972). Lately, however, two major concerns arose regarding this technique. First, the rise of mobile-phone-only households raised concerns about coverage bias (Baker *et al.*, 2013). As the landline coverage in Germany has been declining over the last two decades from 97 percent in 1998 to only 84 percent in 2018 (Statista, 2018a), it could not be guaranteed that every citizen had the same chance of being randomly selected. As a matter of fact, a complete sample frame for the entire German population is not available anymore. Second, due to the decline in responses, the concern of nonresponse bias arose (Curtin *et al.*, 2005; Baker *et al.*, 2013). Alongside those serious concerns, RDD is very time-consuming and costly and therefore neither practical nor feasible possible in this study. Therefore, due to these concerns, non-probability sampling was applied in this study.

4.4.3.1 Non-Probability Sampling

A summary of the various non-probability sampling types is presented in Table 4.4 below.

Table 4.4: Non-Probability Sampling Types adopted from Saunders et al. (2009, p. 236)

Sample type	Likelihood of sample being representative	Types of research in which useful	Relative costs	Control over sample contents
Quota	Reasonable to high	Where costs constrained or data needed very quickly	Moderately high to reasonable	Relatively high
Purposive	Low	Working with very small samples	Reasonable	Reasonable
Snowball	Low	Where difficulties in identfying cases	Reasonable	Quite low
Self-selection	Low	Where exploratory research needed	Low	Low
Convenience	Very low	Where very little variation in population	Low	Low

The selection of one type of sampling over the other is primarily based on the researcher's subjective judgement (Saunders *et al.*, 2009). This study aims to give first insights into the user acceptance of ADVs of the German population. Hence, it is important that the findings in this study can be at least partially generalised to the entire German population. In line with Table 4.4 and the usefulness of a variety of sample types to answer the research question, quota sampling is the most reasonable non-probability sampling type for this study. Therefore, quota sampling will be explained in greater detail in the following.

Quota sampling is intensively used in commercial research like political opinion polling (Bryman and Bell, 2015). It "is based on the premise that your sample will represent the population as the variability in your sample for various quota variables is the same as that in the population" (Saunders *et al.*, 2009, p. 235). Often, age, gender, and household income are used to represent the entire population (Saunders *et al.*, 2009; Bryman and Bell, 2015). For calculating the number of units for each quota, external data such as census results are often considered. The calculation of the actual quota sizes is based on the predetermined sample size (Yang and Banamah, 2014). As a final step, participants are conveniently selected from the population based on the criteria selected beforehand (e.g., age, gender, household income) until the quotas are appropriately filled. Since the selection of the participants is in most cases based on the researcher, quota sampling is often argued to be not fully representative in contrast to probability (Bryman and Bell, 2015).

Since quota sampling is the closest sampling type to probability sampling when it comes to representativeness (Yang and Banamah, 2014), some practitioners even claim that it is almost as good as probability sampling (Bryman and Bell, 2015). However, compared to probability sampling techniques, quota sampling has certain advantages. First, it is lower cost and less time-intensive; second, it can be set up quickly (Saunders *et al.*, 2009); and third, quota sampling is relatively easy to administer because no population listing (i.e., sample frame) is required (Breakwell *et al.*, 2012). Overall, considering these advantages, it is the best and most feasible sampling strategy within this research project.

4.4.3.2 Sampling Process and Quotas

To be able to collect the highest quality of data the sampling and data collection of the research was conducted in cooperation with Qualtrics. Qualtrics is a world-leading enterprise for survey technology and was chosen because they have been providing online samples for several years and have around 20 high quality online panel providers ("Grand Mean Certified Sample Partner") from which the data is obtained. Additionally, they have completed over 15,000 projects in various industries (e.g., consumer goods, financial services) (Qualtrics, 2014).

Respondents were randomly selected by Qualtrics panel partners from the German panel base. German panel members (i.e., 18 years and above) were invited via email to participate in this study. This process of sample recruitment increased the representativeness of the findings in this study because participant selection was not based on the researcher. Within the invitation email, participants were informed about the length of this questionnaire as well as the fact that this survey was only conducted for research purposes and they could unsubscribe at any time. However, to avoid self-selection bias no specific details on the content of the survey were included. Additionally, to ensure the validity and exclude duplications of the data, Qualtrics checked every IP address. Moreover, each panel partner used deduplication technology to provide the most reliable results and retain the integrity of the survey data (Qualtrics, 2014).

The quotas for this study were developed based on the census data of the Statistical Bureau of Germany (*destatis*) as well as the European Union (*eurostat*). Age, gender, and monthly household net-income were selected as the quota variables (see Figure 4.2, Figure 4.3, and Figure 4.4). This is especially common in market research surveys (Saunders *et al.*, 2009). Once the quotas were filled adequately, the data collection for this specific quota stopped and no further data was gathered.

Figure 4.2 represents the German population in regard to the quota age. 51 percent of Germans are female, and 49 percent are male.

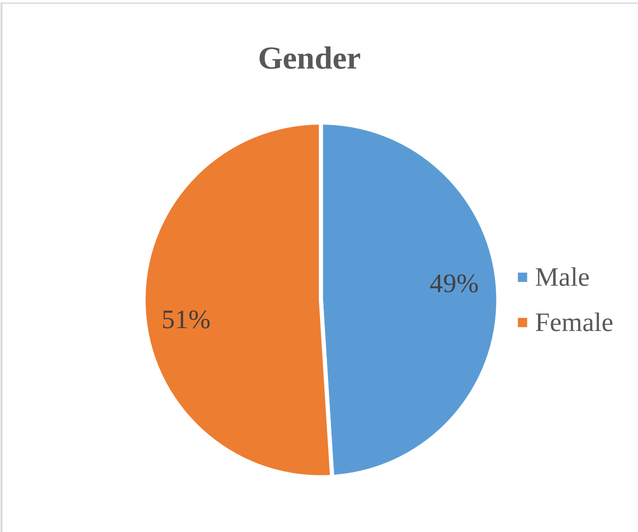

Figure 4.2: Quota Gender (Eurostat, 2017)

Figure 4.3 represents the German population in regard to the quota age. Notably, over 50 percent of Germans are above 50 years old.

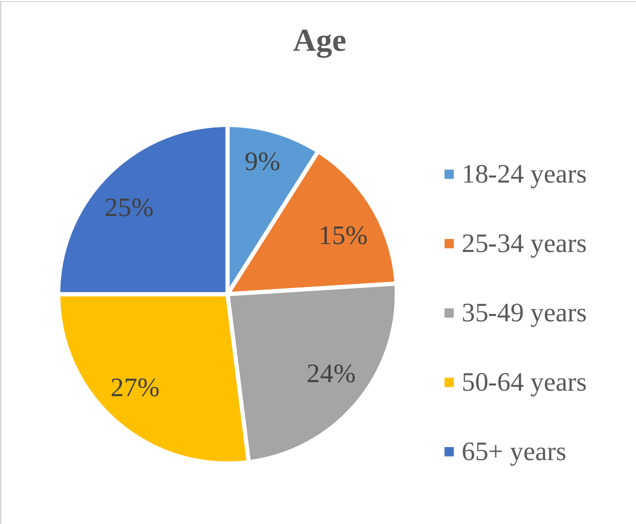

Figure 4.3: Quota Age (Eurostat, 2017)

Figure 4.4 represents the German population in regard to the quota monthly household net-income. 56 percent of Germans have a monthly household net-income of 2,000 euros or above.

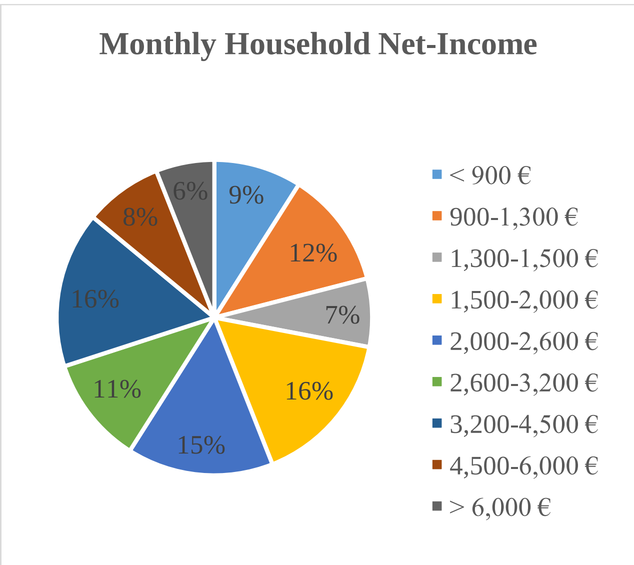

Figure 4.4: Quota Monthly Household Net-Income (Destatis, 2017b)

4.4.3.3 Sample Size

Compared to probability sampling, in non-probability sampling there are not any rules regarding the sample size. The decision on the sample size in this study was based on the requirements for the statistical analysis used as well as the objective to be able to partially generalise the findings to the German population. In this study structural equation modelling (SEM) is applied. Compared to other multivariate approaches, SEM requires a larger sample size to obtain reliable estimates (Hair *et al.*, 2010). However, there are various recommendations available in the literature for what determines a “large” sample size with reference to SEM or confirmatory factor analysis, respectively. Those recommendations generally are stated either in terms of the absolute minimum sample size or the relative level between N (i.e., minimum sample size) to the overall number of variables used (MacCallum *et al.*, 1999; Kline, 2011).

On the one hand, Ding *et al.* (1995) recommend a minimum absolute sample size of 100. This is also referred to as the $N \geq 100$ rule (In’nami and Koizumi, 2013). Comrey and Lee (1992) also provide a guide for the adequacy of sample size. They state that a sample size of 100 = poor, 200 = fair, 300 = good, 500 = very good, and 1,000 or more = excellent. However, in general, to guarantee robust SEM and to provide parameter estimates with a degree of confidence, no less than 200 cases is recommended (Hair *et al.*, 2010; Kline, 2011).

On the other hand, however, the sample size recommendations are based on the complexity of the research model (Hair *et al.*, 2010; Kline, 2011).Thus, a simpler model with fewer parameters requires a smaller sample size, whereas a more complex model with many parameters requires a larger sample size in order for the findings to be reasonably robust (Hair *et al.*, 2010; Kline, 2011). In this perspective, Cattell (1979) recommends three to six cases per item, with a minimum of 250 cases. A more demanding recommendation suggests the minimum sample size to be at least 10 times the number of cases per item (Everitt, 1975). This is referred to as the $N{:}q \geq 10$ rule (In’nami and Koizumi, 2013). However, it needs to be considered that “as the N:q ratio decreases below 10:1 (e.g., N = 50, q = 10 for a 5:1 ratio), so does the trustworthiness of the results” (Kline, 2011, p. 12).

Taking into consideration the research goal of this study – to be partially representative for the German population – as well as the complexity underlying the theoretically developed research framework (i.e., 14 constructs with 47 items in the initial measurement model) a large sample is needed to be able to produce reliable, trustworthy, and robust findings. Hence, the N:q ≥ 10 rule recommended by Everitt (1975) was used in a first step to determine the absolute minimum sample size for this study. Following this rule, the absolute minimum sample size should be 470 cases. In addition to this consideration, Hair *et al.* (2010) recommend that for complex models with a large number of constructs that the sample size should be around 500 to obtain trustworthy results. Considering both recommendations, it was decided to set the sample size in this study to be at least 500. In doing so, it was possible to comply with both recommendations.

Even though 500 is considered large enough to obtain trustworthy results in SEM analysis, it needs to be borne in mind that a sample of 500 is only 0.0006[7] percent of the German population (83 million citizens) (Destatis, 2019a). As such, it is representative of only a very small portion of the population. Here, it is worth mentioning again that this study does not try to be fully representative, rather it aims to give a first snapshot of the acceptance factors of the German population (see chapter 8.4).

4.4.4 Data Analysis

In this subsection the basics for analysing the research data will be presented. This will include the presentation of the measurement scales used in this research as well as the description and justification of the analysis procedures applied in this study. In more detail, the descriptive as well as the inferential statistics will be presented.

4.4.4.1 Measurement Scales

Before conducting the data analysis, the measurement scales of the various questions in the questionnaire need to be considered to be able to conduct meaningful analysis (Hair *et al.*, 2010). Based on the type of characteristics represented, measurement scales are differentiated into nonmetric (qualitative) and metric (quantitative) scales (Hair *et al.*, 2010). On the one hand, nonmetric data is a categorical measurement; hence, it is not

[7] Own Calculation: 100 % = 83,000,000 citizens; 1 % = 830,000 citizens; 500 citizens = 0.0006 %.

expressed in terms of numbers (Verma, 2013). It can be measured with nominal and ordinal scales (Hair *et al.*, 2010; Verma, 2013). On the other hand, metric data is "used when subjects differ in amount or degree on a particular attribute" (Hair *et al.*, 2010, p. 6). Here, data is measured either on an interval or ratio scale (Hair *et al.*, 2010; Verma, 2013). The lowest level of measurement is the nominal scale followed by ordinal, interval, and ratio scales (Hair *et al.*, 2010). A basic overview can be found in Table 4.5 below.

Table 4.5: Levels of Measurement

<table>
<tr><th colspan="2">Scale</th><th>Description</th><th>Reference</th></tr>
<tr><td rowspan="2">Nonmetric</td><td>Nominal scale</td><td>Scale for classifying qualitative criteria.</td><td rowspan="4">(Hair et al., 2010; Verma, 2013)</td></tr>
<tr><td>Ordinal scale</td><td>Variables can be ordered or ranked only.</td></tr>
<tr><td rowspan="2">Metric</td><td>Interval scale</td><td>Variables can be ordered and ranked as well as have constant units of measurement but have no absolute zero point.</td></tr>
<tr><td>Ratio scale</td><td>Variables can be ordered, ranked, have constant units of measurement, and have an absolute zero point.</td></tr>
</table>

Since this study focuses mainly on the user acceptance of ADVs and by doing so, investigates people's opinions and attitudes, most of the questions are based on Likert item questions ("strongly disagree" to "strongly agree"). In general, Likert item questions only classify a ranking without indicating the magnitude between the conceptual intervals, therefore, the basic structure is strictly speaking ordinal (nonmetric) (Meffert *et al.*, 2008; Hair *et al.*, 2014a). As a matter of fact, only statistical analyses that are suitable for ordinal data might be applicable. However, in social sciences and business economics, Likert scales are often considered as "quasi"-metric and therefore used and treated in the same way as interval scales (Meffert *et al.*, 2008; Homburg and Krohmer, 2011; Hair *et al.*, 2014a). This is based on the argument that depending on the presentation of the Likert scale, participants might consider the intervals between the scales as constant and therefore qualify as an interval scale (Meffert *et al.*, 2008). In this study, the Likert scales are presented with the exact same distance between the answer options (see Appendix B:

Survey Questionnaire – German Version as well as the online questionnaire on the Qualtrics platform), thus, it is assumed that the level of measurement of Likert scales is interval and therefore based on a metric scale. With this assumption in mind, the statistical methods used for interval data is applicable to Likert scale data (Meffert *et al.*, 2008).

4.4.4.2 Descriptive and Inferential Statistics

The descriptive data analysis in this study was carried out using IBM SPSS25 to describe the basic characteristics of the research data. This includes three parts of data analysis: (1) data normality, (2) the frequencies and percentages of respondents' characteristics and profiles, and (3) the measures of central tendencies and variability for the Likert item-based questions. A detailed description of these procedures and the data analysis is presented in subchapter 5.3.

In order to answer the research question comprehensively, inferential statistics are used. In this study, by using inferential statistics, the aim is to draw inferences and conclusions regarding the user acceptance of ADVs in Germany. Inferential statistics include many mathematical techniques. One string of techniques is summarised under multivariate data analysis (e.g., multiple regression, factor analysis, etc.), which helps the researcher to expand his/her explanatory ability as well as efficiency (Hair *et al.*, 2010). However, all of the commonly used multivariate techniques have one limitation in common: "each technique can examine only a single relationship at a time" (Hair *et al.*, 2010, p. 629). However, in this research, it is important to examine interrelated relationships, which is often the case in social and behavioural science. Therefore, structural equation modelling (SEM) is best suited in this study. In the following, the SEM technique will be explained in more detail.

SEM is considered a family of statistical models (Hair *et al.*, 2014a) that uniquely combines factor analysis and multiple regression analysis (Hox and Bechger, 2004), which enables the researcher to "examine a series of dependence relationships simultaneously" (Hair *et al.*, 2010, p. 630). In other words, it investigates the structure of interrelationships amongst multiple constructs at a time (i.e., dependent or independent variables) (Werner and Schermelleh-Engel, 2009). In this context, constructs are also called latent or unobservable factors, which are simultaneously represented by several indicator variables (items) (Hair *et al.*, 2010), which leads to more valid conclusions on the construct level because it reduces the measurement error of that construct (Werner and Schermelleh-Engel, 2009; Hair *et al.*, 2010).

SEM often uses a confirmatory, hypothesis-testing approach to the data and is therefore especially suitable for theoretical model testing and confirming (Hair *et al.*, 2010; Kline, 2011; Byrne, 2016). Byrne (2016) states that SEM has four outstanding benefits over traditional multivariate techniques: (1) SEM uses a confirmatory rather than exploratory approach to the data analysis (even though the latter can be addressed); (2) SEM provides explicit estimates of error variance parameters, whilst traditional statistical techniques are incapable to either assess or correct the measurement error; (3) observable as well as unobservable (i.e., latent) variables can be used in the same model, while former methods are based only on observed variables; and (4) SEM can model multivariate relationships and estimate indirect effects, whereas there are no widely used and easy-to-apply alternatives.

In this study, SEM was applied to be able to evaluate the relationships of the extended UTAUT2 model (i.e., the theoretically developed research framework) and to test the hypotheses among the constructs. IBM AMOS25 (further referred to as AMOS) was used as a software package to calculate the SEM model using the maximum likelihood technique. AMOS is covariance-based and as such especially suitable for confirmatory research, whereas, for instance, the software package PLS is variance-based and therefore more suitable for exploratory research (Roldán and Sánchez-Franco, 2012; Hair *et al.*, 2014b). Despite the fact that all covariance-based SEM software packages produce fairly similar estimates (up to two decimals), they all have their own strengths and special features. For an overview of eight software packages see Narayanan (2012). In general, however, there "is no golden rule on what software a researcher should pick when developing a CB-SEM [i.e., covariance-based SEM]" (Hair *et al.*, 2014b, p. 47). According to Narayanan (2012), the main differences come with the user interface. Compared to other software packages, AMOS is considered very user-friendly because you can draw the models graphically and no further syntax programming is needed (Narayanan, 2012; Hair *et al.*, 2014b). Moreover, the output format of AMOS is well organised and quickly accessible (Hair *et al.*, 2014b). Despite its software advantages, "AMOS is gaining momentum" because it is part of the SPSS software package (Hair *et al.*, 2014b, p. 47). Therefore, data modifications can easily be made in SPSS and the analysis can be re-run in AMOS without further adjustments (Weiner, 2013; Hair *et al.*, 2014b).

In this study, the two-step approach for SEM analysis recommended by Anderson and Gerbing (1988) was applied. This assures that well-established construct measures are represented in the valid structural model, which is clearly an advantage over the one-step approach (Hair *et al.*, 2014a). In doing so, the structural equation model comprises a measurement model as well as a structural model. On the one hand, the measurement model "specifies the rules of correspondence between measured and latent variables (constructs)" (Hair *et al.*, 2010, p. 636). For this, a confirmatory factor analysis (CFA) was applied and assessed through the goodness-of-fit indices, construct validity, and reliability. On the other hand, the structural model specifies the relationships between constructs on the basis of the proposed theoretical framework developed in this thesis (Hair *et al.*, 2014a). The structural model is assessed through the goodness-of-fit indices as well as the path estimates and their significance. The analysis of the measurement model of the theoretically developed research framework is presented in subchapter 6.3 followed by the analysis of the structural model in subchapter 6.4.

4.5 Ethical Considerations

Ethical considerations are an important aspect of any research project (Neuman, 2010). In this research several steps were considered to ensure the highest standards of ethical research practice. First, an ethical application for this research project was submitted to the Online Research Ethics and Governance Approval System of Northumbria University. This research has been approved by the Postgraduate Research Ethics Committee of Northumbria University Newcastle Business School with the reference number 4410. Second, participants were informed in the invitation email that taking part in this research project was totally voluntary, and they were assured that the responses would only be used for research purposes and all information provided will be kept anonymous and confidential. Third, all participants were informed perspicuously about the research topic, its underlying structure, as well as the purpose of this study in the cover letter of the online questionnaire. Finally, in the case of any concerns regarding the research project, I provided my contact details in the cover letter so that the participants could get in touch with me if desired.

4.6 Conclusion

Within this chapter, the underlying research methodology was described and explained in detail. This included consistent decisions on the research philosophy (i.e., positivism), the research approach (i.e., deductive), as well as the research design, which included the research strategy (i.e., survey), the data collection method (i.e., questionnaire design and development, pre-testing, translation procedures), as well as the sampling strategy (i.e., sampling process, quotas (i.e., age, gender, and monthly household net-income) and sample size (i.e., n = 500). Furthermore, the data analysis procedures using descriptive and inferential statistics were explained and described in detail, with focus on SEM. The decisions for each methodological choice and statistical procedures were presented with a clear reasoning. Finally, the ethical considerations were presented.

Chapter 5: Descriptive Data Analysis

5.1 Introduction

In this chapter the descriptive data analysis results are presented. The chapter starts with the presentation of the data-screening procedures, which were carried out to obtain high data quality. It includes a description of the data collection and the evaluation of the soft-launch as well as the full-launch data. Furthermore, the descriptive data analysis procedures are given, including the analysis of data normality, the analysis of the respondents' characteristics and profiles, as well as the analysis of the central tendencies and variabilities of the item-based questions (i.e., theoretical framework questions). Finally, the results of the open-ended question are presented at the end of this chapter.

5.2 Data Screening

Before starting the data analysis procedures, a pre-analysis data screening was conducted. This is considered an initial step before the actual data analysis, as it will help to avoid incorrect findings and results (Hair *et al.*, 2014a). Through the data screening process, the data were evaluated regarding outliers, missing data as well as quota requirements. The data was collected in two steps: first, through the soft launch and second, through the full launch. Both procedures will be explained in more detail in the following.

5.2.1 Soft-Launch Data Collection and Screening

The soft-launch data collection took place between the 3rd and the 4th of December 2018 and included 10 percent of the aimed overall number of datasets. In this study, it included 50 complete datasets. The soft launch was used to find out whether the online questionnaire works as intended and to make any amendments before the full launch of the questionnaire. In this study, two quality checks were conducted, which are presented in the following.

First, the soft-launch data was reviewed regarding any mistakes in the online questionnaire programming (i.e., question links and compulsory questions). The reviewing process revealed that the programming worked as intended and no amendments needed to be done. Second, the data was reviewed regarding any outliers (i.e., unusual responses). Since the questionnaire asked the respondents about their opinions and attitudes by using Likert scales to identify the relevant constructs of user acceptance of ADVs, identifying outliers is difficult. This is because all answers are based solely on the individual opinion. Therefore, it would not be right to exclude one dataset just because a respondent is of a different opinion compared to the majority. However, the data was reviewed visually to identify any unusual and suspicious answers or missing data. As a result, six straight liners (i.e., respondents who always stated the same answer in the item-based questions) were identified as outliers and discarded; however, no missing data was identified. Overall, this left 44 complete datasets after the screening process of the soft-launch data.

To further increase the quality of the respondents' answers, two quality checks were incorporated into the online questionnaire. First, a median completion time for the full-launch data collection was set as a minimum of two-thirds of the soft-launch completion time, which is the industry standard of Qualtrics. In the soft launch, the median time was four minutes. Hence, the minimum time for completion was set to three minutes. It is worth mentioning that all the straight liners identified completed the questionnaire under the cut-off set of three minutes. Thus, by including the minimum time, the aim was to identify any outliers already present during the data collection. Second, an attention check was incorporated in the middle of the item-based questions (i.e., "please answer this question with agree"). Attention checks are regularly used in survey research to check whether the respondents read the questions carefully before stating an answer (Kung *et al.*, 2018). Therefore, it was considered to be a good option in this study to further increase the data quality.

5.2.2 Full-Launch Data Collection and Screening

The full launch of the questionnaire data collection took place in the period between the 5th of December 2018 and the 7th of January 2019. The data collection proceeded until the specified percentage for each quota was filled relative to the aim of 500 respondents. However, for a quota to be filled adequately, only complete datasets that fulfilled the requirements set before (i.e., $\geq$ 3 minutes for completion and right answer for the attention check) as well as the selection of the German nationality were counted. Incomplete datasets as well as datasets not fulfilling the requirement were automatically discarded by the online survey system. Overall, 457 datasets were recorded as fulfilling all the requirements during the full launch. As within the soft-launch data, the data was checked for any straight liners (i.e., outliers). As a result, no outliers were identified. This shows that the incorporation of the quality checks (i.e., attention check and minimum completion time) allowed for the detection of all straight liners and therefore increased the data quality. After screening the datasets from the full launch (i.e., 457 datasets), the data was added to the soft-launch data (i.e., 44 datasets). In total, **501 complete datasets** were collected, which were used to check whether the quota requirements were properly fulfilled in order to be approximately representative of the German population regarding age, gender, and monthly household net-income. This is reviewed in the following (see Table 5.1).

Table 5.1: Quota Requirements

Quotas (n = 501)	**cluster**	**needed (%)**	**outcome (%)**	**acceptable?**
Gender	male	49	49	yes
	female	51	51	yes
Age	18 – 24	9	9	yes
	25 – 34	15	15	yes
	35 – 49	24	23.0	yes
	50 – 64	27	27.5	yes
	65 +	25	25.5	yes
Household Net-Income (monthly)	below 900 €	9	9	yes
	900 – 1,300 €	12	12	yes
	1,300 – 1,500 €	7	7	yes
	1,500 – 2,000 €	16	16	yes
	2,000 – 2,600 €	15	15	yes
	2,600 – 3,200 €	11	11	yes
	3,200 – 4,500 €	16	16	yes
	4,500 – 6,000 €	8	8	yes
	6,000 above €	6	6	yes

The reviewing process revealed that almost all of the quota sections were perfectly filled. There are only slight differences in the age section (35 – 49 years, - 1 percent; 50 – 64 years, + 0.5 percent; 65 + years, + 0.5 percent). Since these are rather small (≤ 1 percent), they are acceptable. Overall, the gathered data is comparable on a relative basis to the census data of Germany regarding gender, age, and the monthly household net-income and can therefore be considered as approximately representative of the German population. Additionally, the aim to reach a sample size of 500 respondents to conduct a robust and reliable SEM analysis was also fulfilled.

5.3 Descriptive Statistics

Descriptive statistics are used to quantitatively describe and summarise the features of the data collected. To give a broad overview of the gathered data, multiple descriptive statistics are used. First, the final data is checked for normality. Second, the demographic characteristics and profiles of the respondents are summarised using frequencies and percentages. Third, the Likert item-based questions are analysed with respect to the measures of central tendency and variability. These analyses are presented in the following subchapters.

5.3.1 Data Normality

According to Hair *et al*. (2014a, p. 38), "the starting point for understanding the nature of any variable is to characterise the shape of its distribution." A normal distribution is characterised as being bell-shaped, where the middle is considered the centre of the distribution (Thompson, 2009). Univariate normality can be tested graphically as well as statistically (Hair *et al.*, 2014a). In this study, the constructs that are proposed to determine the user acceptance of ADVs (i.e., PE, EE, SI, FC, HM, PS, INO, PR_O, TT_O, PR_SR, PR_PR, TT_S, TT_P) were tested statistically. In doing so, skewness and kurtosis values of the data were calculated.

On the one hand, skewness is a measure of the symmetry of a distribution (Hair *et al.*, 2014a). Thus, it describes how the data is balanced (Vieira, 2017). In other words, skewness shows to what extent the variables relate to the mean (Kline, 2011; Vieira, 2017). If the data is positively skewed than it includes "relatively few large values and tails off to the right" (Hair *et al.*, 2014a, p. 34). In the opposite case that the data is negatively skewed – then it has "relatively few small values and tails off to the left" (Hair *et al.*, 2014a, p. 34). In case the values of skewness fall outside the range of + / - 1, then the distribution indicates skewed data and therefore a violation of symmetry (Hair *et al.*, 2014a; Vieira, 2017).

On the other hand, kurtosis describes the peakness or flatness of a distribution in comparison to the normal distribution (Hair *et al.*, 2014a). A positive value shows a peaked distribution, whereas a negative value shows a relative flat distribution (Hair *et al.*, 2014a). A relative normal peak of the distribution is indicated when the value lies within the range of + / - 1 (Vieira, 2017). For both skewness and kurtosis, determining the z-scores (i.e., skewness divided by the standard error or kurtosis divided by the standard error) is commonly done to further investigate normality. However, for sample sizes > 300, one should only depend on the absolute values of skewness and kurtosis to investigate normality (Kim, 2013). Therefore, in the case of this study, the z-scores were not considered. The data was checked, and all measured constructs fall in the range of + / - 1 for skewness and kurtosis as recommended. Therefore, there is no violation to the symmetry, and the flatness/peakness of the data distribution is considered normal (see Table 5.2 on the following page).

Table 5.2: Skewness and Kurtosis

Construct	n	Skewness	Std. Error of Skewness	Kurtosis	Std. Error of Kurtosis
Performance Expectancy (PE)	501	- 0.431	0.109	- 0.692	0.218
Effort Expectancy (EE)	501	- 0.801	0.109	0.270	0.218
Social Influence (SI)	501	- 0.202	0.109	- 0.748	0.218
Facilitating Condition (FC)	501	- 0.801	0.109	- 0.114	0.218
Hedonic Motivation (HM)	501	- 0.566	0.109	- 0.512	0.218
Price Sensitivity (PS)	501	- 0.673	0.109	- 0.051	0.218
Perceived Performance Risk (PR_PR)	501	- 0.511	0.109	0.437	0.218
Perceived Safety Risk (PR_SR)	501	- 0.457	0.109	- 0.306	0.218
Overall Perceived Risk (PR_O)	501	- 0.030	0.109	- 0.558	0.218
Parcel Drop-Off Performance (TT_P)	501	- 0.429	0.109	- 0.077	0.218
Street Performance (TT_S)	501	- 0.229	0.109	- 0.484	0.218
Overall Trust in Technology (TT_O)	501	- 0.470	0.109	- 0.503	0.218
Innovativeness (INO)	501	- 0.193	0.109	- 0.784	0.218
Behavioural Intention (BI)	501	- 0.210	0.109	- 0.874	0.218

5.3.2 Respondents' Demographic Characteristics and Profiles

The respondents' characteristics are described by calculating the frequencies and the percentage of the various categories. On the one hand, these are basic demographics of the participants, including age, gender, monthly household net-income, educational level, and employment status. On the other hand, the online affinity of respondents, especially their online shopping behaviour (i.e., frequency of online shopping, using mobile apps), as well as their awareness of ADVs are described. This descriptive analysis was done to get a detailed overview of the study participants. Additionally, through the questions on online shopping and app usage, the aim was to describe the status of participants regarding their online technology affinity (i.e., using online shopping and usage of mobile apps). The findings are presented in the following figures and are summarised in Table 5.3 on page 200 of this thesis. This is followed by a more detailed discussion.

Overall, 501 complete datasets were collected and could be used for data analysis. 254 females (51 percent) as well as 247 males (49 percent) took part in this study (see Figure 5.1).

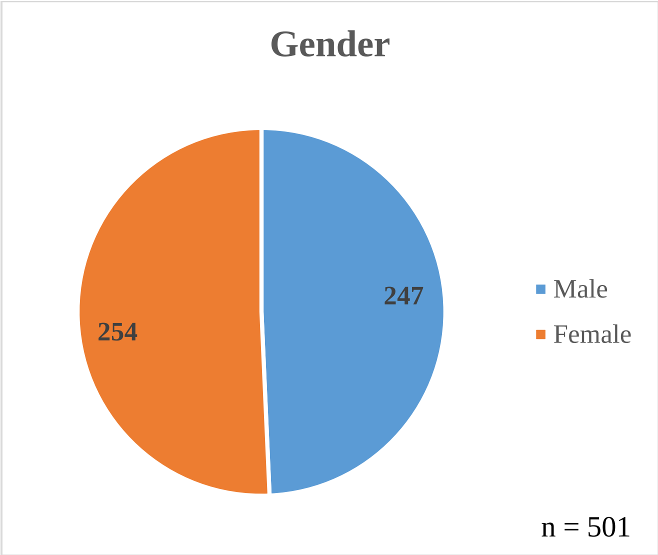

Figure 5.1: Respondents' Gender

The majority of the participants were aged between 50-65 + years (53 percent). However, this is not surprising when considering the quotas set in this study, which represent the German population (see Figure 5.2).

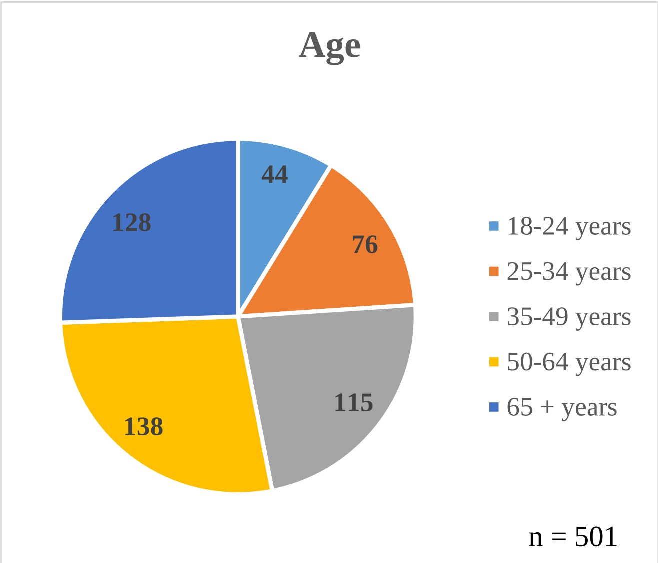

Figure 5.2: Respondents' Age

In line with the quotas age and gender, monthly household net-income of the respondents is representative of the German population on a relative basis (see Figure 5.3).

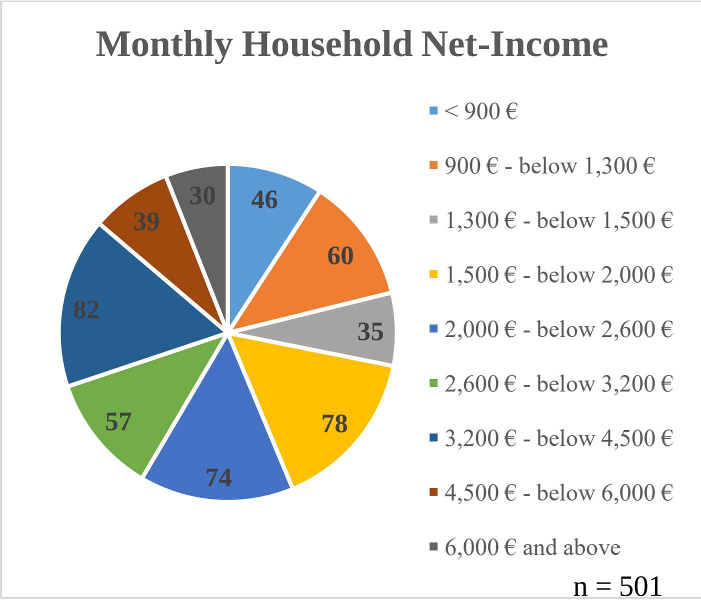

Figure 5.3: Respondents' Monthly Household Net-Income

The majority of the participants (224 participants; 45 percent) stated to have a secondary school certificate or below, whereas only five participants (1 percent) have a doctorate (see Figure 5.4).

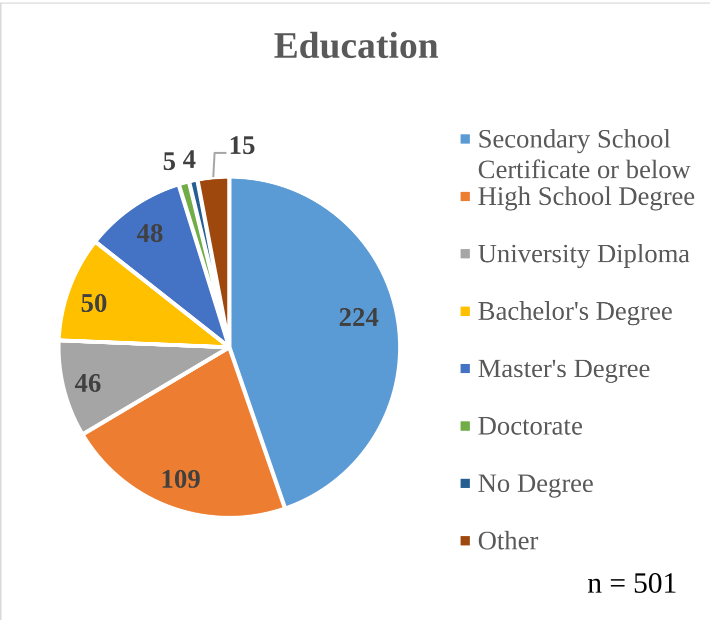

Figure 5.4: Respondents' Education

Half of the participants (50 percent) stated to be employed full-time or part-time and 33 percent stated to be retired (163 participants) (see Figure 5.5).

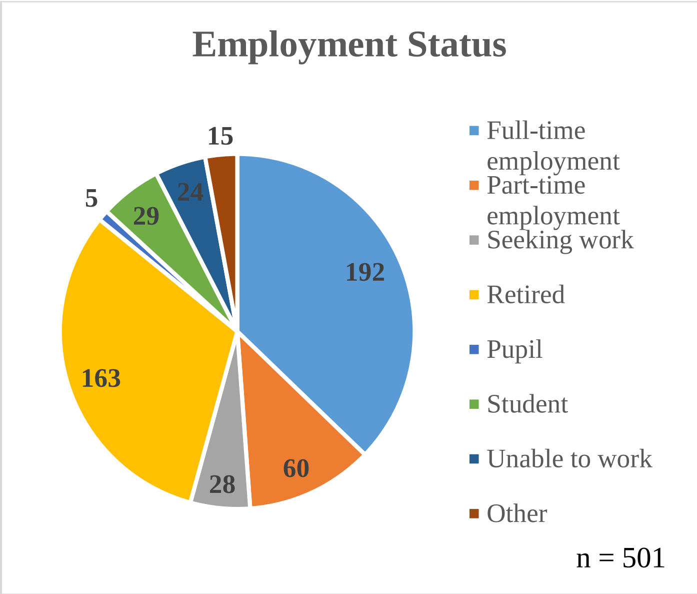

Figure 5.5: Respondents' Employment Status

Almost half (42 percent) of the participants stated to shop online monthly, whereas only a very limited number of participants stated to never show online (1 percent) (see Figure 5.6).

Figure 5.6: Respondents' Online Shopping Behaviour

Three quarter of the participants stated to use mobile apps, which shows the high affinity of mobile technology among the participants (see Figure 5.7).

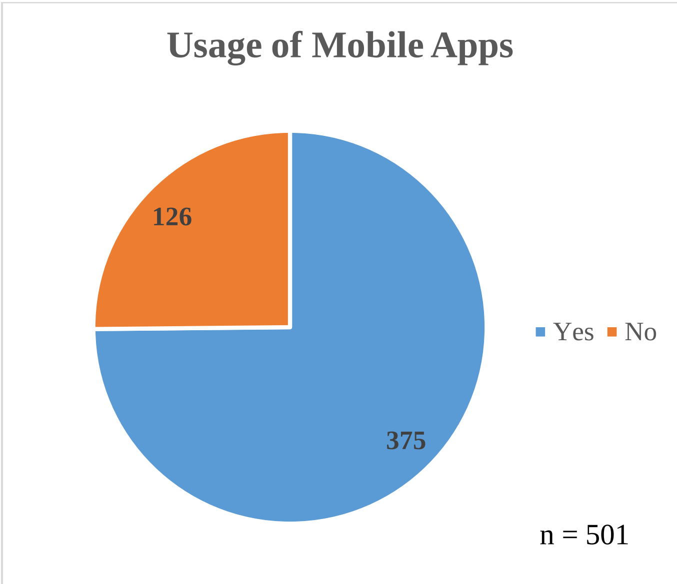

Figure 5.7: Respondents' Usage of Mobile Apps

Among those participants who stated to use mobile apps, 268 participants stated to use mobile apps for online shopping. In regard to the participants who stated to use mobile apps this is a frequency of 72 percent. Comparing this number to the total number of participants (n = 501) only 53 percent of the participants use mobile apps for online shopping (see Figure 5.8).

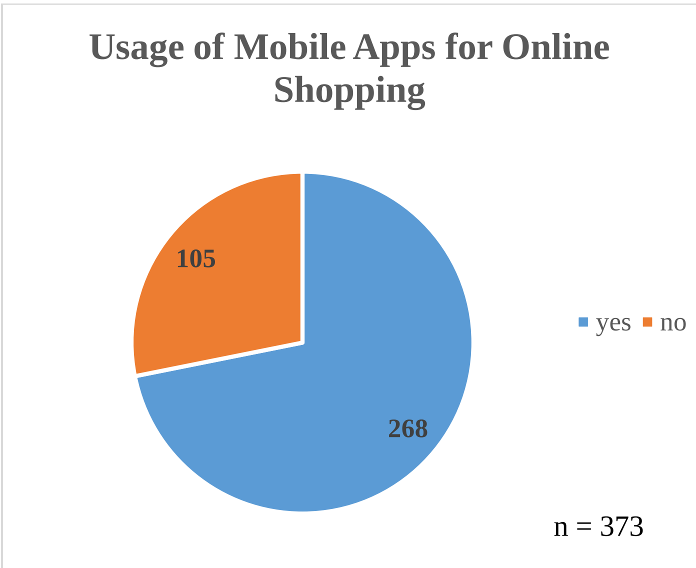

Figure 5.8: Respondents' Usage of Mobile Apps for Online Shopping

51 percent of the participants stated that they have never heard about ADVs before reading the information sheet of the questionnaire in this study (see Figure 5.9).

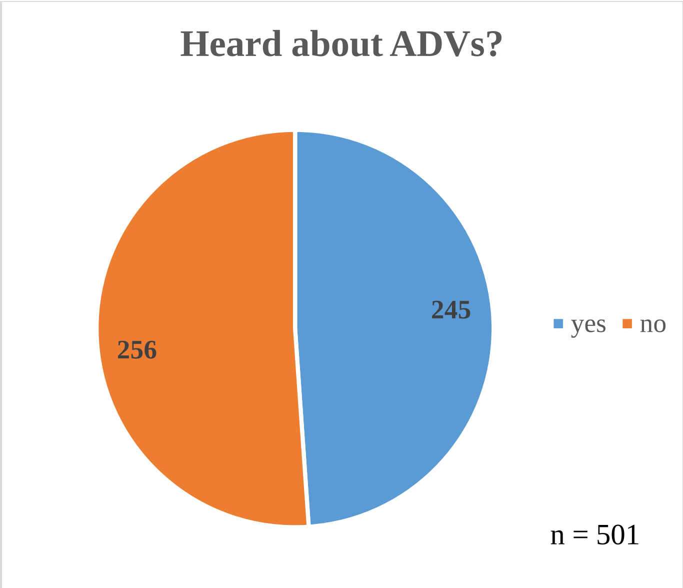

Figure 5.9: Respondents' Familiarity with ADVs

Alongside the little familiarity of the participants with ADVs, 94 percent of the participants who stated that they have heard about ADVs before taking part in this survey, have never used ADVs as a delivery option, whereas only 6 percent used them. Comparing this number to the overall number of participants (n = 501), only 2.7 percent of the participants used ADVs before.

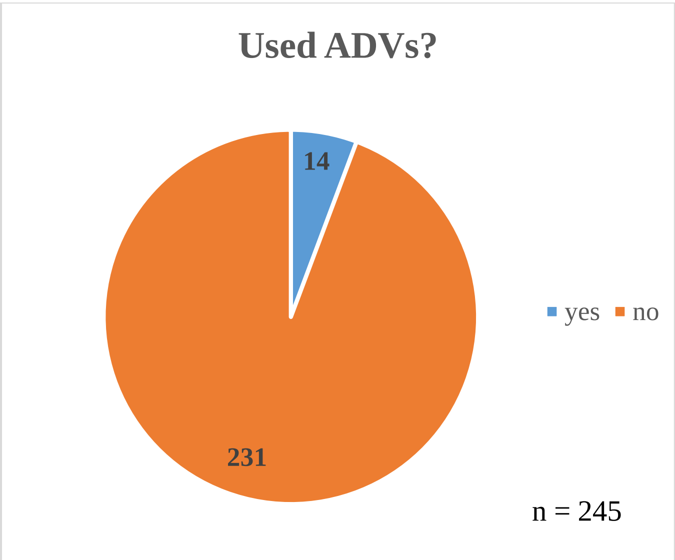

Figure 5.10: Respondents' Usage of ADVs

Table 5.3 summarises all the information presented in the foregoing figures. As such, it presents the variable, the category, the frequencies, as well as the percentages. This is followed by a more detailed discussion.

Table 5.3: Respondents' Demographic Characteristics and Profiles

Variable	**Category**	**Frequency (n = 501)**	**%**
Gender	Male Female	247 254	49 51
Age	18 – 24 years 25 – 34 years 35 – 49 years 50 – 64 years 65 + years	44 76 115 138 128	9 15 23 27.5 25.5
Monthly Household Net-Income	< 900 € 900 € – below 1,300 € 1,300 € – below 1,500 € 1,500 € – below 2,000 € 2,000 € – below 2,600 € 2,600 € – below 3,200 € 3,200 € – below 4,500 € 4,500 € – below 6,000 € 6,000 € and above	46 60 35 78 74 57 82 39 30	9 12 7 16 15 11 16 8 6
Education	Secondary School Certificate or below High school degree University diploma Bachelor's degree Master's degree Doctorate No degree other	224 109 46 50 48 5 4 15	45 22 9 10 10 1 1 3
Employment status	Full-time employment Part-time employment Seeking work Retired Pupil Student Unable to work	192 60 28 163 5 29 24	38 12 6 33 1 6 5
Online shopping	Never Rarely Once a year A few times a year Monthly Weekly Daily	5 25 5 122 210 130 4	1 5 1 24 42 26 1
Usage of mobile apps	Yes No	375 126	75 25
Usage of mobile apps for online shopping	Yes No	268 105 (n = 373[8])	72 28
Heard about ADVs	Yes No	245 256	49 51
Used ADVs	Yes No	14 231 (n=245)	6 94

[8] Two participants who stated to use mobile apps, stated also that they never do online shopping; therefore, the number of responses is 373 and not 375.

As already discussed in section 5.2.2, the variables gender, age, and monthly household net-income are approximately representative of the German population. Regarding the educational level, roughly half of the respondents (45 percent) have a secondary school certificate or below, one-fifth of the respondents (22 percent) have a high school degree, and almost one-third (29 percent) have a university education (i.e., university diploma, bachelor's, or master's degree). Comparing this with the values of the German Bureau of Statistics (*destatis*), around 53 percent of Germans have a secondary school certificate or below, around 32 percent have a high school degree and around 18 percent have a university education (Destatis, 2017a). Thus, the respondents in this study are slightly higher-educated than the German average.

Furthermore, the data mirrors the German employment status quite well. 50 percent of the participants are working either full-time or part-time and 33 percent are retirees, which is not surprising because more than one-fourth of the participants are above 65 years of age. Moreover, seven percent of respondents stated to be students. Compared to the number of the German Bureau of Statistics (*destatis*) 2.9 million students are enrolled at German universities, which represents 3.5 percent of the German population (Destatis, 2019b). In this study, double as many students took part; thus, students are overrepresented.

Regarding the online affinity, the data makes clear that 99 percent of the participants use the internet regularly to buy products online and therefore get parcels delivered to their homes'. In more detail, 42 percent stated to shop online monthly, 26 percent weekly, and 24 percent a few times a year. Additionally, 75 percent are familiar with mobile apps. Out of these, 72 percent stated to use mobile apps to shop for products online. This shows not only the clear online activeness but also the technology affinity of the respondents, which is necessary to use ADVs as a delivery option. Taking these findings into consideration the participants can be considered as potential and regular users of ADVs as a delivery option for home delivery.

Finally, and not surprisingly, only about half the participants have heard about ADVs (49 percent). Moreover, only fourteen participants (approximately 2.7 percent) stated that they have used ADVs before. This, however, is not surprising because ADVs are still in a testing phase (i.e., pre-market introduction) and the focus of communicating information of autonomous vehicles is still on autonomous cars and buses rather than vehicles used for logistical purposes. Therefore, in contrast to other acceptance studies that investigated user acceptance after the market introduction of the technology (e.g., studies on mobile banking), the findings of this study can be used to actually develop ADVs with the customer in mind before the broad market introduction, which might increase user acceptance.

5.3.3 Measures of Central Tendency and Variability

In this section the measures of central tendency of the Likert item-based questions to determine user acceptance of ADVs (theoretical framework questions) are presented. Here, the most common measure of central tendency – the mean – is presented. The mean is calculated by totalising all values for all subjects and dividing this total by the overall number of subjects (Klugh, 1986; Blaikie, 2006). Additionally, since the measures of central tendency do not provide any information on the data variability from one subject to another, the variance and the standard deviation for each item was calculated. On the one hand, the standard deviation is defined as the average distance from the mean in which each of the values lies. On the other hand, the variance is the average squared deviations about the mean (Thompson, 2009). In other words, the standard deviation is the square root of the variance. The findings with respect to the measure of central tendencies, the standard deviation as well as the variance for each item are presented in Table 5.4.

Table 5.4: Mean, Variance and Standard Deviation

Item	n	Mean	Variance	Std. Deviation
PE1	501	4.66	3.200	1.789
PE2	501	4.47	3.357	1.832
PE3	501	4.05	3.658	1.913
PE4	501	4.48	3.522	1.877
EE1	501	5.16	2.314	1.554
EE2	501	5.03	2.467	1.571
EE3	501	4.92	2.560	1.600
EE4	501	4.94	2.586	1.608
SI1	501	4.03	3.061	1.750
SI2	501	3.98	3.130	1.769
SI3	501	3.88	2.983	1.727
FC1	501	5.11	4.186	2.046
FC2	501	4.77	3.311	1.820

Table 5.4: Mean, Variance and Standard Deviation – Continued

Item	n	Mean	Variance	Std. Deviation
FC3	501	5.10	3.263	1.806
FC4	501	4.80	2.812	1.677
HM1	501	4.67	3.380	1.838
HM2	501	4.54	3.293	1.815
HM3	501	4.50	3.274	1.810
PSR1	501	4.94	3.599	1.897
PSR2	501	5.58	3.016	1.737
PSR3	501	2.64	2.438	1.561
PSR4	501	5.25	3.061	1.749
PSR5	501	5.29	3.222	1.795
PR_PR1	501	5.15	1.702	1.305
PR_PR2	501	5.16	1.800	1.342
PR_PR3	501	4.73	2.251	1.500
PR_SR1	501	4.87	2.380	1.543
PR_SR2	501	4.73	2.438	1.561
PR_SR3	501	4.70	2.513	1.585
PR_OR1	501	4.37	2.442	1.563
PR_OR2	501	4.26	2.617	1.618
PR_OR3	501	4.03	2.657	1.630
TT_P1	501	4.22	2.325	1.525
TT_P2	501	4.26	2.262	1.504
TT_P3	501	4.37	2.181	1.477
TT_S1	501	3.87	2.440	1.562
TT_S2	501	3.92	2.486	1.577
TT_S3	501	4.02	2.368	1.539
TT_OT1	501	4.33	2.603	1.613
TT_OT2	501	4.32	2.699	1.643
TT_OT3	501	4.24	2.905	1.704
INO1	501	4.48	2.558	1.599
INO2	501	3.62	3.491	1.869
INO3	501	4.59	2.833	1.683
BI1	501	3.83	3.288	1.813
BI2	501	3.86	3.182	1.784
BI3	501	3.94	3.159	1.777

Reviewing the above table, it is most interesting that the respondents of this study seem to hold on average neutral acceptance towards the use of ADVs as a delivery option. Mathematically speaking, the mean scores of behavioural intentions (i.e., user acceptance) to use ADVs were not higher than the scale mid-point 4. According to Liu *et al.* (2019b), who investigated the acceptance of autonomous vehicles in China, it is quite common for the public to hold a neutral opinion of emerging technologies, because the public still needs to form an opinion in relation to the technology. This supports the need for investigating the acceptance of ADVs at an early stage, because the findings can still be incorporated into the development and design of such vehicles, which might improve user acceptance during the introduction stage.

5.4 Open Question Analysis

Following the descriptive analysis in this study, the online questionnaire also included one open question where participants were asked whether they want to say anything else that might be relevant for the topic of investigation. Out of 501 participants, 89 participants used this opportunity (some stated more than one topic). Since the answers of the participants are qualitative in nature due to the open question structure, thematic analysis was used to analyse the responses. Thematic analysis is one of the most common qualitative data analysis techniques (Braun and Clarke, 2006). In this study, the answers of the participants were coded in two steps. First, the answers of the participants that seemed to share a common meaning were grouped together. This step is also called interpretive coding. Second, the interpretive codes were then checked, and overarching themes were developed (King and Horrocks, 2010). The results of the thematic analysis can be found in Table 5.5.

Table 5.5: Thematic Analysis of Open Question

No.	Themes	Number of participants
1	good/cool/interesting topic	31
2	dangerous/risky	17
3	job loss	9
4	risk of theft	8
5	missing infrastructure	5
6	needless	5
7	not suitable for rural areas	4
8	not trustworthy	4
9	additional traffic congestion	3
10	does not work properly	3
11	affordable pricing	3
12	futuristic	2
13	no mobile device	1
14	more research needs to be done	1
15	legal aspects	1
16	residential building with several floors (no door delivery)	1
17	other technologies are better suited for home delivery	1

The qualitative findings indicate that several people find this type of delivery interesting and have positive attitudes towards it. The second most often mentioned topic was that ADVs are dangerous and risky. This supports the incorporation of risk into the theoretical framework in this study and is in line with the findings by Marsden *et al.* (2018) and Braun and Buckstegen (2017). Interestingly, several participants also stated that they believe that ADVs will lead to several job losses and ultimately increased unemployment. However, taking into consideration the heavily increasing parcel volume in Germany, a large number of additional drivers is needed to cope with this situation successfully. To date, however, there is already a clear shortage of drivers (Oliver Wyman Consulting, 2019; HDS Consulting, 2019). Therefore, additional and innovative delivery options that are not dependent on a delivery person – like ADVs – are needed. Overall, the findings of this open question should be taken into consideration for further research. For instance, people might believe that there is a higher risk of theft when using ADVs as a delivery option and therefore the intention to use them might be lower (see subchapter 8.5 recommendations for further research).

5.5 Conclusion

In this chapter the data screening procedures were presented. This included the identification of six outliers in the soft-launch data collection stage as well as the procedures to avoid further outliers in the full-launch stage (i.e., minimum completion time, attention check). The total number of datasets in this study is 501 completes. The data is normally distributed taking into account skewness and kurtosis. Furthermore, the analysis of the respondents' characteristics and profiles showed that the sample is approximately representative of the German population regarding age, gender and monthly household net-income. Next, the analysis of the central tendencies and variabilities of the item-based questions (theoretical framework questions) were presented, which showed for instance that participants have still a neutral acceptance towards the use of ADVs as a home delivery option. Finally, the analysis of the open-ended question revealed that ADVs are generally considered an interesting topic; however, participants also stated negative associations like danger/risk or potential job loss, which should be considered in further research studies.

Chapter 6: Structural Equation Modelling Analysis

6.1 Introduction

After presenting the descriptive statistics and therewith also setting the basis for further multivariate data analysis, in this chapter the theoretically developed framework will be assessed. As explained in section 4.4.4.2, structural equation modelling (SEM) will be applied in two steps: the assessment of the measurement model and the assessment of the structural model. This chapter starts with a presentation of the commonly used goodness-of-fit indices and follows with the assessment of the measurement model analysis. This includes the assessment of the goodness-of-fit of the measurement model (i.e., CFA model), the model inspections and modifications, as well as the analysis of the construct validity. Next, the structural model analysis is presented. This includes the assessment of goodness-of-fit indices as well as the testing of the hypotheses (i.e., assessing the structural paths). After having identified the statistically significant and insignificant constructs, the SEM analysis will be assessed again (i.e., measurement model and structural model analysis) by dropping the insignificant constructs. This step will help to develop a research model that can generally be used to investigate user acceptance of ADVs in the context of last-mile delivery.

6.2 Goodness-of-Fit Indices

In general, three types of goodness-of-fit indices are differentiated. First, "absolute fit indices are a direct measure of how well the model specified by the researcher reproduces the observed data" (Hair *et al.*, 2010, p. 666). Examples of absolute fit indices are the chi-square statistic, the normed chi-square statistic, and the root mean square error of approximation (RMSEA). Second, incremental fit indices differentiate themselves from absolute fit indices in that they assess how well the estimated model fits relative to some alternative baseline model (Hair *et al.*, 2010). As with the absolute fit indices, there are many alternative incremental fit indices available that can be applied; two examples are the Tucker-Lewis index (TLI) and the comparative fit index (CFI) (Kline, 2011; Hair *et al.*, 2014a). Third, parsimony fit indices provide information about which model amongst competing models is best, considering the fit relative to the model complexity. One example of a parsimony fit index is the parsimony normed fit index (PNFI). However, parsimony fit indices are rarely used for model assessment (Hair *et al.*, 2014a). Thus, they are also not applied in this study to assess the model fit.

A summary of the most widely reported fit indices (Hair *et al.*, 2014a), including the abbreviations and thresholds regularly used, is presented in Table 6.1. In this study, these goodness-of-fit indices were calculated using AMOS25.

Table 6.1: Commonly Used Goodness-of-Fit Indices

	Index	Abbreviation	Threshold	Reference
Absolute fit indices	Chi-square and degrees of freedom	**χ^2 (df)**	p-value > 0.05	(Hair *et al.*, 2014a; Byrne, 2016)
	Normed chi-square	**CMIN/DF**	$1.0 < \chi^2/df < 3.0$	(Hair *et al.*, 2014a; Byrne, 2016)
	Root mean square error of approximation	**RMSEA**	≤ 0.05	(Browne and Cudeck, 1992; Hu and Bentler, 1999; Kaplan, 2009)
Incremental fit indices	Tucker-Lewis index	**TLI**	≥ 0.95	(Hu and Bentler, 1999; Kaplan, 2009)
	Comparative fit index	**CFI**	≥ 0.95	(Hu and Bentler, 1999; Schermelleh-Engel *et al.*, 2003; Kaplan, 2009)

In this regard, it needs to be considered that there is no single index that can be used to distinguish good models from poor ones (Hair *et al.*, 2014a). Accordingly, it is recommended to use multiple goodness-of-fit indices, which can support the determination of an acceptable model fit (Hair *et al.*, 2014a; Byrne, 2016). Hair *et al.* (2014a) recommend the use of three to four indices to be able to establish adequate model fit. Moreover, they suggest complementing the chi-square and the associated degrees of freedom with at least one absolute fit index as well as one incremental fit index (Hair *et al.*, 2014a).

However, it needs to be considered that when using the chi-square test, the results can often be misleading because it is very sensitive to the sample size (Werner and Schermelleh-Engel, 2009). When using a large sample, which is the case in this study (n

= 501), it is very likely that the chi-square outcome is significant and therefore it would be recommended to reject the model, even though only tiny differences between the observed and the perfect model occur (Werner and Schermelleh-Engel, 2009). One fit index that has been developed to overcome the dependency problem on the sample size is the normed chi-square (CMIN/DF). Therefore, it is recommended to use the CMIN/DF in addition to the chi-square (Werner and Schermelleh-Engel, 2009; Hair *et al.*, 2014a).

Considering these guidelines, in this study the chi-square is complemented with the CMIN/DF to overcome the issue with the large sample. Furthermore, the RMSEA, comprising an additional absolute fit index and the TLI and the CFI, which comprise two incremental fit indices, will be used to assess the model fit in this study using the thresholds presented in Table 6.1.

It is worth mentioning that the Goodness-of-Fit Index (GFI), which was regularly used to assess the model fit in various previous studies, is not considered in this thesis to assess the model fit. This is based on the findings by Sharma *et al.* (2005) who found in a Monte Carlo simulation of covariance structured models that the GFI performs the worst with respect to its effects regarding the sample size, number of indicators and detecting model misspecifications. As a result, it is no longer recommended to use the GFI to assess the model fit (Sharma *et al.*, 2005).

6.3 Measurement Model Analysis

The measurement model will be assessed by applying a confirmatory factor analysis (CFA). In other words, it is tested "how well measured variables represent a smaller number of constructs" (Hair *et al.*, 2014a, p. 602). CFA differs from exploratory factor analysis (EFA) in that it is theory-based (Hair *et al.*, 2014a). The constructs and items that describe these need to be specified before the model can be computed. According to Hair *et al.* (2014a, p. 603), "CFA statistics tell us how well our theoretical specification of the factors matches reality (the actual data)." Therefore, it allows for confirmation or rejection of a preconceived theory (Hair *et al.*, 2014a). Since this study is based on existing theory by utilising and testing a modified version of the UTAUT2 model as well as using previously validated scales, the CFA approach is most applicable.

The assessment of the measurement model will be presented in the following subchapters. This includes the assessment of the initial measurement model fit, the measurement model inspection and modification procedures, the final measurement model fit, as well as the assessment of the construct validity of the final measurement model.

6.3.1 Initial Measurement Model Fit

The initial measurement model comprises 14 constructs (PE; EE; SI; FC; HM; PS; PR_PR; PR_SR; PR_O; TT_P; TT_S; TT_O; INO; BI) that are measured by 47 items. An overview of the constructs, the measured items, and the code names is presented in subchapter 3.4. In this study the confirmatory factor analysis (CFA) is applied using the maximum likelihood method. Running the initial measurement model revealed the following results (see Table 6.2):

Table 6.2: Goodness-of-Fit Indices Initial Measurement Model

Indices	**χ^2**	**df**	**CMIN/DF**	**RMSEA**	**TLI**	**CFI**
Standards	-	-	Between 1 and 3	≤ 0.05	≥ 0.95	≥ 0.95
Results	2219.764	943	2.354	0.052	0.949	0.956

As expected, due to the large sample size, the chi-square is significant (p-value = 0.000). Therefore, when relying only on the chi-square the model should be rejected. However, within this study, multiple fit indices are considered. All other fit indices have reached or are at the cut-off level recommended. Therefore, the model already shows adequate fit. Nevertheless, it is recommended in addition to evaluating the goodness-of-fit statistics to check a number of model diagnostics, which might reveal some areas to further improve the model or even reveal problematic areas not revealed until this point (Hair *et al.*, 2014a). In doing so, the following diagnostic measures were examined: standardised regression weights, standardised residual covariances, and modification indices (Hair *et al.*, 2014a). This examination will be presented in the following subchapter.

6.3.2 Measurement Model Inspection and Modification

The model fit assessment is done in a step-by-step procedure, meaning that when a problematic item is identified, it is inspected in detail. In case the item qualified for deletion, it was deleted, and the model was rerun. In this study the model was rerun three times until the final measurement model was established.

To qualify for deletion more than one criterion stated in the following should not be met:

1. **Standardised regression weights** should be **above the threshold of 0.70**
2. **Standardised residual covariance** should be **in the range of |2.58|**
3. **Modification indices for the regression weights** should be **below 4.0**

According to Hair *et al.* (2014a), items should be deleted when they prove problematic on most of these levels. Byrne (2016) supports this view by stating that only those items that demonstrate high standardised residual covariances as well as high modification indices of the regression weights should be candidates for deletion. Based on these criteria, three items were deleted (i.e., PSR3, PSR1, and PR_PR3). The inspection process will be described in detail in the following.

The first diagnostic measure is to check the standardised regression weights (i.e., factor loadings). In the initial measurement model all standardised regression weights, except for the PSR3, are above the recommended threshold value of 0.70 (Hair *et al.*, 2014a). The values range from 0.74 to 0.97. However, PSR3 holds a negative 0.136 value (≈ - 0.14), which indicates some problems with the item. Therefore, the standardised residual covariances as well as the modification indices for the regression weights for item PSR3 were checked. The inspection of the standardised residual covariances revealed that many residuals exceeded the threshold of |2.58|, even though exceeding the threshold of |2.58| in the range of |2.58| to |4| might not be that problematic in case no other diagnostic measures indicate a problem (Hair *et al.*, 2014a). However, in this case, the standardised residual covariances of PSR3 even exceeded in some case the threshold of |4|. As a final step, the items modification indices for the regression weights were checked for item PSR3. The assessment revealed that the modification indices of the regression weights were all in a range between 6.10 to 33.5, which is considered high, thus, indicating some issues with unidimensionality. As a result, all three assessment criteria stated above were checked and revealed some issues with item PSR3. Therefore, the item PSR3 was deleted.

As a next step, the model was rerun again. All standardised regression weights are now above the recommended level of 0.70. Furthermore, the standardised residual covariances are checked again for any further items that exceed the level of |4| or items lying in the range of |2.58| to |4|, which might be problematic. The inspection revealed that item PSR1 has many standardised residual covariances above |2.58|, and one value even exceeded the threshold of |4|. Therefore, the modification indices for the regression weights of item PSR1 were inspected. As a result, all values lie between the range of 4.0 to 48.8. Again, indicating some problems with the item’s unidimensionality. Since both, the standardised residual covariances as well as the modification indices for the regression weights indicate some issues with that item, PSR1 was deleted.

As a next step, the model was rerun again. Since all standardised regression weights were already inspected, the standardised residual covariances were directly checked. Item PR_PR3 was identified as potentially problematic since many standardised residual covariances are in the range of |2.58| to |4|. However, as stated before, these might only indicate problems in case any other diagnostic method revealed a problem. Thus, the modification indices for standardised regression weights were checked and revealed values of 6.9 to 51.2, indicating again some lack of unidimensionality of the item. Since the construct has only three items, deleting PR_PR3 reaches the minimum of items necessary for identification (two-indicator rule) (Kline, 2011). Nevertheless, it is possible to retain a construct with only two items if those items are highly correlated with each other (r > 0.70) (Worthington and Whittaker, 2006). In this case, the correlation for the remaining items PR_PR1 and PR_PR2 is 0.858. Thus, it was not seen as problematic to delete item PR_PR3.

As a final step, the model was rerun again. The matrix of the standardised residual covariances displayed only one value above the cut-off of |2.58| (i.e., FC4 <–> PSR2 = -2.85) but still in the range of |2.58| to |4|. Since this is not seen as problematic no action was taken, given the overall positive results as well as the solid theoretical basis of the model (Hair *et al.*, 2014a).

6.3.3 Final Measurement Model Fit

The final measurement model still comprises 14 constructs (PE; EE; SI; FC; HM; PS; PR_P; PR_S; PR_O; TT_P; TT_S; TT_O; INO; BI). However, since three items were deleted, they are measured by only 44 items. The goodness-of-fit indices are presented in Table 6.3 below. For more details on the standardised regression weights, the standardised residual covariances as well as the modification indices of the final measurement model of the theoretical research framework, see Appendix C: Measurement Model.

Table 6.3: Goodness-of-Fit Indices Final Measurement Model

Indices	**χ^2**	**df**	**CMIN/DF**	**RMSEA**	**TLI**	**CFI**
Standards	-	-	Between 1 and 3	≤ 0.05	≥ 0.95	≥ 0.95
Results	1746.510	811	2.154	0.048	0.96	0.966

Again, as expected, the chi-square is significant (p-value = 0.000). Therefore, when relying only on the chi-square the model should be rejected. However, within this study, multiple fit indices were considered. All other fit indices have now clearly exceeded the minimum thresholds recommended. Therefore, it can be concluded that the deletion of the three items improved the model fit to an excellent level. The final measurement model is presented in Figure 6.1 on the following page.

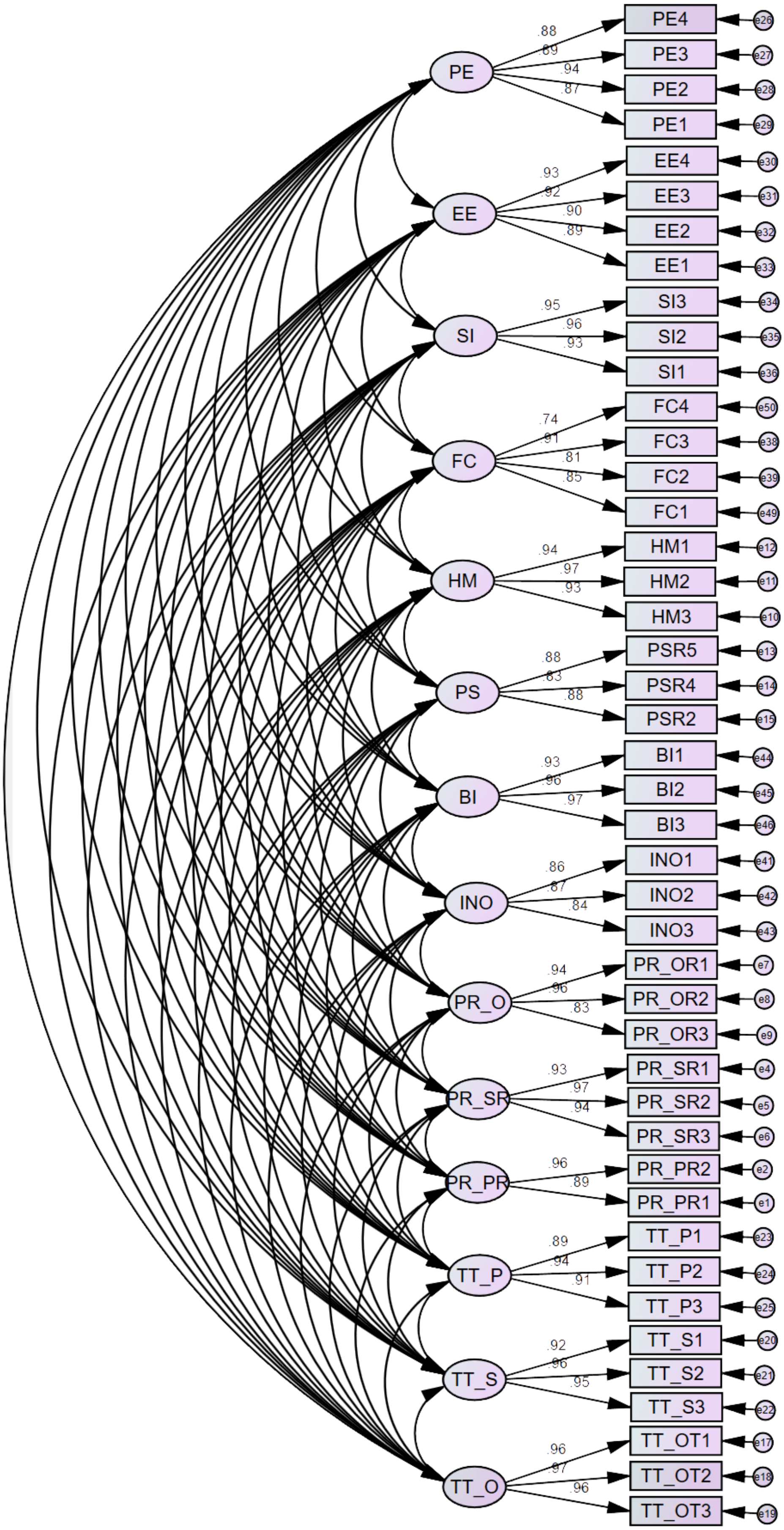

Figure 6.1: Final Measurement Model

6.3.4 Construct Validity

Since the constructs are well defined at this stage, the final modified model is assessed regarding construct validity. In other words, it is checked whether the measured variables (i.e., items) actually represent the latent construct for which they are designed to measure (Kline, 2011; Hair *et al.*, 2014a). Checking construct validity is one of the primary goals of CFA/SEM (Hair *et al.*, 2014a). However, it needs to be considered that there is no single test for construct validity (Kline, 2011). Validity in this study is assessed by convergent validity, discriminant validity, as well as nomological validity. The assessment of the convergent validity and discriminant validity is presented in the following. Nomological validity is tested in the structural model assessment section because it tests whether correlations make sense. In other words, nomological validity is a plausibility test (Hair *et al.*, 2014a).

6.3.4.1 Convergent Validity

Convergent validity of a construct "assesses the degree to which two measures of the same concept are correlated" (Hair *et al.*, 2014a, p. 124). It is achieved when multiple items operate in a consistent manner (Straub *et al.*, 2004) and can be assessed by standardised regression weights, average variance extracted, and construct reliability (Hair *et al.*, 2010). First, the standardised regression weights were taken from the AMOS output. Second, construct reliability "is a measure of the degree to which a set of indicators of a latent construct is internally consistent based on how highly interrelated the indicators are with each other" (Hair *et al.*, 2014a, p. 548). For each set of items representing one construct, reliability was calculated using IBM SPSS25. In doing so, the Cronbach's alpha was calculated, as it is the commonly applied reliability estimate (Hair *et al.*, 2014a). The average variance extracted "is calculated as the mean variance extracted from the items loading on a construct and is a summary indicator of convergence" (Hair *et al.*, 2014a, p. 619). Since the average variance extracted (AVE) can neither be calculated in SPSS25 nor in AMOS, it was calculated using Microsoft Excel with the following formula (Hair *et al.*, 2014a):

$$AVE = \frac{\sum_{i=1}^{n} \lambda^2{}_i}{n}$$

λ^2 is representing the squared standardised regression weights (factor loadings) and n is representing the number of items (Hair *et al.*, 2010; Hair *et al.*, 2014a). As a rule of thumb, the standardised regression weights should be above 0.7, the average variance extracted (AVE) should be above 0.5, and the construct reliability should be above 0.7 to account for convergent validity (Hair *et al.*, 2014a). See Table 6.4 for the results.

Table 6.4: Convergent Validity and Reliability

Construct	Item	Standardised Regression weights	Average Variance Extracted	Construct Reliability (Cronbach's Alpha)
PE	PE1	0.868	0.801	0.940
	PE2	0.940		
	PE3	0.885		
	PE4	0.884		
EE	EE1	0.888	0.825	0.949
	EE2	0.899		
	EE3	0.919		
	EE4	0.926		
SI	SI1	0.933	0.903	0.965
	SI2	0.965		
	SI3	0.952		
FC	FC1	0.849	0.685	0.892
	FC2	0.807		
	FC3	0.909		
	FC4	0.736		
HM	HM1	0.943	0.900	0.963
	HM2	0.972		
	HM3	0.931		
PS	PSR2	0.878	0.747*	0.898**
	PSR4	0.832		
	PSR5	0.882		
PR_O	PR_OR1	0.939	0.826	0.932
	PR_OR2	0.956		
	PR_OR3	0.826		
PR_PR	PR_PR1	0.891	0.861***	0.923****
	PR_PR2	0.963		
PR_SR	PR_SR1	0.925	0.889	0.959
	PR_SR2	0.968		
	PR_SR3	0.936		
TT_O	TT_OT1	0.955	0.921	0.972
	TT_OT2	0.966		
	TT_OT3	0.957		
TT_P	TT_P1	0.887	0.832	0.937
	TT_P2	0.943		
	TT_P3	0.906		

Table 6.4: Convergent Validity and Reliability – Continued

Construct	Item	Standardised Regression weights	Average Variance Extracted	Construct Reliability (Cronbachs' Alpha)
TT_S	TT_S1	0.916	0.887	0.959
	TT_S2	0.958		
	TT_S3	0.951		
INO	INO1	0.859	0.738	0.892
	INO2	0.874		
	INO3	0.844		
BI	BI1	0.929	0.905	0.966
	BI2	0.956		
	BI3	0.968		

Note: * AVE before excluding the items PSR3 and PSR1 = 0.585; ** alpha before excluding the items PSR3 and PSR1 = 0.775; *** AVE before excluding item PR_PR3 = 0.768; **** alpha before excluding item PR_PR3 = 0.898

Inspecting Table 6.4 above, all standardised regression weights are above the minimum threshold of 0.70, the AVE values are all above 0.50, and the construct reliability (Cronbach's alpha) of the items are all above 0.70. Overall, the results in Table 6.4 show a high level of convergent validity of the constructs used in this study. As a next step, discriminant validity was checked. This will be presented in the following subchapter.

6.3.4.2 Discriminant Validity

"Discriminant validity is the extent to which a construct is truly distinct from other constructs" (Hair *et al.*, 2014a, p. 619). Thus, evidence that a construct is unique and only captures some phenomena others do not is represented with high discriminant validity (Hair *et al.*, 2014a). According to Fornell and Larcker (1981), it is tested by comparing the square roots of the AVE to the correlation coefficients. If the square roots of the AVE are higher than the correlation coefficients, then discriminant validity is supported. The results are presented in the Table 6.5 on the following page. It shows that the square-rooted AVE values are all greater than the inter-construct correlations. Thus, discriminant validity is supported in this study, meaning all constructs are unique.

Overall, the CFA measurement model results show that the constructs used in this study have great validity in terms of convergent validity as well as discriminant validity.

Table 6.5: Square Roots of AVE and Inter-Construct Correlations

	AVE	PR_PR	PR_SR	PR_O	HM	PS	TT_O	TT_S	TT_P	PE	EE	SI	FC	INO	BI
PR_PR	0.861	**0.928**													
PR_SR	0.889	0.591	**0.943**												
PR_O	0.826	0.613	0.857	**0.909**											
HM	0.900	-0.246	-0.350	-0.428	**0.949**										
PS	0.747	0.303	0.245	0.248	-0.479	**0.864**									
TT_O	0.921	-0.407	-0.521	-0.640	0.695	-0.478	**0.960**								
TT_S	0.887	-0.361	-0.563	-0.588	0.638	-0.498	0.861	**0.942**							
TT_P	0.832	-0.382	-0.457	-0.538	0.657	-0.440	0.870	0.836	**0.912**						
PE	0.801	-0.233	-0.368	-0.423	0.807	-0.450	0.668	0.604	0.638	**0.895**					
EE	0.825	-0.180	-0.265	-0.362	0.664	-0.309	0.597	0.551	0.610	0.714	**0.908**				
SI	0.903	-0.282	-0.294	-0.363	0.734	-0.526	0.639	0.582	0.619	0.741	0.639	**0.950**			
FC	0.685	-0.143	-0.215	-0.345	0.628	-0.274	0.554	0.504	0.563	0.601	0.789	0.624	**0.828**		
INO	0.738	-0.252	-0.271	-0.348	0.661	-0.509	0.559	0.530	0.577	0.574	0.545	0.627	0.604	**0.859**	
BI	0.905	-0.343	-0.415	-0.514	0.771	-0.634	0.768	0.730	0.713	0.760	0.601	0.745	0.584	0.702	**0.951**

Note: the values on the diagonal (bold) are the square roots of the AVE; values below the diagonal are the inter-construct correlations ($p < 0.001$).

6.4 Structural Model Analysis

After the measurement model was assessed and the outcome revealed satisfactory results, the next step was to assess the structural model. This was done by assessing the fit indices and the path coefficients. In contrast to the measurement model, the focus of the structural model shifts to the relationships between the latent constructs (Hair *et al.*, 2014a). In more detail, "the structural model applies the structural theory by specifying which constructs are related to each other and the nature of each relationship" (Hair *et al.*, 2014a, p. 641).

The structural model was created in IBM AMOS25 by deleting all double-headed arrows (i.e., covariances) of the final measurement model and drawing the hypothesised structural paths (causal arrows) into the model as presented in Figure 6.2. The aim of hypotheses testing was to determine which independent constructs influence the dependent constructs (Hair *et al.*, 2014a).

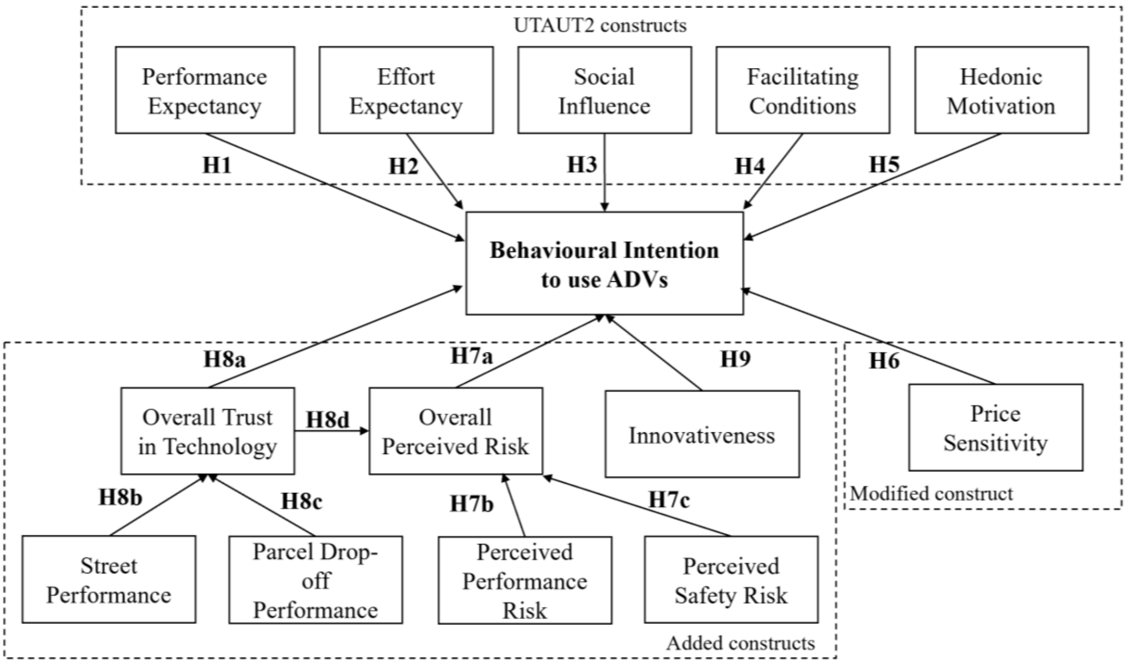

Figure 6.2: Hypothesised Structural Model

The model specified performance expectancy (PE), effort expectancy (EE), social influence (SI), facilitating conditions (FC), hedonic motivation (HM), price sensitivity (PS), perceived performance risk (PR_PR), perceived safety risk (PR_SR), parcel drop-off performance (TT_P), and street performance (TT_S) as exogenous (independent) constructs, whereas overall trust in technology (TT_O) and overall risk (PR_O) are simultaneously dependent and independent constructs. Moreover, behavioural intention (BI) is only considered as an endogenous (dependent) construct. Table 6.6 shows the exogenous and endogenous constructs and presents the hypotheses by indicating the causal paths.

Table 6.6: Exogenous and Endogenous Constructs and Hypothesised Relationships

Exogenous Construct (independent)	**Endogenous Construct (dependent)**	**Hypothesis**	**Hypothesised Relationship**
Performance expectancy (PE)	Behavioural Intention (BI)	H1	PE → BI (+)
Effort Expectancy (EE)	Behavioural Intention (BI)	H2	EE → BI (+)
Social Influence (SI)	Behavioural Intention (BI)	H3	SI → BI (+)
Facilitating Conditions (FC)	Behavioural Intention (BI)	H4	FC → BI (+)
Hedonic Motivation (HM)	Behavioural Intention (BI)	H5	HM → BI (+)
Price Sensitivity (PS)	Behavioural Intention (BI)	H6	PS → BI (-)
Overall Perceived Risk (PR_O)	Behavioural Intention (BI)	H7a	PR_O → BI (-)
Perceived Performance Risk (PR_PR)	Overall Perceived Risk (PR_O)	H7b	PR_PR → PR_O (+)
Perceived Safety Risk (PR_SR)	Overall Perceived Risk (PR_O)	H7c	PR_SR → PR_O (+)
Overall Trust in Technology (TT_O)	Behavioural Intention (BI)	H8a	TT_O → BI (+)
Street Performance (TT_S)	Overall Trust in Technology (TT_O)	H8b	TT_S → TT_O (+)
Parcel drop-off Performance (TT_P)	Overall Trust in Technology (TT_O)	H8c	TT_P → TT_O (+)
Overall Trust in Technology (TT_O)	Overall Perceived Risk (PR_O)	H8d	TT_O → PR_O (-)
Innovativeness (INO)	Behavioural Intention (BI)	H9	INO → BI (+)

6.4.1 Structural Model Fit

The procedure of the structural model assessment followed the same steps as with the confirmatory factor analysis (CFA). As a first step, the model-fit-indices were assessed. The model fit criteria were the same as for the measurement model (CFA model) in the previous subchapters. Following these criteria, the structural model provides good fit, as can be seen in Table 6.7 below.

Table 6.7: Structural Model Fit

Indices	χ^2	df	CMIN/DF	RMSEA	TLI	CFI
Standards	-	-	Between 1 and 3	≤ 0.05	≥ 0.95	≥ 0.95
Results	1827.153	833	2.193	0.049	0.959	0.964

As a next step, the validity of the structural model is assessed based on the comparison of the structural model fit compared to the CFA model (Hair *et al.*, 2014a). See Table 6.8.

Table 6.8: Model Fit Comparison CFA and Structural Model

Indices	CFA	structural model	Difference
χ^2	1746.51	1827.153	80.643
DF	811	833	22
p-value	0.0000	0.0000	-
CMIN/DF	2.154	2.193	0.039
TLI	0.96	0.959	-0.001
CFI	0.966	0.964	-0.002
RMSEA	0.048	0.049	0.001

The comparison of the chi-square of the CFA and the structural model shows a delta of 80.643 with 22 degrees of freedom (p = 0.000). The delta of 22 degrees of freedom shows that all but 22 structural paths are estimated. Since this delta is highly significant, further structural paths could be considered (Hair *et al.*, 2014a). However, since this research is explanatory rather than exploratory, no further paths are considered in this study. Overall, considering all other goodness-of-fit statistics presented in Table 6.8, no substantive changes occurred between the CFA and the structural model fit. In other words, the structural model fit statistics are not substantially different to the CFA, and therefore it can be concluded that the structural model does not lack validity (Hair *et al.*, 2014a). However, as with the assessment of the CFA model, the structural model assessment is not entirely based on the goodness-of-fit indices alone. In this study the validity of the hypothesised relationships was also assessed by the parameter estimates (i.e., standardised regression weights). This is presented in the following subchapter.

6.4.2 Hypotheses Testing

To support the hypothesised relationships, the standardised path coefficients (i.e., standardised regression weights) were required to be significant at the $p < 0.05$ level (Hair *et al.*, 2014a). To be significant at the $p < 0.05$ level, the critical ratio value must be higher than 1.96 or lower than - 1.96 (Hair *et al.*, 2014a).

Table 6.9: Path Coefficients Structural Model

			Estimate	Standardised estimate	Standard error	Critical ratio	P-value
TT_O	←	TT_S	0.468	0.435	0.049	9.635	***
TT_O	←	TT_P	0.585	0.512	0.053	11.052	***
PR_O	←	PR_S	0.673	0.658	0.037	18.361	***
PR_O	←	PR_P	0.162	0.129	0.039	4.130	***
PR_O	←	TT_O	- 0.234	- 0.247	0.027	- 8.794	***
BI	←	PE	0.223	0.222	0.050	4.476	***
BI	←	EE	- 0.077	- 0.069	0.054	- 1.434	0.151
BI	←	SI	0.120	0.118	0.042	2.858	**
BI	←	FC	0.040	0.042	0.045	0.899	0.369
BI	←	HM	0.114	0.118	0.045	2.503	*
BI	←	PS	- 0.222	- 0.210	0.033	- 6.634	***
BI	←	INO	0.208	0.171	0.047	4.437	***
BI	←	PR_O	- 0.080	- 0.070	0.034	- 2.381	*
BI	←	TT_O	0.269	0.248	0.039	6.827	***

Note: ***$p < 0.001$; **$p < 0.01$; *$p < 0.05$; estimate = regression weight; standardised estimate = standardised regression weight

Taking into consideration the results presented in Table 6.9, most of the hypothesised links are significant at the p-level of *** $p < 0.001$, ** $p < 0.01$, or * $p < 0.05$, respectively.

However, the paths, EE → BI and FC → BI could not be proven statistically significant and therefore were rejected. Hence, the analysis of the parameter estimates revealed that out of 14 hypotheses, 12 hypotheses were accepted. Overall, 12 estimates are consistent with the hypotheses and therefore the theoretically proposed framework could be proven with a caveat for the two paths mentioned before. Furthermore, the structural model was able to explain 80 percent of the variance in BI, 79 percent of the variance in PR_O, as well as 82 percent of the variance in TT_O, which also supports the validity of the structural model. Collectively, these results reflect the expectations specified in the theoretically developed framework and thus support nomological validity (Hair *et al.*, 2014a).

In addition to the hypotheses testing of the research constructs proposed, in a second step demographic variables (i.e., age and gender) were also included into the structural model as control variables. However, neither age nor gender had a significant effect on behavioural intention (see Table 6.10). Additionally, the inclusion of the control variables did not significantly change the standardised estimates of the other constructs (for further details see Appendix E.1). Thus, it can be concluded that age and gender do not significantly influence behavioural intention to use ADVs for last-mile delivery in the German context.

Table 6.10: Path Coefficients Control Variables

			Estimate	Standardised estimate	Standard error	Critical ratio	P-value
BI	←	Age	- 0.017	- 0.013	0.034	- 0.512	0.609
BI	←	Gender	- 0.036	- 0.010	0.077	- 0.469	0.639

The final structural model is presented in Figure 6.3 on the following page, including the values provided in this subchapter. Additionally, Table 6.11 gives an overview of all hypotheses, the hypothesised relationships, their directions as well as the standardised regression weights and the results.

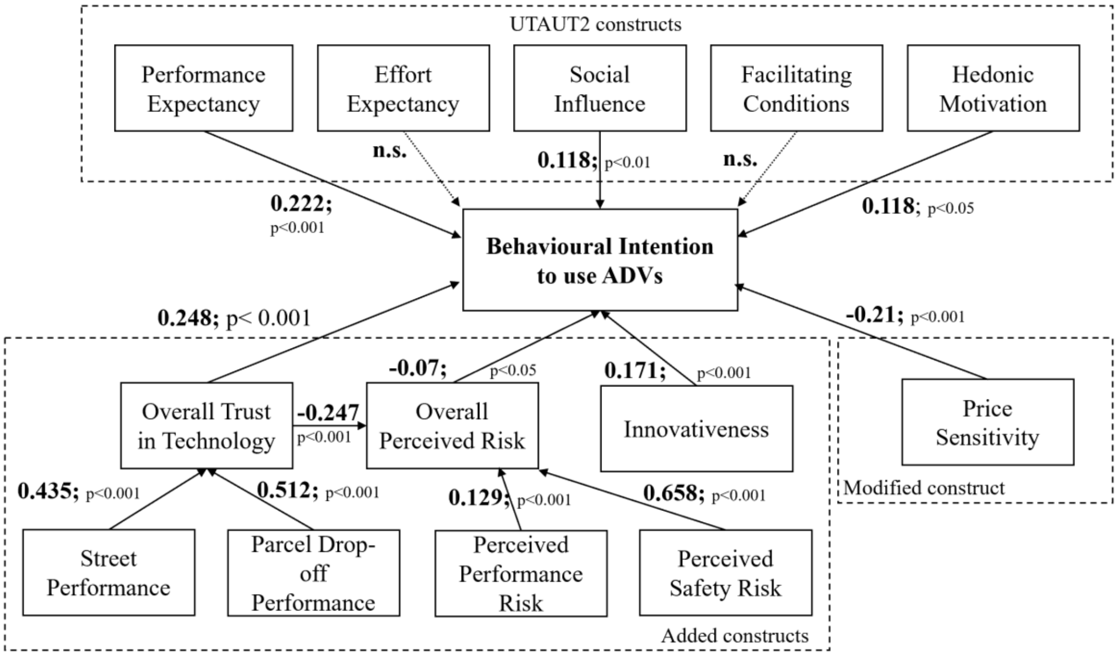

Figure 6.3: Final Structural Model

Table 6.11: Hypotheses Results

Hypothesis	Hypothesis Relationship	Standardised Regression Weights	Result
H1: Performance expectancy positively influences behavioural intention to use ADVs.	PE → BI (+)	0.222	Supported ***
H2: Effort expectancy positively influences behavioural intention to use ADVs.	EE → BI (+)	- 0.069	Rejected
H3: Social influence positively influences behavioural intention to use ADVs.	SI → BI (+)	0.118	Supported **
H4: Facilitating conditions positively influences behavioural intention to use ADVs.	FC → BI (+)	0.042	Rejected
H5: Hedonic motivation positively influences behavioural intention to use ADVs.	HM → BI (+)	0.118	Supported *
H6: Price sensitivity negatively influences behavioural intention to use ADVs.	PS → BI (-)	- 0.210	Supported ***

Table 6.11: Hypotheses Results – Continued

Hypothesis	Hypothesis Relationship	Standardised Regression Weights	Result
H7a: Overall perceived risk negatively influences behavioural intention to use ADVs.	PR_O → BI (-)	- 0.070	Supported *
H7b: Perceived performance risk positively influences overall perceived risk.	PR_PR → PR_O (+)	0.129	Supported ***
H7c: Perceived safety risk positively influences overall perceived risk.	PR_SR → PR_O (+)	0.658	Supported ***
H8a: Overall trust in technology positively influences behavioural intention to use ADVs.	TT_O → BI (+)	0.248	Supported ***
H8b: Parcel drop-off performance positively influences overall trust in technology.	TT_P → TT_O (+)	0.512	Supported ***
H8c: Street performance positively influences overall trust in technology.	TT_S → TT_O (+)	0.435	Supported ***
H8d: Overall trust in technology negatively influences overall perceived risk.	TT_O → PR_O (-)	- 0.247	Supported ***
H9: Innovativeness positively influences behavioural intention to use ADVs.	INO → BI (+)	0.171	Supported ***

Note: *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$

H1: Performance expectancy positively influences behavioural intention to use ADVs.

The standardised regression weight from performance expectancy (PE) to behavioural intention (BI) is 0.222 at a significance level of $p < 0.001$, which shows that this path is statistically significant. Thus, the result revealed that H1 is supported. Overall, it can be concluded that PE has a positive and significant effect on BI and an increase in PE will positively influence BI.

H2: Effort expectancy positively influences behavioural intention to use ADVs.

The standardised regression weight from effort expectancy (EE) to BI is - 0.069 and statistically insignificant. Therefore, H2 cannot be supported on this basis and therefore the hypothesis was rejected. As a result, it can be stated that EE does not statistically significantly influence BI in the context of user acceptance of ADVs in last-mile delivery in Germany (see subchapter 7.3.2.1 for a detailed discussion).

H3: Social influence positively influences behavioural intention to use ADVs.

The standardised regression weight for social influence (SI) to BI revealed a value of 0.118, which is statistically significant at the level of $p < 0.01$. Therefore, H3 is supported and SI has a positive and statistically significant effect on BI. An increase of SI will therefore positively influence BI.

H4: Facilitating conditions positively influences behavioural intention to use ADVs.

The standardised regression weight for facilitating conditions (FC) to BI is 0.042 and is statistically insignificant. As a matter of fact, H4 cannot be supported on this basis and was rejected. On this basis, it can be concluded that FC has no statistically significant effect on BI and therefore does not statistically influence the user acceptance of ADVs in last-mile delivery in Germany (see subchapter 7.3.2.2 for a detailed discussion).

H5: Hedonic motivation positively influences behavioural intention to use ADVs.

The standardised regression weight for hedonic motivation (HM) to BI is 0.118 at a statistical significance level of $p < 0.05$. Thus, H5 is supported. This demonstrates that HM has a positive effect on BI to use ADVs and indicates that HM positively influences BI and therefore user acceptance of ADVs in last-mile delivery in Germany.

H6: Price sensitivity negatively influences behavioural intention to use ADVs.

The standardised regression weight for price sensitivity (PS) to BI is - 0.210 and statistically significant at the level of $p < 0.001$. Hence, H6 is supported. This demonstrates that PS has a negative effect on BI to use ADVs in last-mile delivery in Germany. Therefore, an increase of PS will have negative effects on BI and therefore on the user acceptance of ADVs.

H7a: Overall perceived risk negatively influences behavioural intention to use ADVs.

The standardised regression weight for overall perceived risk (PR_O) to BI is - 0.07 and statistically significant ($p < 0.05$). This result supports H7a and indicates that PR_O negatively influences BI to use ADVs in last-mile delivery in Germany. Therefore, an increase of PR_O will negatively influence BI to use ADVs as a delivery option.

H7b: Perceived safety risk positively influences overall perceived risk.

The standardised regression weight for perceived safety risk (PR_SR) to PR_O is 0.658 and statistically significant ($p < 0.001$). Therefore, H7b is supported. This demonstrates that PR_SR has a positive and significant effect on PR_O, implying that if PR_SR increases, then PR_O will also increase.

H7c: Perceived performance risk positively influences overall perceived risk.

The standardised regression weight for perceived performance risk (PR_P) to PR_O is 0.129 and statistically significant at the level $p < 0.001$. Therefore, H7c is supported. This reveals that PR_PR has a positive and significant effect on PR_O, indicating that an increase of PR_PR positively influences PR_O.

H8a: Overall trust in technology positively influences behavioural intention to use ADVs.

The standardised regression weight for overall trust in technology (TT_O) on BI is 0.248 and statistically significant at the level $p < 0.001$, which supports H8a. This indicates that TT_O positively affects BI to use ADVs, thus indicating that an increase TT_O will lead to an increase in BI.

H8b: Parcel drop-off performance positively influences overall trust in technology.

The standardised regression weight for parcel drop-off performance (TT_P) to TT_O is 0.512 and statistically significant ($p < 0.001$), which strongly supports H8b. This demonstrates that TT_P has a positive and significant effect on TT_O, indicating that TT_P positively influences TT_O in the context of last-mile delivery in Germany.

H8c: Street performance positively influences overall trust in technology.

The standardised regression weight for street performance (TT_S) to TT_O is 0.435 and statistically significant at the level $p < 0.001$. Therefore, H8c is supported. This indicates that TT_S positively and significantly affects TT_O, and an increase of TT_S will therefore lead to an increase in TT_O.

H8d: Overall trust in technology negatively influences overall perceived risk.

The standardised regression weight for TT_O to PR_O is - 0.247 and statistically significant at the level of $p < 0.001$. Thus, the results reveal support for H8d. This demonstrates that TT_O negatively influences PR_O. As a matter of fact, an increase in TT_O will lead to a decrease of PR_O.

H9: Innovativeness positively influences behavioural intention to use ADVs.

The standardised regression weight for innovativeness (INO) to BI is 0.171 and statistically significant ($p < 0.001$). This result reveals support for H9. Hence, INO positively influences BI to use ADVs. It can be concluded that an increase of INO will positively influence BI in the context of last-mile delivery in Germany.

6.5 Re-Estimation of the Research Framework

As outlined before, within the hypotheses testing, two insignificant paths (i.e., effort expectancy and facilitating conditions) were identified. To strengthen the research findings as well as to be able to develop a general research model, these insignificant constructs were dropped and the structural equation modelling, including the measurement model analysis and the structural model analysis, was re-estimated. In doing so, the same steps were conducted as for the measurement model and the structural model analysis in the previous subchapters of this thesis. As a result, all paths were significant and the final model to investigate behavioural intention (i.e., user acceptance) of ADVs in Germany could be developed at this stage. In other words, the findings provide strong support for the *"Autonomous Delivery Vehicle Acceptance Model"* within the German last-mile delivery context. The detailed findings of the re-estimations of the structural equation modelling are presented in the following subchapters.

6.5.1 Measurement Model Analysis

The measurement model analysis included the same steps as for the initial measurement model analysis in the previous subchapter. This includes the analysis of the measurement model fit as well as the construct validity. The latter includes the discriminant validity and convergent validity. Also, nomological validity will be tested in the structural model analysis.

6.5.1.1 Measurement Model Fit

After excluding the insignificant constructs (i.e., effort expectancy and facilitating conditions), the measurement model comprises 12 constructs (PE; SI, HM PS, PR_P; PR_S; PR_O; TT_P; TT_S; TT_O; INO; BI) measured by 36 items (see Figure 6.4). The measurement model was re-estimated, and the goodness-of-fit indices presented in Table 6.12 were calculated.

Table 6.12: Goodness-of-Fit Indices – Re-Estimated

Indices	χ^2	df	CMIN/DF	RMSEA	TLI	CFI
Standards	-	-	Between 1 and 3	≤ 0.05	≥ 0.95	≥ 0.95
Results	1155.120	528	2.188	0.049	0.968	0.973

Following the cut-off criteria presented in Table 6.1 in subchapter 6.2, the results show an excellent fit of the measurement model. In addition to the model fit analysis, the standardised regression weights (cut-off criteria: > 0.70), the standardised residual covariances (cut-off criteria: range |2.58|), as well as the modification indices (cut-off criteria: < 4) were also checked again for any improvements (Hair *et al.*, 2014a). The inspection revealed no problems with the items. For more details on the standardised regression weights, the standardised residual covariances, as well as the modification indices of the re-estimated measurement model, see Appendix D: Re-Estimated Measurement Model. The re-estimated measurement model is presented in Figure 6.4 on the following page.

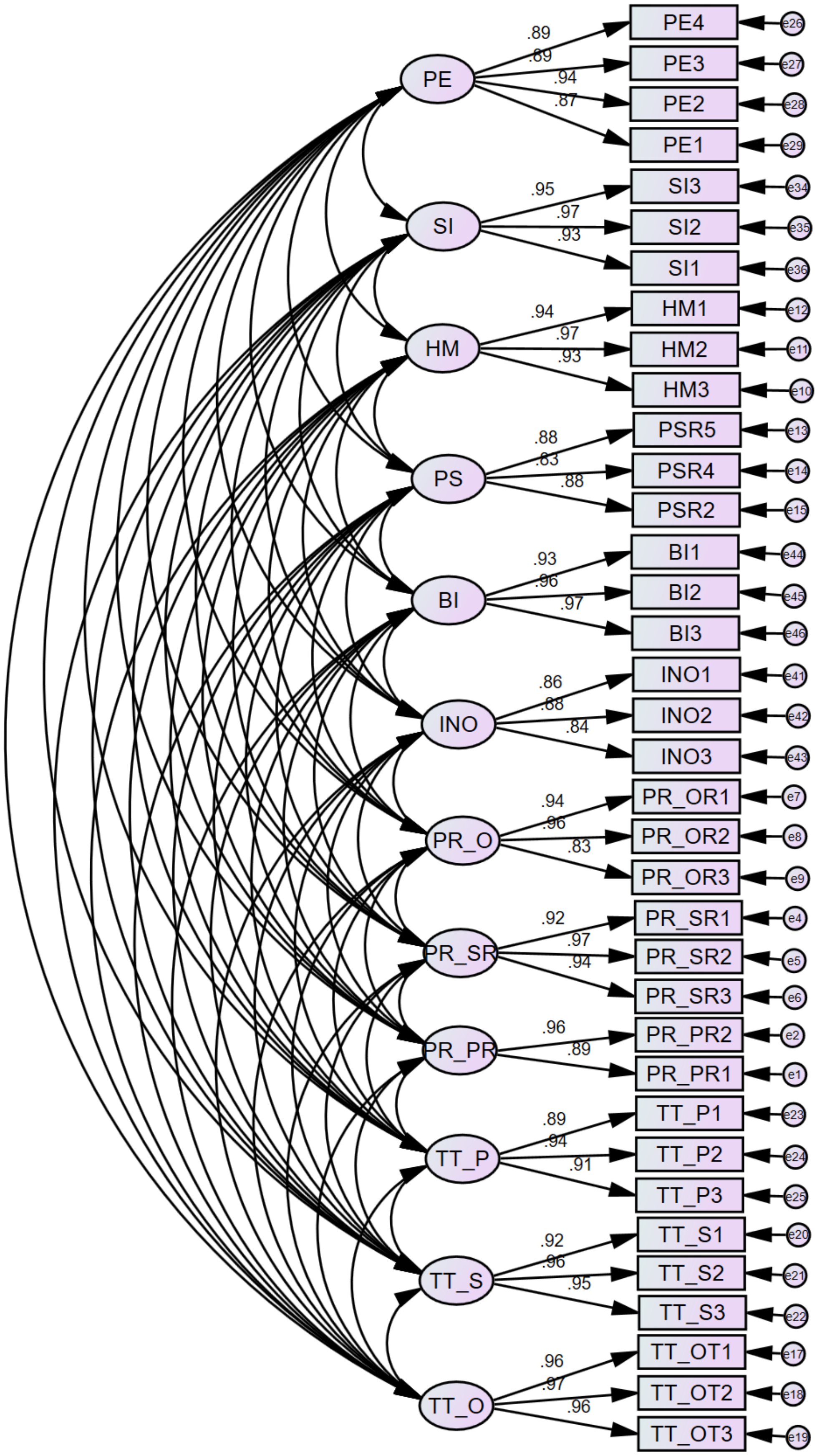

Figure 6.4: Measurement Model – Re-Estimated

6.5.1.2 Construct Validity

In addition to the goodness-of-fit indices, the measurement model was also checked again regarding its construct validity. This includes the convergent validity as well as the discriminant validity. Nomological validity will also be checked in the structural model analysis section. The analysis revealed that the model has a good convergent validity as well as discriminant validity. The findings are presented in the following subchapters.

6.5.1.2.1 Convergent Validity

Table 6.13: Convergent Validity – Re-Estimated

Construct	Item	Standardised Regression weights	Average Variance Extracted	Construct Reliability (Cronbach's Alpha)
PE	PE1	0.866	0.801	0.940
	PE2	0.939		
	PE3	0.887		
	PE4	0.886		
SI	SI1	0.933	0.903	0.965
	SI2	0.965		
	SI3	0.952		
HM	HM1	0.943	0.900	0.963
	HM2	0.971		
	HM3	0.932		
PS	PSR2	0.877	0.747	0.898
	PSR4	0.832		
	PSR5	0.882		
PR_O	PR_OR1	0.940	0.826	0.932
	PR_OR2	0.955		
	PR_OR3	0.825		
PR_PR	PR_PR1	0.891	0.861	0.923
	PR_PR2	0.963		
PR_SR	PR_SR1	0.925	0.889	0.959
	PR_SR2	0.968		
	PR_SR3	0.936		
TT_O	TT_OT1	0.955	0.921	0.972
	TT_OT2	0.966		
	TT_OT3	0.957		
TT_P	TT_P1	0.887	0.832	0.937
	TT_P2	0.944		
	TT_P3	0.905		
TT_S	TT_S1	0.916	0.887	0.959
	TT_S2	0.958		
	TT_S3	0.951		

Table 6.13: Convergent Validity – Re-Estimated – Continued

Construct	Item	Standardised Regression weights	Average Variance Extracted	Construct Reliability (Cronbach's Alpha)
INO	INO1	0.861	0.737	0.892
	INO2	0.876		
	INO3	0.839		
BI	BI1	0.929	0.905	0.966
	BI2	0.956		
	BI3	0.968		

Inspecting Table 6.13, all standardised regression weights are above the minimum threshold of 0.70, the AVE values are all above 0.50, and the construct reliability (Cronbach's alpha) of the items are all above 0.70. Overall, the results in Table 6.13 show a high level of convergent validity of the constructs used in this study. As a next step, discriminant validity was also checked again.

6.5.1.2.2 Discriminant Validity

The results are presented in Table 6.14 below, which shows that the square-rooted AVE values are all greater than the inter-construct correlations, which is recommended by Fornell and Larcker (1981). Thus, discriminant validity is supported.

Table 6.14: Square Roots of AVE and Inter-Construct Correlations – Re-Estimated

	AVE	PR_PR	PR_SR	PR_O	HM	PS	TT_O	TT_S	TT_P	PE	SI	INO	BI
PR_PR	0.861	**0.928**											
PR_SR	0.889	0.591	**0.943**										
PR_O	0.826	0.614	0.857	**0.909**									
HM	0.900	-0.246	-0.350	-0.428	**0.949**								
PS	0.747	0.303	0.245	0.249	-0.479	**0.864**							
TT_O	0.921	-0.407	-0.521	-0.640	0.695	-0.478	**0.960**						
TT_S	0.887	-0.361	-0.563	-0.588	0.638	-0.497	0.861	**0.942**					
TT_P	0.832	-0.382	-0.456	-0.538	0.657	-0.44	0.870	0.836	**0.912**				
PE	0.801	-0.233	-0.368	-0.423	0.807	-0.451	0.668	0.604	0.638	**0.895**			
SI	0.903	-0.282	-0.294	-0.363	0.734	-0.526	0.639	0.581	0.619	0.741	**0.950**		
INO	0.737	-0.252	-0.271	-0.348	0.662	-0.509	0.560	0.531	0.578	0.575	0.628	**0.859**	
BI	0.905	-0.343	-0.415	-0.514	0.771	-0.634	0.768	0.730	0.713	0.760	0.745	0.702	**0.951**

Note: the values on the diagonal (bold) are the square roots of the AVE; values below the diagonal are the inter-construct correlations ($p < 0.001$).

Taking together the results of the convergent and discriminant validity, no validity concerns exist.

6.5.2 Structural Model Analysis

After the measurement model was re-estimated and the outcome revealed satisfactory results, the next step was to assess the structural model again. This was done by assessing the fit-indices as well as the path coefficients, which is in line with the previous procedures carried out in this thesis.

6.5.2.1 Structural Model Fit

The calculation of the structural model fit indices revealed the following results, presented in Table 6.15.

Table 6.15: Structural Model Fit Indices – Re-Estimated

Indices	χ^2	df	CMIN/DF	RMSEA	TLI	CFI
Standards	-	-	Between 1 and 3	≤ 0.05	≥ 0.95	≥ 0.95
Results	1226.326	546	2.246	0.05	0.966	0.971

The model fit criteria were the same as for the structural model in the previous subchapters. Following these criteria, the structural model provides good fit. As a next step, the validity of the structural model was also assessed based on the comparison of the structural model fit compared to the CFA model (Hair *et al.*, 2014a). See Table 6.16 for details on this comparison.

Table 6.16: Model Fit Comparison CFA and Structural Model – Re-Estimated

Indices	CFA	Structural Model	Difference
χ^2	1155.12	1226.326	71.206
DF	528	546	18
p-value	0.0000	0.0000	-
CMIN/DF	2.188	2.246	0.058
TLI	0.968	0.966	- 0.002
CFI	0.973	0.971	- 0.002
RMSEA	0.049	0.05	0.001

The comparison of the chi-square of the CFA and the structural model shows a delta of 71.206 with 18 degrees of freedom (p = 0.000). Again, the delta of 18 degrees of freedom shows that all but 18 structural paths are estimated. Since this delta is highly significant, further structural paths could be considered (Hair *et al.*, 2014a). However, since this research is explanatory rather than exploratory no further paths are considered in this study. Overall, considering all other goodness-of-fit statistics presented in Table 6.16, no substantive changes occurred between the CFA model and the structural model. In other words, the structural model fit statistics are not substantially different to the CFA and therefore it can be concluded that the structural model does not lack validity (Hair *et al.*, 2014a). As in the previous subchapter, the assessment of the structural model is not entirely based on the goodness-of-fit indices alone. In this study the validity of the hypothesised relationships was also assessed by the standardised regression weights. This is presented in the following subchapter.

6.5.2.2 Hypotheses Testing

As outlined before, to support the hypothesised relationships the standardised path coefficients (i.e., standardised regression weights) were required to be significant at the $p < 0.05$ level (Hair *et al.*, 2014a) (see Table 6.17). In addition, the control variables age and gender were also tested again. However, the results revealed the same findings as for the theoretically developed research framework (for more details see Appendix E.2: Re-Estimated Path Coefficients Including Control Variables).

Table 6.17: Path Coefficients Structural Model – Re-Estimated

			Estimate	Standardised estimate	Standard error	Critical ratio	P-value
TT_O	←	TT_S	0.469	0.435	0.049	9.650	***
TT_O	←	TT_P	0.584	0.511	0.053	11.040	***
PR_O	←	PR_SR	0.674	0.658	0.037	18.365	***
PR_O	←	PR_PR	0.162	0.129	0.039	4.141	***
PR_O	←	TT_O	- 0.233	- 0.242	0.027	- 8.785	***
BI	←	PE	0.200	0.199	0.046	4.350	***
BI	←	SI	0.119	0.117	0.041	2.910	**
BI	←	HM	0.114	0.118	0.045	2.510	*
BI	←	PS	- 0.223	- 0.211	0.032	- 6.919	***
BI	←	INO	0.212	0.175	0.044	4.810	***
BI	←	PR_O	- 0.082	- 0.070	0.034	- 2.441	*
BI	←	TT_O	0.262	0.248	0.039	6.770	***

Note: ***$p < 0.001$; **$p < 0.01$; *$p < 0.05$; estimate = regression weight; standardised estimate = standardised regression weight

The analysis revealed that all structural paths are significant now (see Table 6.17). As a matter of fact, all proposed hypotheses could be supported (see Table 6.18). Collectively, these results reflect the expectations specified in the research model and thus support nomological validity (Hair *et al.*, 2014a).

Table 6.18: Hypotheses Results – Re-Estimated

Hypothesis	Hypothesis Relationship	Standardised Regression Weights	Result
H1: Performance expectancy positively influences behavioural intention to use ADVs.	PE → BI (+)	0.199	Supported ***
H3: Social influence positively influences behavioural intention to use ADVs.	SI → BI (+)	0.117	Supported **
H5: Hedonic motivation positively influences behavioural intention to use ADVs.	HM → BI (+)	0.118	Supported *
H6: Price sensitivity negatively influences behavioural intention to use ADVs.	PS → BI (-)	- 0.211	Supported ***
H7a: Overall perceived risk negatively influences behavioural intention to use ADVs.	PR_O → BI (-)	- 0.072	Supported *
H7b: Perceived performance risk positively influences overall perceived risk.	PR_PR → PR_O (+)	0.129	Supported ***
H7c: Perceived safety risk positively influences overall perceived risk.	PR_SR → PR_O (+)	0.658	Supported ***
H8a: Overall trust in technology positively influences behavioural intention to use ADVs.	TT_O → BI (+)	0.242	Supported ***
H8b: Parcel drop-off performance positively influences overall trust in technology.	TT_P → TT_O (+)	0.511	Supported ***

Table 6.18: Hypotheses Results – Re-Estimated Research Framework – Continued

Hypothesis	Hypothesis Relationship	Standardised Regression Weights	Result
H8c: Street performance positively influences overall trust in technology.	TT_S → TT_O (+)	0.435	Supported ***
H8d: Overall trust in technology negatively influences overall perceived risk.	TT_O → PR_O (-)	- 0.246	Supported ***
H9: Innovativeness positively influences behavioural intention to use ADVs.	INO → BI (+)	0.175	Supported ***

Note: *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$

As a result, the ***"Autonomous Delivery Vehicle Acceptance Model"*** **(ADV-AM)** has been developed. See the final model presented in Figure 6.5 below. The final model was able to explain 80 percent of the variance in behavioural intention, 82 percent of the variance of overall trust in technology, and 79 percent of the variance in overall perceived risk.

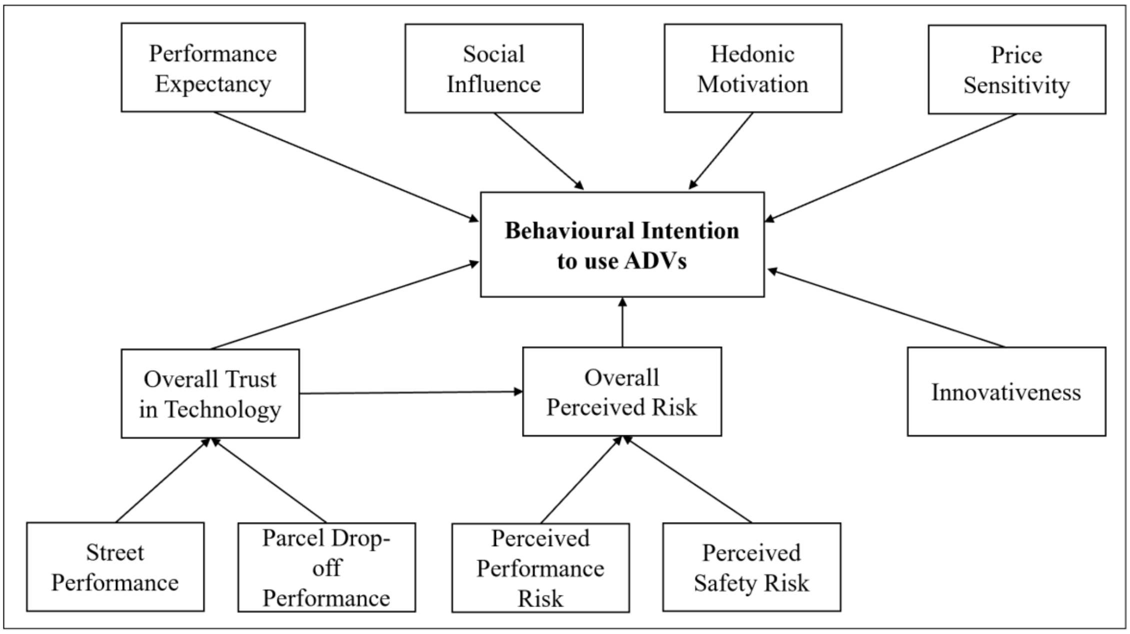

Figure 6.5: Autonomous Delivery Vehicle Acceptance Model (ADV-AM)

6.6 Conclusion

This chapter presented the analysis of the structural equation model. The assessment was carried out in two steps: first, the measurement model was assessed, and second, the structural model was assessed. The goodness-of-fit indices for the measurement model showed great fit after the initial measurement model was modified (i.e., deletion of three items). Furthermore, the measurement model analysis revealed that the model has great construct validity (i.e., convergent and discriminant validity). The assessment of the structural paths as well as the goodness-of-fit indices for the structural model showed good fit of the structural model. As a result, 12 out of 14 hypotheses could be supported. In more detail, performance expectancy (PE), social influence (SI), hedonic motivation (HM), price sensitivity (PS), overall trust in technology (TT_O), overall perceived risk (PR_O), and innovativeness (INO) determine behavioural intention (BI) to use ADVs for last-mile delivery in Germany, whereas insignificant relationships were found for effort expectancy (EE) and facilitating conditions (FC) on behavioural intention (BI). Additionally, it has been found that street performance (TT_S) and parcel drop-off performance (TT_P) influence overall trust in technology (TT_O), and safety risk (PR_SR) and performance risk (PR_PR) influence overall perceived risk (PR_O).

Following the fact that effort expectancy (EE) and facilitating conditions (FC) were found insignificant when calculating the theoretically developed research framework, the SEM analysis was estimated again by dropping those two constructs. The results revealed that the measurement model as well as the structural model provide good fit to the data and all hypotheses could be supported at this stage. As a consequence, the "Autonomous Delivery Vehicle Acceptance Model" could be developed.

Chapter 7: Discussion

7.1 Introduction

Within this chapter the findings of this research project are discussed in relation to the developed "*Autonomous Delivery Vehicle Acceptance Model"* (ADV-AM) as well as previous literature. The chapter will start with a brief overview and discussion of the main descriptive results obtained in this study. Next, the research model that was verified in this study will be discussed. This includes a brief overview of the research model results as well as a detailed discussion of the significant constructs in regard to the previous literature. Additionally, both insignificant constructs (i.e., effort expectancy and facilitating conditions) will be discussed to place the findings within the broader academic literature. The chapter will close with a general discussion of the applicability of UTAUT2 as a baseline model for this study.

7.2 Descriptive Results

Within this study, a self-administered questionnaire survey was conducted. Overall, 501 participants fully completed the online questionnaire (conversion rate: 42 percent), which was then used for data analysis. Through quota sampling it was possible to gather approximately representative data for the German population in terms of age, gender, and monthly household net-income. Compared to other acceptance studies reviewed in this thesis, which applied mainly convenience sampling (e.g., Liu *et al.*, 2019d), this is outstanding. Therefore, the results are of real value for practitioners because they reflect the German population in terms of age, gender, and monthly household net-income. As such the findings cannot only be taken into consideration for vehicle development but also for marketing purposes (see subchapter 8.3.2).

Moreover, the descriptive findings of this study show that 99 percent of the participants have used online shops to buy products. Following this, they have received parcels on their doorstep. Therefore, the participants of this study are believed to be potential and regular users of ADVs for home delivery. In this regard, it is worth mentioning that the analysis of the items' means revealed that the respondents of this study seem to still hold on average neutral acceptance towards the use of ADVs as a delivery option. In other words, the mean scores of behavioural intentions to use ADVs for last-mile delivery were not higher than the scale mid-point 4. However, this is in line with other research that has investigated disruptive technologies (e.g., AVs) before or in the beginning of the market introduction (Liu *et al.*, 2019b). Here, it is argued that the neutrality of user acceptance is related to the fact that the public has not have much experience with ADVs and therefore still needs to form an opinion in relation to ADVs for last-mile delivery. This is in line with the findings that 51 percent of the participants had never heard about ADVs as a delivery option after they read the information sheet about ADVs in the questionnaire and only 2.7 percent of the participants (i.e., 14 participants) stated that they had the opportunity to interact with ADVs before taking part in this survey. Taking these findings together, the participants in this study were mainly inexperienced when it comes to ADVs.

However, these findings were not surprising because ADVs are not yet available as a regular delivery option in Germany, and the marketing as well as the trials of those vehicles are very limited at the moment (e.g., Starship Technology in Hamburg and BUGA:log in Heilbronn). In this regard, it is worth mentioning that investigating user acceptance very early in the developmental process is highly recommended because it increases the flexibility to change and modify the technology (e.g., making corrections and adjustments) (Kollmann, 1998; Davis *et al.*, 1989; Davis, 1993; Fraedrich *et al.*, 2016). Moreover, Venkatesh *et al.* (2003) even state that investigating user acceptance well after the market introduction is a major shortcoming in previous technology acceptance studies. Therefore, investigating user acceptance of new technologies with participants that have no or only little experience has become a common approach (e.g., Slade *et al.*, 2015; Liu *et al.*, 2019c).

Considering the above arguments and statements, the approach taken in this thesis to investigate user acceptance of ADVs before the broad market introduction is supported. The findings can now be incorporated into the development and design of such vehicles, which might even improve user acceptance during the introduction stage. Nevertheless, the low experience of the participants in this study needs to be considered carefully because the importance of certain constructs might change after people gain more experience with ADVs (see subchapter 8.4), which has been found in previous acceptance research in the context of AVs (e.g., Xu *et al.*, 2018).

Finally, 75 percent of the participants are experienced with mobile apps and 72 percent of those have already used mobile apps for online shopping. This shows that the majority of the participants in this study is familiar with mobile app technology. On the one hand, this is surprising given the large number of older people due to the quotas set in this study. On the other hand, people might be more open-minded when it comes to the usage of ADVs because using mobile app technology is a precondition for using ADVs as a delivery option (e.g., connecting the smartphone to the vehicle to open the parcel locker).

7.3 Autonomous Delivery Vehicle Acceptance Model

Within this study, the UTAUT2 model was used as a foundation and was modified as well as extended to fit in the context of user acceptance of ADVs for last-mile delivery in Germany. In doing so, previous literature was reviewed in the areas of user acceptance of ADVs, SSTs, as well as AVs. As a result, the final theoretical framework encompassed some of the original UTAUT2 constructs (i.e., performance expectancy, effort expectancy, social influence, facilitating conditions, and hedonic motivation) as well as additional context-specific constructs that were identified in the systematic literature reviews in this thesis: overall perceived risk, overall trust in technology, as well as innovativeness (see subchapter 2.6.5). Additionally, overall perceived risk as well as overall trust in technology were studied as multidimensional constructs in order to investigate both characteristics of ADVs in this study (i.e., driving autonomously and dropping off parcels) (see subchapters 3.3.2.1 and 3.3.2.2). Moreover, price value was modified to price sensitivity to fit the underlying research context (see subchapter 3.3.1.1).

Structural equation modelling was applied for assessing the relationships of the theoretical framework using IBM AMOS25. The assessment of the structural paths revealed that 12 out of 14 hypotheses could be supported by the underlying data. In more detail, this research has provided further evidence for some of the UTAUT2 constructs as well as all the additional context specific constructs: overall trust in technology was the strongest predictor of behavioural intention of ADVs, followed by performance expectancy, price sensitivity, innovativeness, social influence, hedonic motivation, and overall perceived risk. Furthermore, perceived safety risk and perceived performance risk were identified to positively influence overall perceived risk and parcel drop-off performance and street performance were identified to influence overall trust in technology.

To be able to provide a strong research model to the academic research community, both insignificant constructs (i.e., effort expectancy and facilitating conditions) were dropped, and the SEM analysis was re-calculated, including the measurement model analysis as well as the structural model analysis. The findings of the re-estimated framework (i.e., final research model: Autonomous Delivery Vehicle Acceptance Model) show almost exactly the same results for the structural paths. The only difference is that performance expectancy has moved from the second-strongest effect to the third-strongest effect on behavioural intention. The following results were found: overall trust in technology has the strongest effect on behavioural intention ($\beta = 0.242$; p-value: < 0.001) followed by price sensitivity ($\beta = - 0.211$; p-value: < 0.001); performance expectancy ($\beta = 0.199$; p-value: < 0.001), innovativeness ($\beta = 0.175$; p-value: < 0.001), hedonic motivation ($\beta = 0.118$; p-value: < 0.05), social influence ($\beta = 0.117$; p-value: < 0.01), and overall perceived risk ($\beta = - 0.072$; p-value: < 0.05). In addition, it has been found that perceived performance risk ($\beta = 0.129$; p-value: < 0.001) and perceived safety risk ($\beta = 0.658$; p-value: < 0.001) significantly influence overall perceived risk. Furthermore, the results reveal that parcel drop-off performance ($\beta = 0.511$; p-value: < 0.001) and street performance ($\beta = 0.435$; p-value: < 0.001) significantly influence overall trust in technology. Finally, the structural path between overall trust in technology to overall perceived risk was found to be highly significant ($\beta = - 0.246$; p-value: < 0.001).

Overall, with the final research model (see Figure 6.5 in subchapter 6.5.2.2) it was possible to explain 80 percent of the variance in behavioural intention in this study. Using only the applicable and significant constructs from UTAUT2 (i.e., performance expectancy, social influence, and hedonic motivation), the model would only explain 68 percent of the variance in behavioural intention. Therefore, the inclusion of the additional and context-specific constructs clearly increased the predictive power of the research model in the context of ADVs for last-mile delivery. Collectively, reviewing the final model, the large direct effects of overall trust in technology, price sensitivity, and innovativeness on behavioural intention obviously show the importance of tailoring technology acceptance models to their underlying context.

7.3.1 Significant Constructs

In the following subsections the findings of the hypothesis's tests for the final research model (i.e., Autonomous Delivery Vehicle Acceptance Model) will be discussed in detail with regard to previous literature. The following subchapters are arranged in accordance to the final research model: the UTAUT2 constructs will be discussed first, followed by the additional added constructs or modified constructs. Here, it is worth mentioning again that the additional incorporated constructs are of great importance in the underlying context. In particular, overall trust in technology outperformed all other constructs in this study (see subchapter 7.3.1.6). Moreover, following the discussion of the Autonomous Delivery Vehicle Acceptance Model, subsection 7.3.2 also discusses the insignificant effects found in the theoretically developed research framework (i.e., effort expectancy and facilitating conditions) in regard to previous literature.

7.3.1.1 Performance Expectancy

In this study performance expectancy is defined as the degree to which users believe that using ADVs includes certain benefits over the traditional delivery method (Venkatesh *et al.*, 2012), for instance, higher flexibility, higher convenience and higher transparency throughout the delivery process. It was hypothesised that there is a positive and significant relationship between performance expectancy and behavioural intention (H1). The statistical results of the final research model ($\beta = 0.199$; $p < 0.001$) support H1. Therefore, performance expectancy positively affects behavioural intention to use ADVs in last-mile delivery in Germany.

This finding is consistent with the original UTAUT2 model, which states that performance expectancy is a strong predictor of behavioural intention in consumer technology acceptance (Venkatesh *et al.*, 2012). Additionally, Tamilmani *et al.* (2018b) found in their systematic review of UTAUT2 studies that performance expectancy is the strongest predictor of behavioural intention in a consumer context. Furthermore, several empirical consumer studies (i.e., context of SSTs and AVs) reviewed in this thesis are also in line with the positive result in this study: (1) SSTs (e.g., Slade *et al.*, 2015; Alalwan *et al.*, 2018b; Giovanis *et al.*, 2018; Chiu Helena *et al.*, 2010; Mehta *et al.*, 2019; Raza *et* *al.*, 2019; Arain *et al.*, 2019) and (2) AVs (e.g., Kervick *et al.*, 2015; Madigan *et al.*, 2017; Rahman *et al.*, 2017; Leicht *et al.*, 2018).

However, unlike in the original UTAUT study (Venkatesh *et al.*, 2003), in which information systems were investigated, in the final research model of this study performance expectancy had only the third strongest effect on behavioural intention, after overall trust in technology and price sensitivity. This shows that utilitarian benefits are not the most important aspect in acceptance formation; hence, overall trust in technology as well as price sensitivity are more important in the context of ADVs. Nevertheless, the strong results show that utilitarian benefits of ADVs are important to potential users of ADVs. Consistently, Meuter *et al.* (2005) argue that consumers might only adopt a certain technology if they understand their benefits. Therefore, utilitarian benefits need to be considered in the design of the vehicles as well as the mobile app and as such also promoted to the public (see subchapter 8.3.2).

7.3.1.2 Social Influence

Social influence in this study is defined as "the extent to which consumers perceive that important others (e.g., family and friends) believe they should use [ADVs]" as a delivery option (Venkatesh *et al.*, 2012, p. 159). In this study it was hypothesised that there is a positive and significant relationship between social influence and behavioural intention (H3). The statistical results of the final research model (i.e., ADV-AM) support H3 (β = 0.117; $p < 0.01$). Therefore, social influence positively affects behavioural intention to use ADVs in last-mile delivery in Germany, implying that potential users of ADVs are influenced by social pressure. Social influence has the fifth-strongest effect on behavioural intention in this study.

The importance of social influence is concurrent with the original UTAUT and UTAUT2 model (Venkatesh *et al.*, 2003; Venkatesh *et al.*, 2012) as well as the meta-analytical findings by Dwivedi *et al.* (2019). In addition, several consumer adoption studies reviewed in this thesis, for instance in the area of AVs (e.g., Adell, 2010; Madigan *et al.*, 2016; Madigan *et al.*, 2017; Rahman *et al.*, 2017; Leicht *et al.*, 2018) and in various SSTs contexts (e.g., Yu, 2012; Slade *et al.*, 2015; Giovanis *et al.*, 2018; Alalwan *et al.*, 2018a), also support the positive effect of social influence on behavioural intention. Therefore, this finding is not surprising and should be considered by marketers when developing market introduction strategies for ADVs. For details on the managerial implications please see subchapter 8.3.2.

7.3.1.3 Hedonic Motivation

In this study hedonic motivation is defined as the fun and pleasure that derives from using ADVs as a delivery option (Venkatesh *et al.*, 2012). Despite its proposed importance, hedonic motivation did not play a major role in the beginning of the technology acceptance research. Based on previous significant findings from information systems as well as consumer behaviour research (e.g., Childers *et al.*, 2001; van der Heijden, 2004), it was, however, included into the UTAUT2 model. Nevertheless, it is still one of the less researched constructs in UTAUT2 (Tamilmani *et al.*, 2019b).

In this study it was hypothesised that there is a positive and significant relationship between hedonic motivation and behavioural intention (H5). Following the statistical results of the ADV-AM in this study ($\beta = 0.118$; $p < 0.05$), this hypothesis could be supported. Indicating that the fun, entertainment, and pleasure derived from using ADVs as a delivery option plays a significant role in determining its acceptance. In other words, if ADVs are perceived to be entertaining and joyful, the acceptance of ADVs might very likely increase.

This finding is in line with the findings of the original UTAUT2 by Venkatesh *et al.* (2012). Additionally, it is also concurrent with several other consumer studies that have either utilised UTAUT2 and studied the effect of hedonic motivation (Alalwan *et al.*, 2016a; Alalwan *et al.*, 2017; Yahia *et al.*, 2018; Owusu Kwateng *et al.*, 2018; Alalwan *et al.*, 2018b; Madigan *et al.*, 2017; Raza *et al.*, 2019; Arain *et al.*, 2019) or utilised perceived enjoyment (Oghazi *et al.*, 2012; Demoulin and Djelassi, 2016; Saprikis *et al.*, 2018). It is worth mentioning that almost all studies reviewed in this thesis that have incorporated hedonic motivation or enjoyment found a positive significant effect on behavioural intention, which once again shows its importance in the field of user acceptance of new technologies. Therefore, enjoyment and fun aspects should be considered in the vehicle as well as the app development in the context of ADVs in last-mile delivery (see subchapter 8.3.2).

7.3.1.4 Price Sensitivity

Even though a price-related construct was included in UTAUT2 (i.e., price value), it was conceptualised as the perceived value of the product or service (Venkatesh *et al.*, 2012). In other words, it was used to investigate whether a product is reasonably priced or not (Tsai and LaRose, 2015). However, neither the price for the ADVs' deliveries nor the actual value was known by the participants in this study due to the infancy of ADVs. Therefore, it was not possible to investigate this construct without ending in speculative assumptions of potential users rather than valuable knowledge. Thus, price sensitivity was believed to be more reasonable to investigate at this stage.

Price sensitivity in this study is defined as "the way in which buyers react to prices and to price changes" (Goldsmith *et al.*, 2005, p. 501). As such, people who are highly price sensitive will seek lower prices, whereas people who are not that sensitive regarding the price will also consider higher-priced goods or services. In this study it was hypothesised that price sensitivity negatively and significantly influences behavioural intention. With the underlying statistical results of the final research model of this study ($\beta = - 0.211$; $p < 0.001$), it was possible to provide evidence for this hypothesis. Price sensitivity is the second-most important factor in acceptance formation in the context of ADVs and therefore plays an important role alongside overall trust in technology and performance expectancy. In other words, consumers are very likely not willing to pay more for this delivery option compared to its conventional alternative. As a result, it can be stated that deciding which delivery option to choose is based on an economic decision.

Despite the agreement that price sensitivity seems to be important (e.g., Goldsmith and Newell, 1997; Goldsmith *et al.*, 2005), it has been researched less in consumer adoption literature by utilising one of the existing technology acceptance theories (Tsai and LaRose, 2015). Even though some researchers investigated price sensitivity in the technology acceptance theory context, surprisingly, they could not prove a significant effect on behavioural intention (e.g., LaRose *et al.*, 2012; Dudenhöffer, 2013; Chen and Yan, 2018). For instance, in the context of electric cars in Germany, it has been argued that the price sensitivity of individuals does not influence behavioural intention (Dudenhöffer, 2013). In the context of environmentally friendly cars (i.e., electric cars), it could be argued that participants wanted to be perceived as environmentally friendly in society no matter the cost and therefore stated their answers regarding the price accordingly. This seems like a reasonable argument, especially when considering the low number of new registrations of electric vehicles in Germany compared to conventional cars (Kraftfahrtbundesamt, 2019).

Despite the negative findings, there is little doubt that people prefer to buy products that have the same function at a lower price. For instance, Tsai and LaRose (2015) included price sensitivity into the social cognitive theory (SCT) in the context of broadband internet adoption and found a significant negative effect on behavioural intention. Since there is little research on price sensitivity in the domain of technology acceptance, the findings of this study are of special importance not only for managers but also for theorists in the domain of technology acceptance (see subchapter 8.3).

7.3.1.5 Perceived Risk

Overall perceived risk in this study is defined as "the potential loss in the pursuit of a desired outcome" (Featherman and Pavlou, 2003, p. 454) of using ADVs as a delivery option. Therefore, if ADVs include high potential losses, this will very likely decrease user acceptance of ADVs in a last-mile delivery context. Thus, it has been hypothesised in this study that overall perceived risk negatively and significantly influences behavioural intention towards ADVs. The statistical results of the data analysis of the final research model in this study (β = - 0.072; $p < 0.05$) support this hypothesis. This significant effect might reflect respondents' unfamiliarity and inexperience with this particular technology (Koenig-Lewis *et al.*, 2010). Perceived risk is the construct that contributed the smallest effect in the proposed theoretical framework as well as the final research model to determine behavioural intention (i.e., user acceptance). Nevertheless, since the finding is significant it can be concluded that if the potential users' overall perceived risk of ADVs is high, the acceptance will be lowered. Additionally, since several participants stated in the open question that they believe ADVs are dangerous and risky, perceived risk should not be neglected in the context of ADVs in last-mile delivery.

This finding is in line with several other consumer studies that found a significant negative effect of perceived risk on behavioural intention and therefore were able to prove perceived risk as a detractor in the acceptance formation process (e.g., Lu *et al.*, 2009; Herrero Crespo and Rodriguez del Bosque, 2010; Slade *et al.*, 2015; Lee and Lyu, 2019). The small effect of perceived risk on behavioural intention might be due to the inclusion of trust in technology in this study. Since overall trust in technology was found to negatively influence overall perceived risk in this study, it can be argued that the perceived risk is reduced by the high level of trust in ADVs. In other words, the high level of trust in ADVs reduces the environmental uncertainties and related risk factors (see subchapter 7.3.1.6).

Additionally, due to the characteristics of ADVs, perceived risk was proposed to be a multidimensional construct in this study. As such, overall perceived risk was proposed to be determined by perceived performance risk (i.e., parcel drop-off) as well as perceived safety risk (i.e., driving autonomously on public roads). In other words, perceived performance risk and perceived safety risk were hypothesised to positively influence overall perceived risk. The statistical results for both hypotheses could be supported by the data gathered in this study. However, the strength of the effects is quite different. Perceived safety risk ($\beta = 0.658$; $p < 0.001$) shows a much higher effect than perceived performance risk ($\beta = 0.129$; $p < 0.001$), indicating that participants believe that the risk for accidents on public roads is higher than the risk of malfunctioning of the system during parcel drop-off. This finding is in line with the findings by Braun and Buckstegen (2017) and Marsden *et al.* (2018), who both found that risk is mainly related to the uncertainty of ADVs on public roads. Therefore, the aspect of safety risk is of special importance to marketers because focus needs to be drawn to the accurate driving function of ADVs (see subchapter 8.3.2).

Overall, both constructs together were able to explain 79 percent of the variance in overall perceived risk, which provides support for the decision that these two risk aspects are dominant in the area of ADVs, as proposed. In comparison to Jacoby and Kaplan (1972), who investigated five risk facets (i.e., financial, performance, physical/safety, psychological, and social risk) as determinants of overall perceived risk throughout twelve product categories (e.g., fashion items, toothpaste) and found that these five risk components could fairly well predict overall perceived risk in a range from 63 to 83 percent of the variance explained, this is a significant increase. Specifically, it is worth mentioning that within this study 79 percent of the variance in overall perceived risk could be explained by only two determinants, showing the high dominance of the selected risk facets in the context of ADVs.

These findings are of special importance for practitioners and theorists because the direct effects of perceived safety risk and perceived performance risk on overall perceived risk in the context of ADVs, or in its related areas of SSTs and AVs, have not been studied before (see subchapter 8.3). As such, these findings give a more detailed picture of the risk facets of ADVs. However, compared to the descriptive findings of Braun and Buckstegen (2017) and Marsden *et al.* (2018), who stated that ADVs involve great uncertainty when driving on public roads, the findings might not be that surprising. To sum it up, when people imagine ADVs as a delivery option, their highest risk concern is the autonomous driving function, when these vehicles drive autonomously on public roads, even though they are not actively involved, rather than the parcel drop-off process, when they are actively involved.

7.3.1.6 Trust in Technology

In this study the trust construct has been investigated as "trust in technology" and not "trust in a third party", which was the main focus of previous research (McKnight *et al.*, 2002). This decision was based on the fact that within the process of last-mile delivery the recipient interacts only with the technology (i.e., ADVs) due to the absence of a delivery person, who is present in the conventional delivery process. Therefore, overall trust in technology is defined as "the general tendency to be willing to depend on [ADVs]" as a delivery option (McKnight *et al.*, 2011, p. 127). Thus, it was proposed that when trust in technology increases, the acceptance of ADVs also increases. In other words, it was hypothesised in this study that overall trust in technology positively and significantly influences behavioural intention to use ADVs as a delivery option. The statistical result obtained from the final research model in this study confirms this hypothesis ($\beta = 0.242$; $p < 0.001$). Moreover, overall trust in technology was the strongest predictor of behavioural intention to use ADVs in this study. This indicates that despite the importance of other acceptance factors (e.g., price sensitivity and performance expectancy), overall trust in technology should receive the most attention because without trust the likelihood that potential users will use this delivery option will be very limited.

This strong effect of trust in technology is in line with previous studies that found a strong positive and significant effect of trust in technology on behavioural intention. For instance, Choi and Ji (2015) investigated the effect of trust in the context of AVs and found that the effect on behavioural intention was as strong as the effect of perceived usefulness on behavioural intention. In this context, Hegner *et al.* (2019) even found that trust in technology was the strongest predictor of adoption intention of autonomous vehicles. Moreover, Alalwan *et al.* (2017) investigated mobile banking as a self-service technology and found that trust is the strongest predictor of consumer acceptance. In addition to these examples, several other consumer studies could also provide evidence for the positive significant effect of trust in technology on behavioural intention (e.g., Panagiotopoulos and Dimitrakopoulos, 2018; Buckley *et al.*, 2018; Kaushik and Rahman, 2015a; Tarhini *et al.*, 2019).

Additionally, in this study, overall trust in technology was investigated as a multidimensional construct. As such, it was proposed that street performance and parcel drop-off performance positively and significantly influence overall trust in technology. The statistical results obtained in this study support these hypotheses. Unlike the effects of the multidimensional constructs in overall perceived risk, both constructs in the trust construct had similar positive and significant effects. In the case of street performance, the effect was $\beta = 0.435$ ($p < 0.001$), whereas in the case of parcel drop-off performance the effect on overall trust in technology was $\beta = 0.511$ ($p < 0.001$). Therefore, it can be concluded that the participants in this study trusted the performance during parcel drop-off to a slight extent more than the performance of the vehicles when driving autonomously on public roads. This finding is concurrent with the findings of Choi and Ji (2015) in the context of AVs, who found that technical competence, which is defined as the technology performance, is a major determinant of trust in technology.

Despite the fact that it has been found important in one previous study, this study is the first that has investigated two different facets of trust in technology in the area of ADVs for last-mile delivery. Moreover, due to the high variance explained in overall trust in technology (82 percent), it can be concluded that these two determinants are the main trust facets in the context of ADVs. Therefore, the findings shed much light into the overall trust factor in this area and are therefore of special importance to practitioners and theorists alike (see subchapter 8.3).

In addition to the direct effects of overall trust in technology and overall perceived risk on behavioural intention, this study also investigated the effect of overall trust in technology on overall perceived risk. In doing so, it was hypothesised that overall trust in technology negatively and significantly influences overall perceived risk (H8d). The statistical results provide evidence that this effect is negative and significant ($\beta = -0.247$; $p < 0.001$). As argued before, this is in line with the small effect of overall perceived risk on behavioural intention found in this study due to the trust level regarding ADVs. In other words, the high level of trust in ADVs reduces the environmental uncertainties and related risk factors in the context of ADVs. This finding is concurrent with other consumer studies that investigated the effect of trust on perceived risk (e.g., Koenig-Lewis *et al.*, 2010; Slade *et al.*, 2015; Pavlou, 2003; Choi and Ji, 2015).

7.3.1.7 Innovativeness

In this study, innovativeness has been defined as the willingness to try out ADVs as a delivery option. It is worth mentioning that despite the importance of individual differences in innovativeness, no dominant technology acceptance model has incorporated this construct (Agarwal and Prasad, 1998; Slade *et al.*, 2015). In this study, innovativeness was incorporated alongside the original UTAUT2 constructs and as such made the research model more applicable to the context of innovations. It was hypothesised that innovativeness positively and significantly influences behavioural intention to use ADVs. The statistical results obtained within this study confirm this hypothesis. The standardised regression weight from innovativeness to behavioural intention in the final research model was $\beta = 0.175$ ($p < 0.001$), indicating a strong effect of innovativeness on behavioural intention (i.e., user acceptance). This indicates that individual characteristics neglected in previous acceptance theories are an important consideration in the context of ADVs. In other words, consumers with a high level of innovativeness are more willing to accept new technologies like ADVs. Innovativeness has the fourth-largest effect on behavioural intention in this study and is therefore more important than some of the original UTAUT2 constructs like hedonic motivation or social influence.

This positive and significant finding replicated the results from several previous studies in the area of consumer research (Parasuraman, 2000; Agarwal and Prasad, 1998; Midgley and Dowling, 1978) and in particular in the related areas of SSTs and AVs. For instance, Slade *et al.* (2015), Dimitriadis and Kyrezis (2010) and Giovanis *et al.* (2018) investigated the effect of innovativeness in the context of SSTs (i.e., m-payments, m-banking) and found positive significant effects on behavioural intention. In the context of AVs, Chen and Yan (2018) and Hegner *et al.* (2019) were also able to identify a positive significant relationship. Within a logistical background, Chen *et al.* (2018) investigated self-service parcel delivery services (i.e., automated parcel lockers) and also found that innovativeness has a strong positive relationship to behavioural intention. Additionally, Marsden *et al.* (2018) found that ADVs are considered an innovative delivery option, and in accordance with the theory of innovation and diffusion by Rogers (2003), early adopters will very likely be more innovative.

7.3.2 Insignificant Constructs

After discussing the final research model (ADV-AM) results in regard to previous literature, in the following two subchapters the insignificant constructs (i.e., effort expectancy and facilitating conditions) will be discussed based on the findings from the theoretically developed research framework with respect to the existing literature in the areas of consumer acceptance and in particular SSTs and AVs.

7.3.2.1 Effort Expectancy

In this study, effort expectancy is defined as “the degree of ease associated with consumers’ use” of ADVs for delivering parcels to their doorstep (Venkatesh *et al.*, 2012, p. 159). This includes the higher complexity in the delivery process for the recipient since he/she has to communicate via a mobile app with the delivery service provider to set the time and date for delivery as well as with the delivery vehicle during parcel drop-off (e.g., connecting the smartphone to the vehicle). In this study, it has been hypothesised that there is a positive and significant relationship between effort expectancy and behavioural intention (H2). However, the statistical results of the theoretically developed research framework revealed that this relationship could not be proven in the context of ADVs in last-mile delivery in the German context (β = - 0.069; not significant). Therefore, H2 was rejected.

Despite the fact that effort expectancy has been proven to be influential in the organisational environment (Venkatesh *et al.*, 2003) or even in the consumer context (Venkatesh *et al.*, 2012), there are also findings from previous studies in a consumer context (i.e., SSTs and AVs) where effort expectancy/ease of use was not found to be significant, which is in line with the finding in this study (Alalwan *et al.*, 2016b; Hur *et* *al.*, 2017; Yuen *et al.*, 2018; Slade *et al.*, 2015; Rahman *et al.*, 2018; Madigan *et al.*, 2017; Chiu and Hofer, 2015; Hegner *et al.*, 2019; Arain *et al.*, 2019; Tarhini *et al.*, 2019).

Alalwan *et al.* (2016b) argue that the insignificant effect might be due to the full-mediation found of effort expectancy through performance expectancy on behavioural intention. Thus, the direct effect of effort expectancy on behavioural intention disappeared. In other words, if a consumer believes that a certain technology is easy to use and less effort is involved, they will perceive it as more beneficial and useful in their life (Davis *et al.*, 1989). In a similar manner, Madigan *et al.* (2017) argue in the context of autonomous shuttles that the insignificant finding of effort expectancy on behavioural intention might be due to the similarity between using autonomous shuttles and conventional public transportation. Thus, the use of the system is easy and did not require any new skills or expertise. These arguments are also in line with the argument by Yuen *et al.* (2018), who postulate that the insignificant effect of complexity (captured in effort expectancy) on behavioural intention might be due to the overall simplicity of parcel self-collection services. Therefore, they argue that if the system is obviously simple, there is no effect on behavioural intention. A similar but distinct reason for the insignificance of effort expectancy on behavioural intention is presented by Slade *et al.* (2015). They postulate that the insignificance is due to the ubiquity of mobile phone technology. In this context, Chong (2013) states that the insignificance of ease of use is related to the familiarity of the investigated technology. Indeed, it has been suggested that the effect of ease of use decreases over time, as users become more knowledgeable with a specific technology (Venkatesh, 2000).

In the case of ADVs, it was argued that the delivery process is completely different from the conventional delivery process in that the recipient has to take on greater tasks to have their parcel delivered. For instance, they have to set a timeslot via a mobile app and connect their smartphone to the vehicle via Bluetooth. Therefore, it was believed that the complexity for the recipient increases. However, the use of ADVs is to a large extent operated via a smartphone and a mobile app. Since the majority of participants in this study stated that they are experienced and familiar with mobile apps (e.g., Facebook app, online banking apps, Amazon app), the use of smartphones and mobile apps does not seem to be effortful for them in regard to ADVs. Thus, this might provide a reasonable argument that effort expectancy is not a significant predictor of ADV adoption. However, it needs to be considered that ADVs are not regularly available on the delivery market in

Germany yet. Therefore, participants of this study were mainly inexperienced with ADVs, and based the perceived complexity of the mobile app to interact with ADVs on their experience with other mobile apps like Facebook or Amazon. However, according to Xu *et al.* (2018), the effect of effort expectancy on behavioural intention might change after people had their first experience with the technology. For the case of ADVs, this means that effort expectancy might be significant only for people who had already experienced ADVs. Therefore, it is recommended in future studies to differentiate between nonusers and actual users and further investigate the effects of effort expectancy on behavioural intention (see subchapter 8.5).

7.3.2.2 Facilitating Conditions

Facilitating conditions in this study are defined as "consumers' perceptions of the resources and support available" to use ADVs as a delivery option (Venkatesh *et al.*, 2012, p. 159). As suggested by Venkatesh *et al.* (2012), the term facilitating conditions in a consumer context is used like perceived behavioural control in the theory of planned behaviour (Ajzen, 1991). As such, it was hypothesised in this study that there is a positive and significant relationship between facilitating conditions and behavioural intention (H4). The statistical results of the theoretically developed research framework, however, could not provide support for this hypothesis ($\beta = 0.042$; not significant) and therefore it was rejected. This indicates that facilitating conditions do not influence users' behavioural intention of ADVs as a delivery option in the German context.

Interestingly, this finding contradicts the findings of Venkatesh *et al.* (2012) as well as the meta-analytical findings by Dwivedi *et al.* (2019), who were able to identify that facilitating conditions play a major role in a consumer context. Also, in the specific case of AVs, Madigan *et al.* (2017) were able to provide empirical evidence of the importance of facilitating conditions on behavioural intention. However, there are also several consumer studies that could not find a significant effect of facilitating conditions (e.g., Farah *et al.*, 2018; Arain *et al.*, 2019) or perceived behavioural control (e.g., Herrero Crespo and Rodriguez del Bosque, 2010; Wu *et al.*, 2014) on behavioural intention, which is in line with the findings of this study.

Farah *et al.* (2018) argue that the insignificance of facilitating conditions on behavioural intention might be due to the presence of effort expectancy. In this context, it has been argued that issues related to the supporting infrastructure (i.e., external control), which is a key concept in facilitating conditions, are also largely captured in effort expectancy because it taps into the ease of use of a certain system. This argument is in line with the findings by Venkatesh (2000) who was able to identify a full-mediating effect of facilitating conditions (i.e., external control) through effort expectancy. In other words, it is argued that if both constructs, effort expectancy and facilitating conditions, are present, facilitating conditions becomes insignificant on behavioural intention (Venkatesh *et al.*, 2003). However, this argument is not applicable to the finding in this study because both effort expectancy and facilitating conditions could not be proven significant, which is in line with other previous consumer studies (e.g., Chiu and Hofer, 2015; Arain *et al.*, 2019).

Herrero Crespo and Rodriguez del Bosque (2010) postulate that the insignificance of perceived behavioural control (captured in facilitating conditions) on behavioural intention might be due to the high average control perceived in e-commerce. In other words, if users believe that they have all the resources necessary to use a certain technology, then the effect of facilitating conditions might be insignificant. However, the fact that users believe that they are able and fully equipped to operate a certain technology is not a source of motivation in itself and does not automatically mean that they want to use the system (Herrero Crespo and Rodriguez del Bosque, 2010).

In the case of ADVs, it was argued that people need special resources to use ADVs as a delivery option compared to the conventional delivery process. In particular, smartphones were mentioned as necessary devices for authorisation and for opening the parcel locker of the delivery vehicle. The average rating (i.e., mean) for facilitating conditions was 4.95 in this study. As such, on average, participants believed that they have the necessary resources (e.g., mobile device, knowledge, peer support) available to use this kind of delivery system. Therefore, this provides a reasonable argument for the insignificance of the relationship in this study and is in line with the argument from Herrero Crespo and Rodriguez del Bosque (2010). However, as stated before, it needs to be considered that participants were mainly inexperienced with the use of ADVs and therefore the effect of facilitating conditions might change after the participants had their first real experience with ADVs. This would be in line with the findings of Wu *et al.* (2014), who investigated a SST and found that perceived behavioural control was only significant among actual users, whereas for potential users it was not. Therefore, future research should take this into consideration and investigate the difference between actual and nonusers of ADVs (see subchapter 8.5).

7.3.3 Applicability of UTAUT2 in the Context of ADVs

Within this thesis, it has been found that no theoretical model has been applied to investigate the behavioural components and relationships to determine user acceptance in the context of user acceptance of ADVs. Therefore, the UTAUT2 was applied as the baseline model in this study. This decision was based on the fact that UTAUT2 is the most comprehensive model in the technology acceptance area, since it incorporates most of the relevant pre-existing theories and models in the domain of technology acceptance into one unified theory. In addition UTAUT2 is unlike other technology acceptance theories explicitly developed for consumer contexts by considering consumer-relevant constructs like price value and hedonic motivation (Venkatesh *et al.*, 2012). Furthermore, UTAUT2 is relatively new and has not reached a relative level of maturity compared to other technology acceptance theories and models (Slade *et al.*, 2013). Following these arguments, utilising UTAUT2 in this study as a starting point seemed theoretically and practically useful.

However, to fit UTAUT2 to the context of ADVs for last-mile delivery, the model was modified and extended. In doing so, habit was excluded, and price value was modified to price sensitivity. Additionally, overall perceived risk, overall trust in technology, and innovativeness were incorporated. Moreover, perceived performance risk, and perceived safety risk were proposed to influence overall perceived risk; and parcel drop-off performance and street performance were proposed to influence overall trust in technology (see chapter 3).

Following the results of this study, further support for some of the UTAUT2 constructs in the context of ADVs is provided, which shows that the model is partially applicable to the context of last-mile delivery at the current stage of research (i.e., developing stage of ADVs). In particular, performance expectancy, hedonic motivation and social influence were found to be significant in the context of ADVs. However, compared to the original UTAUT2, which comprises seven constructs (i.e., performance expectancy, effort expectancy, social influence, facilitating conditions, hedonic motivations, price value, habit), this study revealed that only three out of seven constructs are applicable in the context of ADVs at the current stage of technology development (i.e., prototype stage). Constructs like habit and price value, for instance, can only be investigated in future studies when ADVs are already introduced on a broader scale to the market of last-mile delivery.

The additional proposed effects of overall perceived risk, overall trust in technology, and innovativeness, as well as modification of price value to price sensitivity were found to also play an important role in affecting nonusers' behavioural intention to use ADVs. In more detail, overall trust in technology was found to be the strongest factor in influencing behavioural intention in the context of ADVs. Performance expectancy was the only original construct that was found to be more important than overall perceived risk, and innovativeness, whereas the effects of social influence and hedonic motivations on behavioural intention were smaller. These results echo the importance of adapting technology acceptance models to the specific context and in particular to a consumer context. Overall, this shows that the UTAUT2 in its original form is only to some extent applicable to the context of ADVs at present and it was the correct decision to modify and extend the original UTAUT2 to the underlying context.

In this regard, however, it needs to be considered that UTAUT2 is due to its comprehensiveness more complex than other theories and models used to investigate technology acceptance (e.g., technology acceptance model or theory of planned behaviour). Applying this comprehensive model, the aim of this study was to draw a broad picture of users' acceptance of ADVs in last-mile delivery, which might not be possible to draw with a simpler model like the technology acceptance model (TAM). However, as mentioned before, the results show that some of the UTAUT2 constructs were not applicable in the underlying context (i.e., habit and price value) and some were found insignificant (i.e., effort expectancy and facilitating conditions) in this study. Therefore, further research might also use simpler models (e.g., TAM) as a starting point to investigate user acceptance of ADVs and incorporate price sensitivity, trust in technology, perceived risk, and innovativeness, which were found to play a major role in acceptance formation in this study. In addition to these constructs there might also be other constructs, like perceived job loss, that have been identified in the open-ended question in this study that are worth investigation (see subchapter 8.5). Then, the findings can be compared, and the decision of the applicability of certain baseline theory or model can be evaluated more comprehensively in future studies.

7.1 Conclusion

This chapter discussed the findings of this research project in detail related to the research question, the developed and verified research model (ADV-AM), as well as the related literature. It showed that only some of the original UTAUT2 constructs are applicable to the context of ADVs. What is more, the new proposed constructs – overall perceived risk, overall trust in technology and innovativeness – as well as the modified construct – price sensitivity – were highly important in the ADVs context, which shows the need to tailor existing technology acceptance models to the specific research context. Due to the insignificant effects as well as the exclusion of some constructs from UTAUT2 in this study, it can be stated that the original UTAUT2 model is only to some extent applicable to the context of user acceptance of ADVs at the current developmental stage and current market introduction, and additional constructs should be considered.

Chapter 8: Conclusions

8.1 Introduction

Within this last chapter of the thesis the research project will be summarised. Throughout this summary, it will clearly be stated through which process the research objectives were fulfilled. Next, the research contributions, which are divided into theoretical contributions and managerial implications, will be outlined. This will be followed by the research limitations and recommendations for further research.

8.2 Summary of the Research Study and Findings

The enormous B2C e-commerce growth in Germany, and with it the increasing transportation volume, leads to a higher number of delivery vehicles in residential areas (Weltevreden, 2008; Liu *et al.*, 2019a). This development imposes a variety of negative externalities (e.g., road congestion and air pollution). In turn, these negative externalities have a direct impact on the quality of life as well as traffic safety (Savelsbergh and van Woensel, 2016). Therefore, governments try to limit the negative effects with traffic restrictions, which negatively influence delivery activities (e.g., low emission zone) (Dablanc and Montenon, 2015; Schönberg *et al.*, 2018). Alongside these challenges, logistics service providers are nowadays also faced with evermore customer demands (i.e., faster delivery, flexible changes, more environmentally friendly operation, etc.) (Florio *et al.*, 2018; Vakulenko *et al.*, 2019).

Since current delivery practices (i.e., van delivery) do not seem to be able to cope with this fast-changing environment efficiently, a realignment of the delivery practices as well as the development of new delivery practices is indispensable (Joerss *et al.*, 2016; Marsden *et al.*, 2018; Florio *et al.*, 2018). Especially, ADVs were identified to be able to revolutionise last-mile delivery (Marsden *et al.*, 2018; Joerss *et al.*, 2016). ADVs in this thesis were defined as electric and self-driving ground vehicles that make the overall last-mile transportation process more efficient (e.g., decreasing transportation costs), more sustainable (e.g., free of local CO_2 emissions) and more customer-focused (e.g., more flexible) (Joerss *et al.*, 2016; Marsden *et al.*, 2018; Schröder *et al.*, 2018). Therefore, ADVs are believed to be a good compromise between efficiency, sustainability, and customer convenience in the context of last-mile delivery. As a result, ADVs have the potential to compete with existing delivery practices in the near future (Joerss *et al.*, 2016; Schröder *et al.*, 2018; Marsden *et al.*, 2018). However, as with other technological developments the feasibility should always be balanced against the customer perceptions as well as their behavioural responses (Collier and Kimes, 2012). In other words, even though ADVs might be technically able to contribute to last-mile efficiency, the successful implementation of ADVs cannot be realised unless end-consumers accept the innovative service concept for home delivery.

At present, little research exists on the acceptance of innovative last-mile delivery solutions and in particular on the acceptance of ADVs for last-mile delivery. Therefore, the key factors that motivate consumers to adopt ADVs remained to be explored. Thus, it was of interest in this thesis to fill this knowledge gap and identify the factors that affect user acceptance of ADVs for last-mile delivery in Germany. Moreover, little theory-based research in the logistics literature exists (Grawe, 2009). As such, to the best of my knowledge, this research study, alongside the publications derived from this thesis (Kapser and Abdelrahman, 2019, in press, in review), is the first that investigated user acceptance of ADVs empirically by utilising an acceptance model to investigate the behavioural components. This study utilised the UTAUT2 as a baseline model and modified as well as expanded it to the specific context of ADVs in last-mile delivery to investigate user acceptance. In doing so, it was aimed to encompass the most important factors that positively or negative influence user acceptance (i.e., behavioural intention) of ADVs. In particular, this study was designed to answer the following research question:

"What are the factors that affect user acceptance of autonomous delivery vehicles (ADVs) in last-mile delivery in Germany?"

To answer this research question comprehensively, the research was aimed to fulfil three objectives, which were outlined in subchapter 1.2. All objectives were fulfilled comprehensively in this thesis. Figure 8.1 on the following page shows a holistic view of this research study. In this study UTAUT2 is applied as a foundation. Additionally, acceptance research from from the areas of autonomous vehicles (AVs) and self-service technologies (SSTs) are synthesised to develop the "Autonomous Delivery Vehicle Acceptance Model", which could be empirically validated in this study.

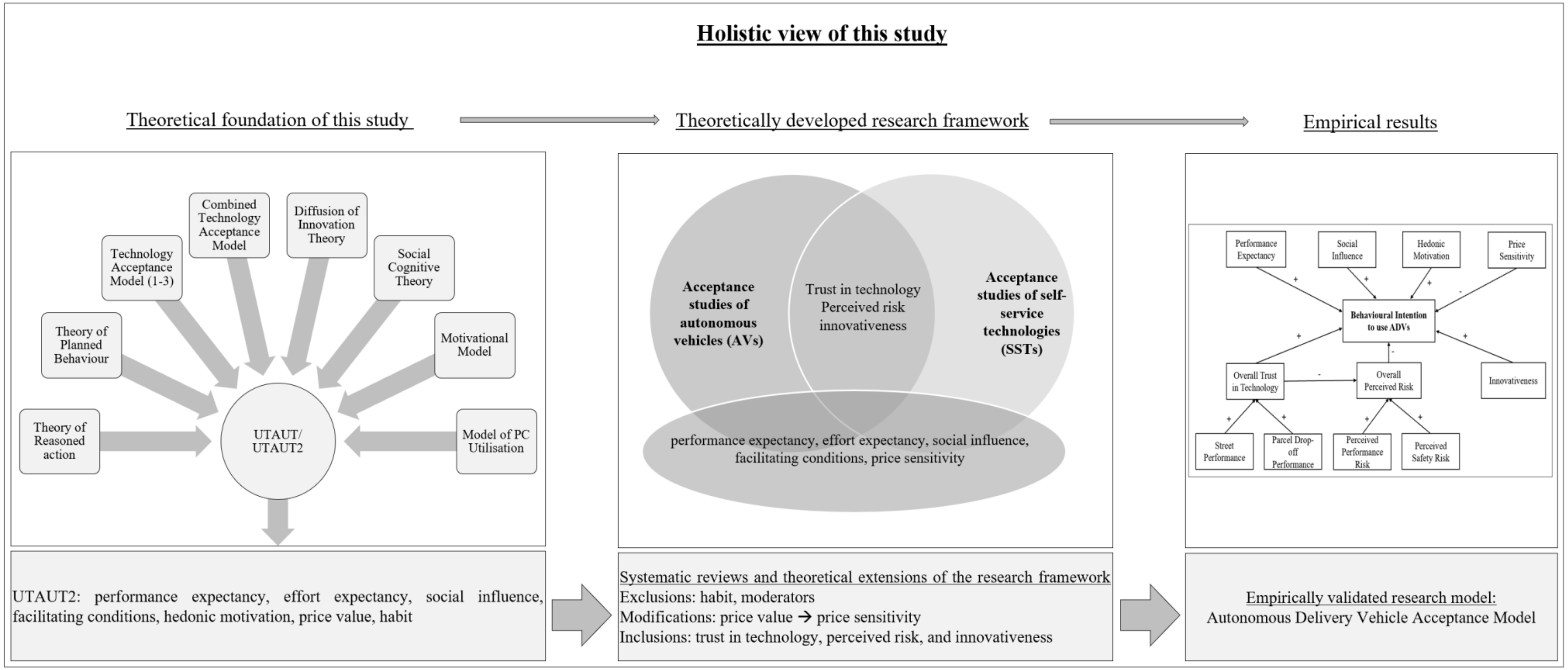

Figure 8.1: Holistic View of This Study

In the following, it will be presented and explained in greater detail how the research objectives were fulfilled.

Objective 1: Determining the factors that positively or negatively influence user acceptance of ADVs in last-mile delivery

First, since a limited amount of literature was available in the context of ADVs, the framework development was based on systematic literature reviews in closely related research areas, namely SSTs and AVs. Through the systematic literature reviews, it was possible to identify additional important factors that were proposed to influence behavioural intention (BI) in the context of ADVs in last-mile delivery. Thus, it was possible to extend and modify UTAUT2 in this study to the underlying research context. In doing so, overall perceived risk (PR_O), overall trust in technology (TT_O), as well as innovativeness (INO) were identified to be of additional importance in the area of ADVs, alongside the UTAUT2 constructs.

Despite the fact that perceived risk as well as trust in technology have mainly been studied as a unidimensional construct in previous studies, these constructs were, due to the characteristics of ADVs (i.e., driving autonomously on public roads and dropping off parcels at their final destination), studied as multidimensional constructs in this thesis. Overall perceived risk (PR_O) was proposed to be determined by perceived safety risk (PR_SR) and perceived performance risk (PR_PR), whereas trust in technology (TT_O) was proposed to be determined by street performance (TT_S) and parcel drop-off performance (TT_P). As such, it was possible to investigate both main characteristics of ADVs and therefore create a more detailed understanding of the facets of trust in technology as well as perceived risk in the context of user acceptance of ADVs in last-mile delivery.

Second, due to the newness of ADVs and the fact that ADVs are still in their developing and testing stage, the knowledge and experience of the participants in this study was generally considered low. Therefore, it was not possible to investigate habit in this study, which was originally used in UTAUT2. Moreover, this study focused on behavioural intention as the main dependent construct and use behaviour was excluded. This was based on the fact that ADVs are not yet available as a regular delivery option in Germany. Furthermore, since the participants in this study had very little or no experience with ADVs, it was also not possible to investigate price value. This was based on the fact that the price as well as the actual value needs to be known beforehand. Therefore, price value was modified to price sensitivity, which is more related to the reaction to price changes (see subchapter 3.3.1.1). In this regard, Germans are in general more price sensitive than other nations (OC & C Strategy Consultants, 2012), therefore, it was important to study a price-related construct in this study.

To sum it up, through the review of literature in the area of technology acceptance in general and in particular through the structured literature reviews in the overlapping research areas of SSTs and AVs, it was possible to fulfil the first objective and theoretically identify the most important constructs that might determine user acceptance in the context of ADVs in last-mile delivery (see Figure 8.2 on the following page).

Objective 2: Developing a theoretical framework that describes the relationships between the factors and user acceptance of ADVs in last-mile delivery

In addition to the identification of the most important constructs that determine user acceptance in the context of ADVs in last-mile delivery, it was also possible to describe the relationships between the proposed constructs in a theoretical framework mainly based on the UTAUT2 but also on other previous literature. As such, the second objective was also fulfilled.

Up to this stage, this research was purely theoretical in nature by considering previous findings from the areas of technology acceptance of ADVs, SSTs, and AVs. The final theoretical framework (see Figure 8.2 on the following page) encompassed nine direct determinants of behavioural intention (i.e., performance expectancy, effort expectancy, social influence, facilitating conditions, hedonic motivation, price sensitivity, overall perceived risk, and overall trust in technology) and four determinants that determine behavioural intention indirectly through overall trust in technology (i.e., street performance, parcel drop-off performance) and overall perceived risk (i.e., perceived performance risk, perceived safety risk). Additionally, trust in technology was proposed to negatively influence perceived risk.

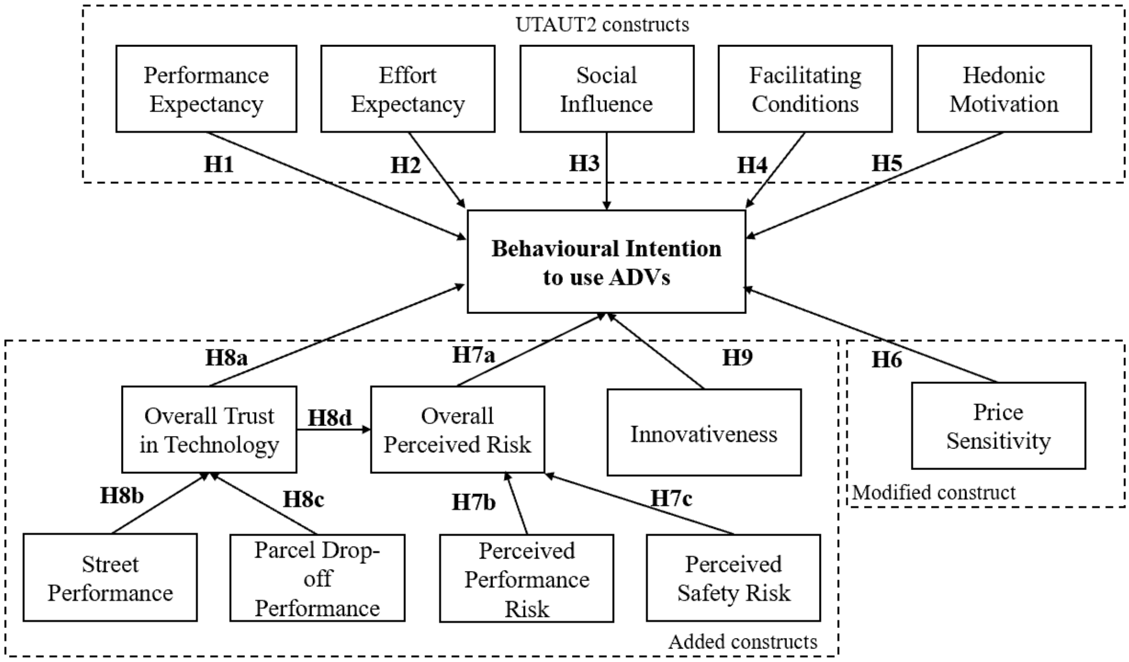

Figure 8.2: Hypothesised Theoretical Framework

Objective 3: Empirically test the validity of the theoretical framework in Germany

In a next step, the theoretically developed framework was tested empirically in Germany and in doing so, the third objective was fulfilled. The empirical study was conducted through an online self-administered questionnaire via Qualtrics. In this study, 501 people completed the survey (conversion rate[9] of 47 percent). Thus, 501 datasets could be used for data analysis. Since this study aimed to be approximately representative of the German population, three quotas were set that represent the German population (i.e., age, gender, monthly household net-income). Considering the quotas set, the 501 datasets were able to represent the German population. The data was analysed using structural equation modelling (SEM) with AMOS (Analysis of Mean and Covariance Structures). In doing so, the hypotheses including the structural paths of the proposed hypothesised framework, were assessed. This assessment revealed that twelve out of fourteen hypotheses were supported. In other words, the theoretically developed framework could be proven with a caveat for two paths.

[9] Conversion rate = how many people completed the survey vs. how many people accessed it.

In addition to the empirical testing of the theoretically developed research framework, the framework was re-estimated again after dropping the insignificant constructs (i.e., effort expectancy and facilitating conditions). As a result, all constructs were found significant and the "***Autonomous Delivery Vehicle Acceptance Model"*** was developed (see Figure 8.3 below, which also includes the positive/negative path labels) that can also be used for further investigations of user acceptance of ADVs in other countries.

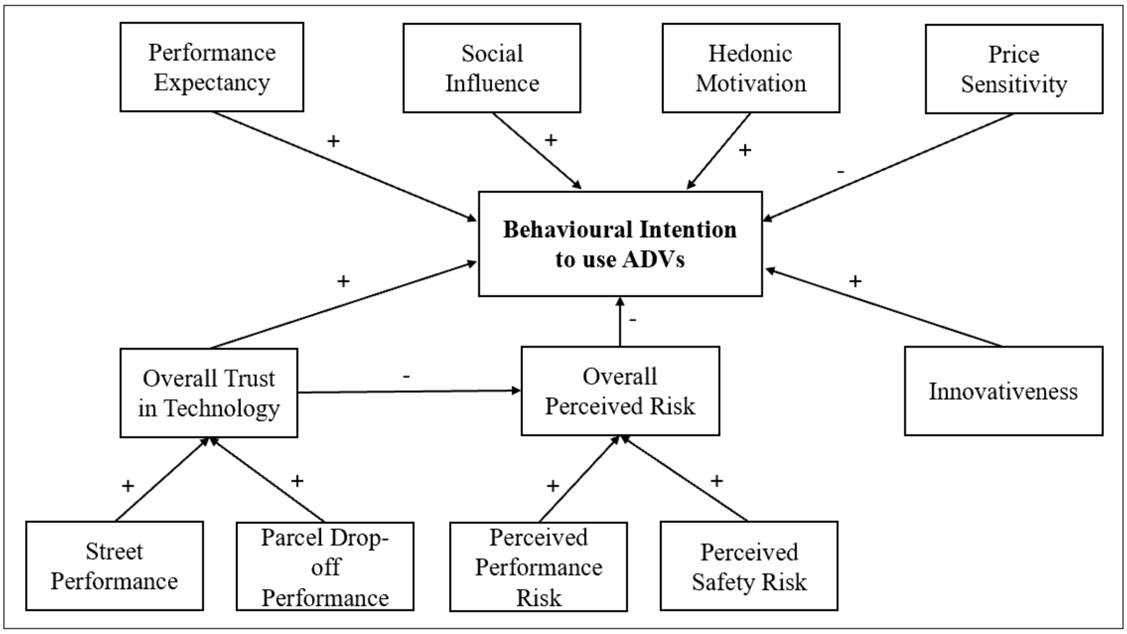

Figure 8.3: Autonomous Delivery Vehicle Acceptance Model (ADV-AM)

This research has provided further evidence for some of the UTAUT2 constructs in a new consumer technology context (i.e., autonomous delivery vehicles for last-mile delivery). Overall trust in technology ($\beta = 0.242$; $p < 0.001$) was the strongest predictor of behavioural intention in the Autonomous Delivery Vehicle Acceptance Model, followed by price sensitivity ($\beta = - 0.211$; $p < 0.001$), performance expectancy ($\beta = 0.199$; $p < 0.001$), innovativeness ($\beta = 0.175$; $p < 0.001$), hedonic motivation ($\beta = 0.118$; $p < 0.05$), social influence ($\beta = 0.117$; $p < 0.01$), and overall perceived risk ($\beta = - 0.072$; $p < 0.05$). The large effects of trust in technology, price sensitivity, and innovativeness on behavioural intentions in the context of ADVs shows the importance of tailoring technology adoption models to their underlying context. Additionally, the effects of perceived safety risk ($\beta = 0.658$; $p < 0.001$) and perceived performance risk ($\beta = 0.129$; $p < 0.001$) were proved to play an important role in determining overall perceived risk. The same is true for the constructs of trust in technology street performance ($\beta = 0.435$; $p < 0.001$) and trust in technology parcel drop-off performance ($\beta = 0.511$; $p < 0.001$). Overall, this study was able to explain 80 percent of the variance in behavioural intention by adopting and extending the UTAUT2 to the context of ADVs.

To sum it up, this study is the first that investigated user acceptance of ADVs by utilising a technology acceptance model (UTAUT2 in this study) and gives first insights into the behavioural components and their relationships in the context of ADVs for last-mile delivery in Germany.

8.3 Contributions and Implications

This study is an important effort towards a deeper understanding of the factors that affect the user acceptance of ADVs for last-mile delivery in Germany. Therefore, this study enriched not only the academic literature in the fields of technology acceptance and logistics innovations but also provides guidance for vehicle developers, marketers and logistics service providers on how to develop, promote, and market ADVs in a successful manner. Within the following subsections, the research contributions, which are divided into theoretical contributions and managerial implications, will be presented.

8.3.1 Theoretical Contributions

This study has several theoretical contributions to the body of literature in technology acceptance, in logistics innovation management as well as in the field of autonomous vehicles. In particular, it contributes to the limited literature available of user acceptance of last-mile delivery innovations – in this study, ADVs – by utilising a theoretically developed and verified research model, which can be used to investigate user acceptance of ADVs. These will be presented in the following.

(1) Utilising the UTAUT2 model in a new context

This is the first study that utilises UTAUT2 as a baseline model not only in the broader context of logistics innovations but also in the specific context ADVs for last-mile delivery. In more detail, this study is the first that investigates, through UTAUT2, the factors that influence an individual's behavioural intention to use ADVs as a delivery service. In other words, this study contributes to the literature by examining the viability and validity of the UTAUT2 model in the context of logistical innovations from a customer perspective, which has mainly been neglected in the logistical innovation literature. The findings show that UTAUT2 is to some extent applicable to investigate user acceptance of ADVs in last-mile delivery. Hence, this study has broadened the applicability of some of the UTAUT2 constructs to a new business context (i.e., logistics innovation management) as well as to a new technological context (i.e., ADVs).

(2) *Modifying and extending the UTAUT2 model to the context of ADVs*

This study also enriches the literature by introducing a modified and extended UTAUT2, which is mainly based on systematic literature reviews in two related research areas (i.e., SSTs and AVs). First, this study is the first that investigates the effects of overall perceived risk, overall trust in technology, and innovativeness on behavioural intention in the specific domain of ADVs for last-mile delivery. As a result, it was possible in this study to provide evidence for the applicability of these constructs in the domain of last-mile delivery and in particular in the specific context of ADVs.

Second, perceived risk and trust in technology have often been studied as unidimensional constructs, whereas this study investigates both aspects multidimensionally and by doing so investigates these constructs from two different angles: SSTs (i.e., parcel drop-off) as well as AVs (i.e., driving autonomously). Thus, this study is the first that sheds light on the constructs of risk and trust in the field of technological innovations in a logistical context and in particular ADVs in last-mile delivery. In more detail, this study found that overall perceived risk is directly determined by perceived safety risk and perceived performance risk, and overall trust in technology is determined by street performance and parcel drop-off performance. Since both constructs explained 82 and 79 percent of the variance in overall perceived risk and overall trust in technology, respectively, it can be concluded with confidence that this study investigated the most important antecedents of perceived risk and trust in technology in the context of ADVs.

Third, within this study, price value was modified to price sensitivity to be able to study a price-related factor at the current stage of technological development (see subchapter 3.3.1.1). As such, this study is the first that investigates and provides evidence for price sensitivity in the context of ADVs for last-mile delivery. Moreover, this study is also the first that investigates price sensitivity in the UTAUT2 context. As such, the findings of this study also provide evidence that price sensitivity can be used as a price-related factor in technology acceptance studies. Hence, it is recommended to include price sensitivity as a price-related factor in technology acceptance models, especially when the technology has not been introduced to the market to investigate whether price is a relevant setscrew in the domain of technology acceptance.

Overall, it can be concluded that the model modifications and extensions clearly broaden the applicability of UTAUT2 to the context of ADVs in last-mile delivery. In other words, the extended and modified UTAUT2 (i.e., Autonomous Delivery Vehicle Acceptance Model) is a suitable theoretical lens and provides a better understanding towards consumers' decision-making processes concerning the selection of last-mile delivery services.

(3) Contribution to the research field of autonomous vehicles (AVs)

Alongside the theoretical contributions to the field of ADVs in last-mile delivery, this research also made a major contribution to the field of autonomous vehicles (AVs). As such, this study is among the first that investigates autonomous vehicles from an outside perspective (i.e., neither the driver nor passenger perspective), which has been studied only minorly before (Hulse *et al.*, 2018). In particular, perceived safety risk (i.e., autonomous driving function) and street performance (i.e., trust in autonomous driving function) might also be of relevance for the acceptance of other autonomous vehicles (e.g., cars or buses). Therefore, these constructs can also be used in further research for investigating the determinants of user acceptance of other AVs from an outside perspective.

(4) Methodological perspective

From a methodological point of view, to the best of my knowledge, this study is the first that applies and provides evidence for the UTAUT2 constructs as well as the "Autonomous Delivery Vehicle Acceptance Model" in the cultural context of Germany. As such, the German questionnaire version, which was developed through a backwards translation process, can be used for further investigation of UTAUT2 and the "Autonomous Delivery Vehicle Acceptance Model" in German-speaking countries (e.g., Austria or Switzerland).

Furthermore, most UTAUT2 studies reviewed in this thesis have investigated the model by applying convenience sampling (often sampling only students), which made it impossible to generalise to a broader population. Since this study applied quota sampling, it is outstanding compared to previous UTAUT2 studies. In this study, the results are partially generalisable to the German population in terms of age, gender, and monthly household net-income. Thus, it is possible with these findings to draw broader conclusions about the German population. Hence, the findings of this study are of real value for logistics service providers, vehicle developers, designers, and marketers, which will be presented in the following.

8.3.2 Managerial Implications

Alongside the theoretical contributions, this study also has a number of managerial implications. As mentioned before, this study combined the literature from two distinct but related and overlapping research fields of ADVs, and by doing so, conceptualised the end-consumers' behavioural intention of ADVs in the domain of last-mile delivery, which has not been studied before. Understanding the customer perspective in the field of last-mile delivery is highly important not only due to the active involvement of the recipient during parcel drop-off but also because of the competitiveness within the field of last-mile delivery. Therefore, this study answers the call from Deutsche Post DHL, which is the major logistics service provider globally, to enhance the understanding of the needs of end-consumers of logistical services (Deutsche Post DHL, 2018a, 2018b). This is increasingly important due to the rising power of end-consumers to dictate how the delivery of their goods should be organised within the last-mile (Wang *et al.*, 2018a). In other words, this study provides fruitful insights into the consumer's decision-making when deciding on the options of last-mile delivery. As such, this study provides a comprehensive model (i.e., ADV-AM) that has been developed and tested prior to the broad market introduction in Germany and therefore can help vehicle developers, designers, and logistics service providers to develop, promote, and market ADVs as an innovative delivery solution that will be accepted by the final customer (i.e., recipient).

First, and most importantly, this study found that overall trust in technology is the most important factor in acceptance formation for ADVs in the context of last-mile delivery in Germany. This implies that trust in ADVs is a ground-breaking precondition for accepting this innovative delivery solution. The findings in this study show that parcel drop-off performance and street performance almost equally determine overall trust in technology. As such, if ADVs are promoted to the public as trustworthy (i.e., autonomously driving function) and in particular if the focus is on the dependability of the characteristics of ADVs (i.e., during parcel drop-off), the acceptance of potential users will very likely increase. Moreover, studies have shown that people are more comfortable with automation technology they have personally experienced because it reduces the fear of the unknown (Hegner *et al.*, 2019). Taking this aspect into consideration, logistics service providers and other last-mile delivery companies (e.g., start-ups) could start with more extensive trials in Germany where the general population can be more actively involved, which will likely increase their trust in ADVs and hence will increase user acceptance. A good example was the trial of the ADV at the federal gardening show in Heilbronn (Germany), where residents and visitors could actively interact with the ADVs.

Second, the price for the last-mile delivery option was found to be very important for Germans. This implies that the usage of one delivery option over the other is an economic decision. As such, it is recommended that the price for the delivery with ADVs is at least not higher than the conventional price for parcel deliveries, even though ADVs include additional advantages for the recipient and might therefore be seen as a premium service. In marketing terms, it is recommended at this stage that logistics service providers use a price penetration strategy, that is, to start with a low price and increase it after a large market share has been reached or after the consumers value the additional advantages enough to be willing to pay extra for it.

Third, this study found that utilitarian benefits (i.e., performance expectancy) of ADVs are also very important to potential users in Germany. Hence, vehicle developers, designers, and marketers should focus the vehicle development and the marketing communication activities of ADVs on the usefulness of this last-mile delivery option (e.g., higher flexibility, higher convenience, etc.) compared to conventional delivery options. In other words, if the characteristics of ADVs were promoted to the public with focus on its advantages, the acceptance of ADVs would very likely increase.

Fourth, alongside the innovation characteristics (e.g., usefulness), this study found that an individual's innovativeness plays an important role in acceptance formation. Following the theory of innovation and diffusion by Rogers (2003), innovators (2.5%) and early adopters (13.5%), who are generally considered to be highly innovative, will try this new delivery technology first, whereas less innovative individuals will react with hesitation or resistance. Therefore, logistics service providers need to understand and respect the differences between their customers. Therefore, it is recommended to marketers of logistics services that ADVs are introduced as an innovative delivery technology to the public. More specifically, the marketing should directly focus on innovative individuals (i.e., innovators or early adopters). Moreover, to speed up the diffusion process and also encourage the early majority to use ADVs as a delivery option, companies could pay incentives or rewards (e.g., monetary and non-monetary bonuses) to innovators and early adopters to recruit other people with lower innovativeness, who have not tested the system before. To sum it up, it is essential that logistics service providers choose the right implementation strategy for the right customer.

Fifth, hedonic factors were found to play an important role in ADVs acceptance formation. As such, the following managerial implications arise. Developers should focus on the hedonic factors for the improvement of the prototype and include aspects or features of the technology that are actually enjoyable and entertaining. From a marketing perspective, specific aspects of ADVs that are considered enjoyable, fun, or entertaining should be promoted to the public to increase the likelihood that potential users accept this technology (e.g., the interaction with the vehicles, the mobile app interface, etc.). Additionally, marketers should focus their communication on the novelty and innovativeness of these vehicles, thereby contribute to hedonic motivation (Alalwan *et al.*, 2018a).

Sixth, social influence was found to have the sixth strongest effect on behavioural intention, therefore, the following implications arise. Marketers might use the influence of social pressure to their advantage when promoting ADVs during the market introduction stage. A similar approach could be used as outlined before. As such, people who have tried ADVs during the trial phase in Germany will receive incentives or rewards to recruit other people who have not tested the system before. Another approach would be to include communication tools like testimonials and endorsements by opinion leaders (Chiu and Hofer, 2015) or even influencers. Nowadays, influencers can be used as opinion leaders and educate people about ADVs for last-mile delivery. To sum it up, when marketers try to influence those people whose opinion is important to others, the acceptance of ADVs will very likely increase, even if the system was not accepted by some individuals before.

Seventh, overall perceived risk was found to have a small but significant influence on the acceptance of ADVs as a delivery option. Moreover, it was stated in the open question that risk is an important aspect for several participants for accepting ADVs as a delivery option. This finding has two major implications for developers and marketers. Firstly, aspects that show the safety and high accuracy of ADVs when driving on public roads should be taken into consideration when promoting these vehicles to the public. Secondly, despite the smaller effect of perceived performance risk, this type of risk should not be neglected. As such, ADVs should be promoted as a delivery option that fulfils the tasks of delivery at least as well as the conventional delivery person. In fact, the marketing should include the advantages of ADVs over its traditional alternative, which will likely increase its acceptance.

Overall, it has been stated that ADVs are able to make the overall last-mile delivery process more efficient, sustainable and customer-focused. However, ADVs can only unfold their full potential if they are fully accepted. By taking into consideration the managerial implications, outlined in this subchapter, in the further development of ADVs as well as in the marketing communications to the public in Germany, user acceptance of ADVs for last-mile delivery will likely increase.

8.4 Limitations of the Study

Despite the fact that this study includes several promising and valuable findings, a few limitations need to be considered, which might open the door for further research (see subchapter 8.5). First, based on the time as well as the financial resources available, a cross-sectional research design was conducted. As such, the data was only collected at a single point of time. In other words, a snapshot of the phenomena under study was taken. Obviously, it would be wrong to assume that the findings in this study can describe the changing process in technology adoption over time. For instance, as more and more information will be available on ADVs in the future, and people become more experienced with ADVs, the constructs found important in this study might change. In particular, as argued before, the effects of facilitating conditions and effort expectancy might be relevant after the participants experienced ADVs as an actual delivery system.

Second, and in line with the limitation stated before, due to the novelty of ADVs, participants in this study did not have any fundamental experience with this technology because the investigation of user acceptance of ADVs took place before the broad market introduction (i.e., use behaviour could not be investigated). Therefore, participants rated the UTAUT2 constructs as well as the additionally added constructs based on the information received by the researcher in the information sheet (see Appendix A: Survey Questionnaire – English Version) or existing knowledge of the participants and as such not by actual experience. This should be considered when interpreting the findings.

Third, the research was conducted in the specific domain of ADVs, which were defined as self-driving ground vehicles in this thesis. Obviously, the findings are not generally applicable to other forms of technology. In particular, even though it might be appealing to generalise these findings to other innovative last-mile delivery solutions like aerial drones or parcel lockers, this is not recommended without clearly considering the underlying research context.

Fourth, since this study investigated the user acceptance of ADVs in the cultural background of Germany, the findings are not generalisable to other countries, especially not to non-western countries, were the culture is enormously different.

Fifth, overall trust in technology (TT_O) and overall perceived risk (PR_O) were hypothesised to be determined by only two constructs in this thesis (i.e., overall trust in technology is determined by street performance and parcel drop-off performance; overall perceived risk is determined by perceived performance risk and perceived safety risk), which was based on the main characteristics of ADVs (i.e., driving autonomously on public roads and dropping off parcels without human – human interaction). However, this narrow view and definition of the constructs limits the scope of overall trust in technology and overall perceived risk. This is especially true when considering the potential trust and risk facets, which could also be relevant in the context of ADVs as a last-mile delivery option (e.g., risk of data loss, trust in the service provider, etc.)

Finally, even though this study gives the first promising insights into the acceptance formation of ADVs for last-mile delivery in Germany, it is not completely generalisable. Despite the fact that within this study quota sampling was applied (i.e., age, gender, and monthly household net-income), the number of responses is only 501. Even though such a sample size is considered statistically acceptable for evaluating complex structural models (Hair *et al.*, 2014a), the stability as well as the rigour of the conceptual model verified in this study could be strengthened by increasing the sample size.

8.5 Recommendations for Further Research

Taking the research limitations outlined in the previous section into consideration, there are several recommendations for further research. First, future research should use the same questionnaire and investigate the verified “Autonomous Delivery Vehicle Acceptance Model” with the same methodological procedures conducted in this study at several points of time. In other words, a longitudinal approach should be conducted. This will help to investigate the changing process of user acceptance (i.e., behavioural intention) over time in the German context. In doing so, it can be investigated to what extent the significance of the structural paths are dependent on the technological developmental level, the information provided in marketing activities, as well as the market penetration.

Second, based on the limitation that the participants in this study had very little or no experience with ADVs, further research should focus on users who have more experience with ADVs (i.e., actual users) rather than potential users. Here, users that have taken part in the trial test of ADVs can be used as participants. This will help to understand the differences between these two user groups and adjust, if necessary, the marketing strategies accordingly. Moreover, this will help to investigate the relationship between behavioural intention and use behaviour, which could not be investigated in this study.

Third, the underlying research model has been verified only in the context of ADVs for last-mile delivery. To be able to strengthen the research model in the domain of logistics innovations, further research could carefully investigate whether this model is also applicable to other logistical innovations that are disruptive in the last-mile delivery process. In this regard, the ADV-AM could be utilised in the domain of areal drones.

Fourth, the study conducted in this thesis was focused on Germany only. Future research should investigate user acceptance of ADVs in several other cultural backgrounds. In other words, the robustness of the research model should be investigated by applying it to other cultural backgrounds. In doing so, English- as well as German-speaking countries can be targeted as a next step, as the questionnaire is available in both languages.

Fifth, due to limited financial resources in this study, only 501 participants could be targeted. It is recommended that future research investigates the verified research model from this study with a larger sample size. This will strengthen the stability as well as the rigour of the Autonomous Delivery Vehicle Acceptance Model verified in this study.

Sixth, to the best of my knowledge this study is the first that investigates price sensitivity in the UTAUT2 context. Further research should not only integrate price sensitivity in other research contexts (i.e., different technologies) to broaden the construct's applicability, but should also investigate the price range that is acceptable for customers. This will help practitioners to clearly define the price for the delivery service with ADVs in last-mile delivery.

Seventh, the inclusion of overall trust in technology (TT_O) and overall perceived risk (PR_O) clearly broadened the applicability of UTAUT2 in the domain of last-mile logistics. However, to get a more detailed understanding of these constructs additional determinants should be investigated that influence these two constructs alongside the proven constructs in this study. This will not only allow to get a better theoretical understanding of these constructs, but also will it help practitioners to adjust the relevant setscrew.

Eighth, even though effort expectancy and facilitating conditions could not be proven as determinants of behavioural intention (i.e., user acceptance) in this study, it is worth to consider both constructs in future studies at a later point of time. This will help to determine whether effort expectancy and facilitating conditions are only relevant after the participants had their first experience with ADVs, which has been found in previous technology acceptance research.

Finally, the findings from the open-question also revealed some interesting findings that should be investigated more closely in future research. For instance, job loss due to automation as well as the risk of theft might be promising additional constructs that are relevant in the area ADVs' acceptance research. Therefore, these should be investigated in detail in future research concerning the acceptance of ADVs for last-mile delivery.

8.6 Conclusion

This research provided a comprehensive view of the user acceptance of ADVs for last-mile delivery in Germany. Therefore, these research findings can be used as a starting point for future studies investigating the acceptance of technological innovations in last-mile delivery as well as the acceptance of ADVs in particular. Since ADVs do not only provide advantages for logistics service providers and the individual recipient but also for society as a whole, this study is just the start of a new research area that will hopefully attract much more attention in the future.

Appendices

Appendix A: Survey Questionnaire – English Version

User Acceptance of Autonomous Delivery Vehicles

- An Empirical Study in Germany -

Dear Sir or Madam,

Thank you very much for taking the time to complete this survey. The survey will take approximately 10-15 minutes for completion, as you will only be asked for each statement to tick one answer. Overall, the survey includes three parts.

The main purpose of this research is to examine user acceptance of autonomous delivery vehicles in last-mile delivery in Germany. Here, last-mile delivery is defined as the final transport process of goods to the recipient's doorstep. This study focuses only on private individuals. By answering this questionnaire, you will contribute to this research by helping us to get a better understanding of the user perspective regarding autonomous delivery vehicles.

As this survey asks you about your perceptions, there are no right or wrong answers. Therefore, it is of highest value to this study that you respond to the questions based only on your own personal judgment.

Your response will be used for research purposes only and your details will be kept anonymous and confidential. Your participation is totally voluntary, and you are free to withdraw at any time without giving a reason. I appreciate your participation as the success of this study greatly depends on it.

Yours faithfully,

Sebastian Kapser

PhD Student

Northumbria University Business School

Email: sebastian.kapser@northumbria.ac.uk

Part 1/3: Respondent's Profile

1. **What is your age?**
   a. 18-24 years
   b. 25-34 years
   c. 35-49 years
   d. 50-64 years
   e. 65 + years

2. **What is your gender?**
   a. Female
   b. Male

3. **What is your nationality?**
   a. German
   b. Other, please specify

4. **What is your monthly household-income (net)?**
   This is the sum of all salaries, wages and incomes from people living together in one household.
   a. below 900 €
   b. 900 € until < 1,300 €
   c. 1,300 € until < 1,500 €
   d. 1,500 € until < 2,000 €
   e. 2,000 € until < 2,600 €
   f. 2,600 € until < 3,200 €
   g. 3,200 € until < 4,500 €
   h. 4,500 € until < 6,000 €
   i. 6,000 € and above

5. **What is your highest education?**
   a. Secondary school certificate or below
   b. High school degree
   c. University diploma
   d. Bachelor's degree
   e. Master's degree
   f. Doctorate
   g. No degree
   h. Other, please specify

6. **What is your current employment status?**
   a. full-time employment
   b. part-time employment
   c. seeking work
   d. retired
   e. pupil
   f. student
   g. unable to work

7. **On average how often do you buy products online?**
   a. Never
   b. Rarely
   c. Once a year
   d. A few times a year
   e. Monthly
   f. Weekly
   g. Daily

8. **Do you use mobile apps in your daily life? (e.g., Facebook, Deutsche Bahn App, Mobile Banking, etc.)**
   a. Yes
   b. No

9. **If 7 (all, except "never") and 8 is yes, have you used mobile apps (e.g. Amazon app, eBay app, etc.) for ordering products online?**
   a. Yes
   b. No

Part 2/3: Information Sheet

Please read the following information carefully!

Autonomous Delivery Vehicles

In this research autonomous delivery vehicles are defined as **self-driving ground vehicles**, which use **electric energy** as a power source. These vehicles drive at a speed of **approximately 5-10 km/h and drive on sidewalks rather than streets**. For safety and security reasons, those vehicles are equipped with various cameras, sensors and satellite navigation system (GPS). Autonomous delivery vehicles look like little robots (picture 1) or like a mobile parcel locker (picture 2) and can **deliver parcels or other goods** like groceries to the doorstep.

To date, autonomous delivery vehicles are in a **testing phase on public roads. In Germany, for instance in Hamburg and Dusseldorf, autonomous delivery vehicles are tested for parcel delivery.** However, they are **not yet regularly available as a delivery option.**

Source: https://www.starship.xyz

Picture 1

Source: https://www.thestar.com

Picture 2

Delivery Process: Interaction and Advantages

To use autonomous delivery vehicles, **you need a mobile device (e.g., smartphone or tablet) for running the mobile app**. **Via the mobile app**, the recipient will be requested to **set the date and timeslot** in which he/she wants to receive the ordered goods. For the recipients this makes the delivery process with autonomous delivery vehicles **more flexible and convenient compared to conventional delivery options**. The mobile app is **easy to use** and regarding the severity for instance comparable to conventional apps like the Amazon or eBay app.

Once the autonomous delivery vehicle arrives at the final destination, **the recipient will receive a message through the app to collect the goods**. To **authorize and to open the locker** of the vehicle the **recipient has to connect their mobile device via Bluetooth to the vehicle**. In the case of an unexpected situation (e.g. the locker cannot be opened), the **recipient can directly call for assistance** through the mobile app or the interface of the vehicle.

Part 3/3: Autonomous Delivery Vehicles and User Acceptance

10. **Have you heard about autonomous delivery vehicles before?**
    a. Yes
    b. No

11. **Have you had the chance to use them?**
    a. Yes
    b. No

For the following questions please imagine autonomous delivery vehicles will be reality in the near future.

Based on your own opinion and judgement, please state to what extent you agree or disagree with the following:

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
12. I would find autonomous delivery vehicles useful in my daily life.							
13. Using autonomous delivery vehicles would help me accomplish things more quickly.							
14. Using autonomous delivery vehicles would increase my productivity.							
15. Using autonomous delivery vehicles would increase my flexibility in my daily life.							

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
16. Learning how to use autonomous delivery vehicles would be easy for me.							
17. My interaction with the autonomous delivery vehicle via the mobile app would be clear and understandable.							
18. I would find autonomous delivery vehicles easy to use.							
19. It would be easy for me to become skilful at using autonomous delivery vehicles.							

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
20. People who are important to me would think that I should use autonomous delivery vehicles.							
21. People who influence my behaviour would think that I should use autonomous delivery vehicles.							
22. People whose opinion I value would prefer that I use autonomous delivery vehicles.							

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
23. I have the resources necessary to use autonomous delivery vehicles (i.e., mobile device).							
24. I have the knowledge necessary to use autonomous delivery vehicles.							
25. Autonomous delivery vehicles are compatible with other technologies I use (e.g., smartphone).							
26. I can get help from others when I have difficulties using autonomous delivery vehicles.							

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
27. Using autonomous delivery vehicles would be fun.							
28. Using autonomous delivery vehicles would be enjoyable.							
29. Using autonomous delivery vehicles would be very entertaining.							

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
30. I would not mind paying more to try out autonomous delivery vehicles as a delivery option.							
31. I would not mind spending a lot of money for getting my orders delivered by autonomous delivery vehicles.							
32. I would be less willing to pay for autonomous delivery vehicles as a delivery option if I thought it to be high in price.							
33. If I knew that autonomous delivery vehicles as a delivery option were likely to be more expensive than conventional delivery options, that would not matter to me.							
34. A really great delivery option would be worth paying a lot of money for.							

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
35. Autonomous delivery vehicles might not perform well and create problems during parcel drop-off (e.g., locker cannot be opened, failure of Bluetooth connection, etc.).							
36. Autonomous delivery vehicles might not work properly during parcel drop- off.							
37. The chances that something would be wrong with the performance of autonomous delivery vehicles during parcel drop-off would be high.							

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
38. Autonomously driving delivery vehicles on public roads would be risky.							
39. Autonomously driving delivery vehicles on public roads would be dangerous.							
40. Autonomously driving delivery vehicles would add great uncertainty to public roads.							

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
41. Overall, using autonomous delivery vehicles as a delivery option would be risky.							
42. Overall, autonomous delivery vehicles as a delivery option would be dangerous to use.							
43. Using autonomous delivery vehicles as a delivery option would expose me to an overall risk.							

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
44. I believe that the interaction with autonomous delivery vehicles during parcel drop-off would be free of error.							
45. I believe that I could depend and rely on autonomous delivery vehicles during parcel drop-off.							
46. I believe that autonomous delivery vehicles would perform consistently under a variety of circumstances during parcel drop-off.							

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
47. I believe that the operation of autonomous delivery vehicles would be free of error when driving on public roads.							
48. I believe that I could depend and rely on autonomous delivery vehicles when driving on public roads.							
49. I believe that autonomous delivery vehicles would perform consistently under a variety of circumstances when driving on public roads.							

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
50. Overall, I would trust autonomous delivery vehicles to be reliable.							
51. Overall, I would trust autonomous delivery vehicles to be dependable.							
52. Overall, I would trust autonomous delivery vehicles.							

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
53. If I heard about a new technology, I would look for ways to experiment with it.							
54. Among my peers, I am usually the first to explore new technologies.							
55. I like to experiment with new technology.							

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
56. I intend to use autonomous delivery vehicles as a delivery option in the future.							
57. I would always try to use autonomous delivery vehicles as a delivery option in my daily life when available in the future.							
58. I plan to use autonomous delivery vehicles frequently when available in the future.							

Finally

59. Would you like to tell us anything else regarding autonomous delivery vehicles? If yes, please specify:

Thank you for taking the time to complete this survey. Your response has been recorded.

Please note that the foregoing questionnaire includes only the content but not the layout used in this study. For the digital version and the layout of the questionnaire (German version) please visit the Qualtrics platform:

https://nbsnu.co1.qualtrics.com/jfe/form/SV_cwlZ6awvLkjbcNf

Appendix B: Survey Questionnaire – German Version

Nutzerakzeptanz von autonomen Lieferfahrzeugen

- Eine empirische Studie in Deutschland -

Sehr geehrte Damen und Herren,

vielen Dank, dass Sie sich die Zeit nehmen, diese Umfrage zu beantworten. Die Umfrage benötigt nur rund 10 bis 15 Minuten Zeit, da Sie für jede Aussage nur eine Antwort auswählen müssen. Insgesamt umfasst die Umfrage drei Teile.

Das Hauptziel dieser Forschung ist es, die Akzeptanz der Nutzerinnen und Nutzer von autonomen Lieferfahrzeugen in der Belieferung der "letzten Meile" in Deutschland zu untersuchen. Unter letzter Meile ist hier der finale Transport der Waren zur Haustüre der Empfängerin oder des Empfängers zu verstehen. Die Studie fokussiert sich nur auf Privatpersonen. Durch die Beantwortung dieses Fragebogens tragen Sie zu diesem Forschungsprojekt bei, indem Sie uns helfen, ein besseres Verständnis der Nutzerperspektive im Hinblick auf autonome Lieferfahrzeuge zu erhalten.

Da diese Umfrage Ihre Wahrnehmungen untersucht, gibt es keine richtigen oder falschen Antworten. Deshalb ist es von großer Bedeutung, dass Sie die Fragen basierend auf Ihrem persönlichen Urteil beantworten.

Ihre Antworten werden ausschließlich für Forschungszwecke verwendet und Ihre persönlichen Daten werden anonym und vertraulich behandelt. Die Teilnahme ist absolut freiwillig und Sie können Ihre Teilnahme jederzeit ohne Angabe von Gründen beenden. Ich weiß Ihre Teilnahme sehr zu schätzen, da der Erfolg der Untersuchung in hohem Maße davon abhängt.

Mit freundlichen Grüßen

Sebastian Kapser

Doktorand

Northumbria University Business School (England)

Email: sebastian.kapser@northumbria.ac.uk

Teil 1/3: Teilnehmer/innen-Profil

1. **Wie alt sind Sie?**
    a. 18-24 Jahre
    b. 25-34 Jahre
    c. 35-49 Jahre
    d. 50-64 Jahre
    e. 65 + Jahre
2. **Welches Geschlecht haben Sie?**
    a. weiblich
    b. männlich
3. **Welche Nationalität haben Sie?**
    a. Deutsch
    b. andere, bitte eintragen:
4. **Wie hoch ist Ihr monatliches Haushaltsnettoeinkommen?**
   Damit ist die Summe aller Löhne, Gehälter und Einkommen der im Haushalt lebenden Personen gemein.
    a. unter 900 €
    b. 900 € bis unter 1.300 €
    c. 1.300 € bis unter 1.500 €
    d. 1.500 € bis unter 2.000 €
    e. 2.000 € bis unter 2.600 €
    f. 2.600 € bis unter 3.200 €
    g. 3.200 € bis unter 4.500 €
    h. 4.500 € bis unter 6.000 €
    i. 6.000 € und darüber
5. **Was ist Ihr höchster Bildungsabschluss?**
    a. mittlere Reife oder darunter
    b. Abitur
    c. Diplomabschluss
    d. Bachelorabschluss
    e. Masterabschluss
    f. Promotion
    g. kein Abschluss
    h. anderer, bitte eintragen.
6. **Wie ist Ihr derzeitiges Arbeitsverhältnis?**
    a. Vollzeit beschäftigt
    b. Teilzeit beschäftigt
    c. arbeitssuchend
    d. im Ruhestand
    e. Schülerin/Schüler
    f. Studentin/Student
    g. erwerbsunfähig
7. **Wie häufig kaufen Sie Produkte durchschnittlich online ein?**
    a. nie
    b. selten
    c. einmal pro Jahr
    d. mehrmals im Jahr
    e. monatlich
    f. wöchentlich
    g. täglich
8. **Nutzen Sie mobile Apps in ihrem Alltag?** *(Beispiele: Facebook App, Deutsche Bahn App, Online Banking Apps, etc.)*
    a. ja
    b. nein
9. **Falls Antwort 7 und 8 ja: Haben Sie schon einmal mobile Apps genutzt (z.B. Amazon-App, eBay-App etc.), um Produkte online zu bestellen?**
    a. ja
    b. nein

Teil 2/3: Informationsblatt

Bitte lesen Sie die folgenden Informationen aufmerksam durch!

Autonome Lieferfahrzeuge

Im Rahmen dieses Forschungsprojekts werden autonome Lieferfahrzeuge als **selbstfahrende und sich selbst steuernde Bodenfahrzeuge** definiert, die elektrischen Strom als Energiequelle nutzen. Diese Fahrzeuge fahren mit einer **Geschwindigkeit von circa 5-10 Stundenkilometer eher auf Bürgersteigen als auf der Straße**. Aus Sicherungs- und Sicherheitsgründen sind die Fahrzeuge mit verschiedenen Kameras, Sensoren und einem Satellitennavigationssystem (GPS) ausgestattet. Autonome Lieferfahrzeuge sehen aus wie kleine Roboter (Bild 1) oder wie mobile Paketboxen (Bild 2) und können **Pakete oder andere Waren,** wie Lebensmittel, bis an die Haustür bringen.

Bisher sind autonome Lieferfahrzeuge auf **öffentlichen Straßen in einer Testphase**. In Deutschland, beispielsweise in Hamburg und Düsseldorf, wird die Paketzustellung mit autonomen Lieferfahrzeugen erprobt. **Es gibt sie aber noch nicht als reguläre Lieferoption.**

© Bildquelle: https://www.starship.xyz

Bild 1

© Bildquelle: https://www.thestar.com

Bild 2

Lieferprozess: Interaktion und Vorteile

Um autonome Lieferfahrzeuge zu nutzen **braucht man ein mobiles und App-fähiges Endgerät (z.B. Smartphone oder Tablet). Über die mobile App** werden die Empfängerinnen und Empfänger aufgefordert, **ein Datum und ein Zeitfenster für die Lieferung** der bestellten Ware anzugeben. **Dies macht den Lieferprozess mit autonomen Lieferfahrzeugen**, im Vergleich zu herkömmlichen Lieferoptionen, **flexibler und bequemer** für die Empfängerinnen und Empfänger. Die Nutzung der mobilen App **ist einfach** und vom Schwierigkeitsgrad **vergleichbar mit herkömmlichen Apps** wie z.B. der Amazon- oder eBay-App.

Sobald das autonome Lieferfahrzeug am Zielort angekommen ist, **erhält die Empfängerin oder der Empfänger eine Nachricht durch die App**, um die Waren abzuholen. **Um sich zu autorisieren und das Schließfach des Fahrzeugs zu öffnen**, **muss die Empfängerin oder der Empfänger ihr/sein mobiles Endgerät über Bluetooth mit dem Fahrzeug verbinden.** Im Fall einer unerwarteten Situation (z.B. das Schließfach lässt sich nicht öffnen), kann die **Empfängerin bzw. der Empfänger direkt Unterstützung über die mobile App oder das Interface des Fahrzeuges rufen**.

Teil 3/3: Autonome Lieferfahrzeuge und Nutzerakzeptanz

10. **Haben Sie schon einmal von autonomen Lieferfahrzeugen gehört?**
    a. Ja
    b. nein

11. **Falls 10 ja: Hatten Sie schon eine Gelegenheit, diese zu nutzen?**
    c. ja
    d. nein

Stellen Sie sich für die folgenden Fragen bitte vor, dass autonome Lieferfahrzeuge in naher Zukunft schon Realität wären.

Bitte geben Sie auf Basis Ihrer Meinung und Ihres Urteils an, in welchem Ausmaß Sie den folgenden Aussagen zustimmen oder nicht zustimmen.

	Stimme überhaupt nicht zu	Stimme nicht zu	Stimme eher nicht zu	Un-entschieden	Stimme eher zu	Stimme zu	Stimme vollständig zu
12. Ich würde autonome Lieferfahrzeuge in meinem Alltag nützlich finden.							
13. Autonome Lieferfahrzeuge würden mir helfen, Dinge schneller zu erledigen.							
14. Die Nutzung von autonomen Lieferfahrzeugen würde meine Produktivität erhöhen.							
15. Die Nutzung von autonomen Lieferfahrzeugen würde meine Flexibilität im Alltag erhöhen.							

	Stimme überhaupt nicht zu	Stimme nicht zu	Stimme eher nicht zu	Un-entschieden	Stimme eher zu	Stimme zu	Stimme vollständig zu
16. Es wäre einfach für mich, den Gebrauch autonomer Lieferfahrzeuge zu erlernen.							
17. Meine Interaktion mit dem autonomen Lieferfahrzeug per mobiler App wäre klar und verständlich.							
18. Ich fände autonome Lieferfahrzeuge einfach zu nutzen.							
19. Es wäre einfach für mich, gekonnt mit autonomen Lieferfahrzeugen umzugehen.							

	Stimme überhaupt nicht zu	Stimme nicht zu	Stimme eher nicht zu	Un-entschieden	Stimme eher zu	Stimme zu	Stimme vollständig zu
20. Personen, die für mich wichtig sind, wären der Meinung, dass ich autonome Lieferfahrzeuge nutzen sollte.							
21. Personen, die mein Verhalten beeinflussen, würden denken, dass ich autonome Lieferfahrzeuge nutzen sollte.							
22. Personen, deren Meinung mir wichtig ist, hätten gerne, dass ich autonome Lieferfahrzeuge nutze.							

	Stimme überhaupt nicht zu	Stimme nicht zu	Stimme eher nicht zu	Un-entschieden	Stimme eher zu	Stimme zu	Stimme vollständig zu
23. Ich habe die nötigen Ressourcen (z.B. ein mobiles Endgerät), um autonome Lieferfahrzeuge zu nutzen.							
24. Ich habe das nötige Wissen, um autonome Lieferfahrzeuge zu nutzen.							
25. Autonome Lieferfahrzeuge sind kompatibel mit anderen Technologien, die ich nutze (z.B. mit meinem Smartphone).							
26. Ich kann Hilfe von anderen bekommen, wenn ich Schwierigkeiten mit autonomen Lieferfahrzeugen habe.							

	Stimme überhaupt nicht zu	Stimme nicht zu	Stimme eher nicht zu	Un-entschieden	Stimme eher zu	Stimme zu	Stimme vollständig zu
27. Autonome Lieferfahrzeuge zu nutzen würde mir Spaß machen.							
28. Autonome Lieferfahrzeuge zu nutzen wäre vergnüglich.							
29. Autonome Lieferfahrzeuge zu nutzen wäre sehr unterhaltsam.							

	Stimme überhaupt nicht zu	Stimme nicht zu	Stimme eher nicht zu	Un-entschieden	Stimme eher zu	Stimme zu	Stimme vollständig zu
30. Es würde mir nichts ausmachen mehr zu zahlen, um autonome Lieferfahrzeuge als Lieferoption auszuprobieren.							
31. Es würde mir nichts ausmachen, viel Geld zu zahlen, um meine Bestellungen mit autonomen Lieferfahrzeugen geliefert zu bekommen.							
32. Ich wäre weniger bereit für die autonome Lieferung meiner Waren zu zahlen, wenn ich diese Lieferoption als teuer erachten würde.							
33. Wenn ich wüsste, dass autonome Lieferfahrzeuge als Lieferoption teurer wären als herkömmliche Lieferoptionen, dann wäre mir das egal.							
34. Eine wirklich großartige Lieferoption wäre es mir wert, viel Geld dafür zu zahlen.							

	Stimme überhaupt nicht zu	Stimme nicht zu	Stimme eher nicht zu	Un-entschieden	Stimme eher zu	Stimme zu	Stimme vollständig zu
35. Es könnte sein, dass autonome Lieferfahrzeuge nicht gut funktionieren und Probleme bei der Paketablieferung machen (z.B. das Schließfach lässt sich nicht öffnen, die Bluetooth-Verbindung klappt nicht etc.)							
36. Es könnte sein, dass autonome Lieferfahrzeuge während der Paketablieferung nicht richtig funktionieren.							
37. Die Wahrscheinlichkeit, dass etwas während der Paketablieferung mit dem autonomen Fahrzeug schiefläuft, wäre hoch.							

	Stimme überhaupt nicht zu	Stimme nicht zu	Stimme eher nicht zu	Un-entschieden	Stimme eher zu	Stimme zu	Stimme vollständig zu
38. Autonom fahrende Lieferfahrzeuge auf öffentlichen Straßen wären riskant.							
39. Autonom fahrende Lieferfahrzeuge auf öffentlichen Straßen wären gefährlich.							
40. Autonom fahrende Lieferfahrzeuge würden große Unsicherheit auf öffentliche Straßen bringen.							

	Stimme überhaupt nicht zu	Stimme nicht zu	Stimme eher nicht zu	Un-entschieden	Stimme eher zu	Stimme zu	Stimme vollständig zu
41. Insgesamt wäre die Nutzung autonomer Lieferfahrzeuge als Lieferoption riskant.							
42. Insgesamt wären autonome Lieferfahrzeuge als Lieferoption gefährlich.							
43. Die Nutzung von autonomen Lieferfahrzeugen als Lieferoption würde mich insgesamt einem Risiko aussetzen.							

	Stimme überhaupt nicht zu	Stimme nicht zu	Stimme eher nicht zu	Un-entschieden	Stimme eher zu	Stimme zu	Stimme vollständig zu
44. Ich glaube, dass die Interaktion mit dem autonomen Lieferfahrzeug während der Paketablieferung fehlerfrei funktionieren würde.							
45. Ich glaube, dass ich mich auf autonome Lieferfahrzeuge, während der Paketlieferung verlassen könnt und sie zuverlässig wären.							
46. Ich glaube, dass autonome Lieferfahrzeuge unter verschiedenen Umständen während der Paketablieferung, konsistent funktionieren würden.							

	Stimme überhaupt nicht zu	Stimme nicht zu	Stimme eher nicht zu	Un-entschieden	Stimme eher zu	Stimme zu	Stimme vollständig zu
47. Ich glaube, dass autonome Lieferfahrzeuge fehlerfrei funktionieren würden, wenn sie auf öffentlichen Straßen fuhren.							
48. Ich glaube, dass ich mich auf autonome Lieferfahrzeuge verlassen könnte und sie zuverlässig wären, wenn sie auf öffentlichen Straßen fuhren.							
49. Ich glaube, dass autonome Lieferfahrzeuge unter verschiedenen Umständen konsistent funktionieren würden, wenn sie auf öffentlichen Straßen fahren.							

	Stimme überhaupt nicht zu	Stimme nicht zu	Stimme eher nicht zu	Un-entschieden	Stimme eher zu	Stimme zu	Stimme vollständig zu
50. Insgesamt würde ich darauf vertrauen, dass autonome Lieferfahrzeuge zuverlässig sind.							
51. Insgesamt würde ich darauf vertrauen, dass man sich auf autonome Lieferfahrzeuge verlassen kann.							
52. Insgesamt würde ich autonomen Lieferfahrzeugen vertrauen.							

	Stimme überhaupt nicht zu	Stimme nicht zu	Stimme eher nicht zu	Un-entschieden	Stimme eher zu	Stimme zu	Stimme vollständig zu
53. Wenn ich von einer neuen Technologie höre, dann würde ich nach Wegen suchen diese auszuprobieren.							
54. In meinem Bekanntenkreis bin ich meist der/die Erste, der/die eine neue Technologie ausprobiert.							
55. Ich probiere gerne neue Technologien aus.							

	Stimme überhaupt nicht zu	Stimme nicht zu	Stimme eher nicht zu	Un-entschieden	Stimme eher zu	Stimme zu	Stimme vollständig zu
56. Ich beabsichtige, autonome Lieferfahrzeuge künftig als Lieferoption zu nutzen.							
57. Ich würde immer versuchen, im Alltag autonome Lieferfahrzeuge als Lieferoption zu nutzen, wenn sie künftig zur Verfügung stünden.							
58. Ich würde versuchen, autonome Lieferfahrzeuge häufig zu nutzen, wenn sie künftig zur Verfügung stünden.							

Zum Schluss

59. Gibt es noch irgendetwas, das Sie uns im Hinblick auf autonome Lieferfahrzeuge sagen möchten? Falls ja, schreiben Sie es bitte auf:

Vielen Dank, dass Sie sich die Zeit genommen haben an dieser Umfrage teilzunehmen. Ihre Antworten wurden gespeichert.

Please note that the foregoing questionnaire includes only the content but not the layout used in this study. For the digital version and the layout of the questionnaire (German version) please visit the Qualtrics platform:

https://nbsnu.co1.qualtrics.com/jfe/form/SV_cwlZ6awvLkjbcNf

Appendix C: Measurement Model

Appendix C.1: Standardised Regression Weights

			Estimate
PR_PR1	←	PR_P	0.901
PR_PR2	←	PR_P	0.94
PR_SR1	←	PR_S	0.925
PR_SR2	←	PR_S	0.968
PR_SR3	←	PR_S	0.936
PR_OR1	←	PR_O	0.94
PR_OR2	←	PR_O	0.955
PR_OR3	←	PR_O	0.825
HM3	←	HM	0.931
HM2	←	HM	0.972
HM1	←	HM	0.943
PSR4	←	PS	0.822
PSR2	←	PS	0.895
TT_OT1	←	TT_O	0.955
TT_OT2	←	TT_O	0.966
TT_OT3	←	TT_O	0.957
TT_S1	←	TT_S	0.916
TT_S2	←	TT_S	0.958
TT_S3	←	TT_S	0.951
TT_P1	←	TT_P	0.888
TT_P2	←	TT_P	0.943
TT_P3	←	TT_P	0.906
PE4	←	PE	0.884
PE2	←	PE	0.94
PE1	←	PE	0.867
EE4	←	EE	0.926
EE3	←	EE	0.918
EE2	←	EE	0.899
EE1	←	EE	0.889
SI3	←	SI	0.952
SI2	←	SI	0.965
SI1	←	SI	0.933
FC3	←	FC	0.909
FC2	←	FC	0.807
FC1	←	FC	0.849
INO1	←	INO	0.859
INO2	←	INO	0.874
INO3	←	INO	0.844
BI1	←	BI	0.929
BI2	←	BI	0.956
BI3	←	BI	0.968
PE3	←	PE	0.885
PSR5	←	PS	0.855
FC4	←	FC	0.736

Table Continued			
			Estimate
PR_PR3	←	PR_P	0.782
PSR1	←	PS	0.837

Appendix C.2: Standardised Residual Covariances

	FC4	BI3	BI2	BI1	INO3	INO2	INO1	FC1	FC2	FC3	SI1	SI2	SI3	EE1	EE2	EE3	EE4	PE1	PE2	PE3	PE4	TT_P3	TT_P2	TT_P1	TT_S3	TT_S2	TT_S1	TT_OT3	TT_OT2	TT_OT1	PSR2	PSR4	PSR5	HM1	HM2	HM3	PR_OR3	PR_OR2	PR_OR1	PR_SR3	PR_SR2	PR_SR1	PR_PR2	PR_PR1
FC4	0																																											
BI3	2.517	0																																										
BI2	2.387	0.053	0																																									
BI1	2.552	-0.094	0.009	0																																								
INO3	0.398	-0.631	-1.25	-0.535	0																																							
INO2	-0.372	-0.031	-0.325	0.535	0.316	0																																						
INO1	0.883	0.61	0.6	1.289	0.042	-0.313	0																																					
FC1	-0.492	-1.03	-1.372	-0.172	-0.513	-1.479	-0.945	0																																				
FC2	0.587	-0.036	-0.315	0.536	1.498	0.622	0.859	-0.374	0																																			
FC3	-0.424	0.012	-0.767	0.385	0.392	-0.523	0.515	0.787	-0.534	0																																		
SI1	2.555	0.311	0.132	0.959	-1.087	0.47	1.047	-0.725	0.08	0.143	0																																	
SI2	1.957	-0.407	-0.637	0.246	-1.025	0.484	0.517	-0.983	-0.09	-0.053	0.017	0																																
SI3	2.004	0.196	-0.079	0.742	-1.468	0.438	0.164	-1.124	-0.092	-0.163	-0.125	0.052	0																															
EE1	0.177	-1.056	-1.504	-0.576	-0.154	-0.925	-0.07	-1.775	1.294	-0.677	-0.395	-0.7	-0.646	0																														
EE2	0.899	-0.084	-0.334	0.332	0.673	0.106	0.746	-0.128	2.084	0.2	0.455	-0.1	0.106	0.023	0																													
EE3	0.787	0.813	0.621	1.024	0.009	-0.517	0.123	-0.976	1.042	0.03	0.595	0.01	0.358	-0.156	-0.082	0																												
EE4	1.121	0.057	-0.122	0.359	0.28	-0.153	0.09	-1.373	1.82	-0.691	0.351	-0.09	0.171	0.336	-0.092	-0.018	0																											
PE1	1.452	0.387	-0.142	0.456	-0.313	-0.15	1.947	0.761	0.222	1.808	0.577	-0.104	-0.12	0.236	0.759	2.027	0.206	0																										
PE2	1.131	-0.336	-0.335	-0.132	-1.209	-0.385	0.647	-0.745	-0.954	0.418	0.004	-0.445	-0.179	-0.319	0.109	1.102	-0.562	0.306	0																									
PE3	0.577	0.127	-0.233	0.01	-0.884	0.828	0.428	-1.561	-0.735	-0.578	0.031	-0.097	0.26	-1.439	-0.557	0.419	-1.052	-0.773	0.074	0																								
PE4	0.815	0.65	-0.113	0.798	-0.662	-0.164	0.645	-0.9	-0.845	0.077	0.691	0.139	0.654	-0.873	-0.119	0.366	-0.649	-0.279	-0.26	0.744	0																							
TT_P3	0.877	0.03	-0.194	-0.282	-0.483	0.149	0.701	-0.906	0.882	0.701	0.195	-0.318	0.093	-0.435	0.265	0.805	-0.152	0.797	-0.388	-0.097	-0.195	0																						
TT_P2	0.883	0.195	0.145	0.362	-0.796	-0.282	0.544	-1.26	-0.011	0.032	0.338	-0.156	0.243	-0.53	-0.079	0.39	0.054	1.004	0.394	-0.105	0.226	-0.083	0																					
TT_P1	0.506	-0.302	-0.452	-0.078	-0.408	0.102	0.708	-0.66	0.38	-0.042	0.12	-0.319	0.057	-0.653	-0.119	0.151	-0.236	0.077	-0.771	-0.912	-0.775	0.137	0.021	0																				
TT_S3	1.947	0.314	0.09	0.187	-0.373	-0.092	0.623	-0.773	0.892	0.204	0.516	-0.351	0.462	-0.334	0.223	0.479	0.056	0.826	0.124	0.14	0.052	0.354	0.17	0.407	0																			
TT_S2	1.292	0.015	-0.148	0.025	-0.673	-0.038	0.577	-1.179	0.621	-0.329	0.289	-0.359	0.133	-0.36	-0.073	0.617	-0.121	0.805	-0.286	-0.095	-0.509	-0.252	-0.301	-0.191	0.009	0																		
TT_S1	1.219	-0.359	-0.386	-0.026	-0.936	0.063	0.568	-1.148	0.429	-0.459	0.286	-0.44	0.119	-0.862	-0.361	-0.296	0.004	0.359	-0.431	-0.219	-0.249	-0.012	-0.104	0.44	-0.137	0.102	0																	
TT_OT3	1.456	0.503	0.315	0.764	-0.604	0.417	0.738	-0.993	0.188	0.173	0.675	-0.089	0.774	-0.994	-0.084	0.501	-0.097	1.094	-0.266	-0.032	0.213	0.317	0.39	-0.392	0.302	0.176	0.521	0																
TT_OT2	1.231	-0.214	-0.297	0.246	-0.418	-0.154	0.424	-1.117	-0.074	-0.037	0.25	-0.6	0.194	-0.909	0.117	0.356	-0.358	0.81	-0.569	-0.827	-0.036	-0.216	0.312	-0.549	-0.135	-0.393	-0.127	-0.024	0															
TT_OT1	1.35	-0.319	-0.502	0.001	-0.832	-0.203	0.433	-0.574	0.028	0.261	0.161	-0.578	0.118	-0.303	0.818	0.915	-0.135	1.521	0.017	-0.099	-0.063	-0.071	0.032	-0.603	0.136	-0.115	0.105	-0.113	0.113	0														
PSR2	-2.852	-0.027	-0.609	-0.259	0.738	-1.898	-0.139	0.808	-0.583	0.174	-0.327	0.233	-0.194	1.845	-0.216	-0.319	-0.459	1.133	0.215	-1.886	-0.793	-0.091	-0.127	0.088	-0.346	-0.479	-0.372	-0.603	0.065	0.207	0													
PSR4	-2.499	0.432	0.148	0.595	1.928	-0.573	1.338	1.573	0.399	0.108	-0.115	0.399	-0.056	1.527	0.175	-0.807	-0.287	0.957	-0.153	-1.456	-0.551	0.035	-0.255	-0.071	0.188	0.138	0.293	-0.206	0.426	0.408	-0.055	0												
PSR5	-2.37	-0.189	0.117	0.29	1.054	-1.143	0.305	1.327	-0.18	0.207	-0.219	0.207	-0.307	1.263	0.247	-0.857	-0.577	1.606	0.719	-0.376	-0.181	0.115	-0.008	0.524	0.371	0.147	0.334	-0.747	-0.04	0.641	-0.078	0.165	0											
HM1	1.758	0.311	0.043	0.571	-0.575	-0.018	1.823	0.137	0.064	0.687	1.09	0.175	0.02	-0.2	0.868	0.848	0.208	1.186	0.668	0.048	0.072	0.122	0.82	0.166	0.359	0.251	0.258	0.677	0.461	0.766	-0.065	0.478	0.796	0										
HM2	1.246	0.052	-0.503	-0.168	-1.1	-0.211	0.895	-0.689	-0.582	0.186	0.49	-0.577	-0.443	-0.632	0.188	0.586	-0.425	0.225	-0.24	-0.414	-0.528	-0.147	-0.054	-0.167	-0.124	0.158	-0.109	0.145	-0.508	-0.065	-0.118	-0.168	0.46	-0.008	0									
HM3	1.486	0.254	0.017	-0.013	-1.29	-0.323	0.764	-1.429	-1.264	-0.42	0.993	-0.043	0.374	-1.245	-0.34	0.063	-0.373	0.243	0.033	0.017	-0.182	-0.398	-0.161	-0.455	-0.351	-0.332	-0.393	-0.111	-0.533	-0.188	-0.877	-1.183	-0.203	-0.216	0.112	0								
PR_OR3	-0.892	0.129	0.39	-0.678	0.274	0.68	-1.759	-0.419	-1.069	-1.047	-0.619	-0.15	-0.606	-0.176	-0.662	-1.018	0.096	-1.385	-0.261	-0.119	-0.357	-0.828	-0.593	-0.437	-0.099	0.284	-0.41	-0.427	-0.517	-0.745	-1.069	-1.525	-0.818	-1.921	-0.623	0.038	0							
PR_OR2	-0.131	0.018	0.217	-0.382	0.427	0.493	-1.023	0.644	-0.384	-0.503	-0.249	0.007	-0.071	0.486	-0.506	-0.697	0.375	-0.905	0.264	-0.032	-0.059	0.034	-0.08	0.703	-0.216	0.357	-0.188	0.087	0.268	0.234	-0.357	-0.582	0.395	-1.126	0.147	0.863	0.119	0						
PR_OR1	0.418	-0.033	0.246	-0.431	0.365	0.213	-0.211	1.075	0.129	0.319	0.384	0.344	-0.01	0.811	0.003	-0.562	0.869	-0.212	0.599	-0.017	0.18	-0.246	-0.148	0.644	-0.138	0.058	-0.107	-0.357	0.143	-0.179	0.572	0.122	0.788	-0.512	0.329	1.206	-0.125	-0.009	0					
PR_SR3	-0.053	-0.65	-0.188	-0.349	0.439	0.262	-0.731	-0.055	-0.516	-0.99	-0.239	0.181	-0.25	-0.192	-1.194	-1.267	-0.129	-1.163	0.002	-0.777	-0.468	-0.601	0.028	-0.063	-0.512	-0.016	-0.281	-0.554	-0.235	-0.609	-0.541	-0.452	0.218	-1.378	-0.533	0.549	0.646	0.737	0.734	0				
PR_SR2	0.491	-0.168	0.447	0.504	0.354	-0.123	-0.342	0.629	-0.085	-0.496	0.094	0.17	-0.171	0.074	-0.237	-0.372	0.809	-0.639	0.486	-0.173	0.155	-0.507	0.089	0.664	-0.019	0.156	-0.172	-0.127	0.424	0.085	-0.334	-0.525	0.142	-0.363	0.126	1.049	-0.616	-0.129	-0.176	-0.046	0			
PR_SR1	0.577	-0.216	0.197	0.612	0.71	-0.193	0.028	1.571	0.344	0.281	0.112	0.164	-0.406	1.017	0.325	-0.076	1.009	-0.302	0.756	-0.037	0.462	-0.482	0.12	0.654	0.071	0.469	0.066	-0.153	0.194	0.417	0.523	0.504	1.162	-0.187	0.065	0.73	-1.212	-0.396	-0.062	-0.188	0.146	0		
PR_PR2	0.188	0.099	0.34	0.388	0.733	-0.834	0.601	1.295	-1.068	-0.014	-0.037	0.481	-0.007	1.208	0.092	-0.934	0.134	0.144	0.402	-0.377	0.005	-0.312	0.099	0.106	0.045	0.478	-0.15	-0.422	0.232	0.271	-0.157	0.125	0.053	0.002	-0.003	0.667	-0.309	-0.281	0.288	-0.08	-0.241	0.459	0	
PR_PR1	-0.862	-0.91	-0.551	-0.685	0.614	-1.605	0.302	0.743	-1.573	-0.478	-0.624	-0.377	-0.99	0.828	-0.042	-1.169	0.119	0.265	-0.316	-1.17	-0.135	-0.493	0.42	-0.042	-0.619	-0.586	-0.545	-0.693	0.305	-0.129	-0.064	0.232	-0.053	-0.345	-0.658	0.01	-0.421	-0.154	0.986	0.341	-0.112	0.537	0	0

Appendix C.3: Modification Indices

			M.I.	Par Change
FC4	←	BI	17.564	0.134
FC4	←	SI	13.441	0.12
FC4	←	PE	4.408	0.069
FC4	←	TT_S	6.687	0.098
FC4	←	TT_O	5.483	0.082
FC4	←	PS	21.413	-0.163
FC4	←	HM	6.441	0.079
FC4	←	BI3	17.259	0.124
FC4	←	BI2	20.813	0.136
FC4	←	BI1	12.059	0.102
FC4	←	SI1	15.743	0.121
FC4	←	SI2	11.416	0.102
FC4	←	SI3	12.486	0.109
FC4	←	EE4	4.633	0.071
FC4	←	TT_S3	7.896	0.097
FC4	←	TT_S2	5.243	0.077
FC4	←	TT_S1	5.423	0.079
FC4	←	TT_OT3	5.58	0.074
FC4	←-	TT_OT2	5.067	0.073
FC4	←	TT_OT1	4.117	0.067
FC4	←	PSR2	17.912	-0.13
FC4	←	PSR4	17.57	-0.127
FC4	←	PSR5	14.32	-0.112
FC4	←	HM1	4.667	0.062
FC4	←	HM2	4.818	0.064
FC4	←	HM3	10.738	0.096
BI2	←	FC	4.41	-0.035
BI2	←	INO3	4.018	-0.033
BI2	←	FC3	8.191	-0.044
BI2	←	PE4	5.617	-0.035
BI1	←	FC	4.492	0.042
BI1	←	SI	4.038	0.041
BI1	←	INO1	4.079	0.042
BI1	←	FC1	6.475	0.041
BI1	←	SI1	4.415	0.04
BI1	←	SI2	4.204	0.038
BI1	←	PR_OR3	4.947	-0.045
INO3	←	BI	4.474	-0.059
INO3	←	SI	8.175	-0.081
INO3	←	PE	4.913	-0.063
INO3	←	PS	8.767	0.09
INO3	←	HM	6.019	-0.066
INO3	←	BI2	5.942	-0.063
INO3	←	BI1	4.912	-0.056
INO3	←	SI1	9.596	-0.081
INO3	←	SI2	5.983	-0.064

Table continued				
			M.I.	Par Change
INO3	←	SI3	9.583	-0.082
INO3	←	PE2	4.992	-0.056
INO3	←	PE3	5.509	-0.056
INO3	←	PSR2	7.169	0.071
INO3	←	PSR4	8.497	0.077
INO3	←	PSR5	5.682	0.061
INO3	←	HM1	4.941	-0.056
INO3	←	HM2	5.852	-0.061
INO3	←	HM3	6.926	-0.067
INO3	←	PR_PR1	4.118	0.071
INO2	←	PS	12.748	-0.115
INO2	←	PR_P	6.644	-0.11
INO2	←	FC4	5.24	-0.066
INO2	←	PSR2	14.416	-0.106
INO2	←	PSR4	10.321	-0.089
INO2	←	PSR5	9.125	-0.081
INO2	←	PR_OR3	5.508	0.07
INO2	←	PR_PR2	5.611	-0.085
INO2	←	PR_PR1	10.063	-0.118
INO1	←	PE	5.269	0.06
INO1	←	HM	8.244	0.071
INO1	←	BI2	4.968	0.053
INO1	←	BI1	5.49	0.055
INO1	←	SI1	4.325	0.051
INO1	←	PE1	13.736	0.088
INO1	←	PE2	5.063	0.052
INO1	←	HM1	14.191	0.087
INO1	←	HM2	6.602	0.06
INO1	←	HM3	5.994	0.058
INO1	←	PR_OR3	12.557	-0.092
INO1	←	PR_OR2	5.533	-0.062
FC1	←	BI	5.771	-0.078
FC1	←	INO	6.617	-0.106
FC1	←	SI	5.704	-0.079
FC1	←	EE	6.876	-0.097
FC1	←	TT_P	6.548	-0.104
FC1	←	TT_S	6.053	-0.094
FC1	←	TT_O	5.129	-0.08
FC1	←	PS	8.895	0.106
FC1	←	PR_P	6.665	0.123
FC1	←	BI3	6.317	-0.076
FC1	←	BI2	5.33	-0.07
FC1	←	INO2	5.299	-0.066
FC1	←-	INO1	8.006	-0.095
FC1	←	FC3	4.388	0.062
FC1	←	SI1	4.986	-0.069
FC1	←	SI2	4.956	-0.068
FC1	←	SI3	5.859	-0.075

Table Continued				
			M.I.	**Par Change**
FC1	←	EE1	11.791	-0.119
FC1	←	EE3	6.234	-0.084
FC1	←	EE4	9.73	-0.104
FC1	←	PE3	4.436	-0.059
FC1	←	TT_P3	7.468	-0.1
FC1	←	TT_P2	6.634	-0.092
FC1	←	TT_P3	5.599	-0.083
FC1	←	TT_S2	5.87	-0.083
FC1	←	TT_S1	4.292	-0.071
FC1	←	TT_OT3	5.678	-0.075
FC1	←	TT_OT2	5.145	-0.074
FC1	←	PSR2	4.546	0.066
FC1	←	PSR4	8.718	0.091
FC1	←	PSR5	7.638	0.083
FC1	←	HM3	4.623	-0.064
FC1	←	PR_SR1	4.243	0.072
FC1	←	PR_PR2	6.145	0.099
FC1	←	PR_PR1	5.803	0.099
FC2	←	EE	9.399	0.109
FC2	←	PR_P	4.852	-0.101
FC2	←	INO3	5.757	0.074
FC2	←	INO2	4.643	0.06
FC2	←	EE1	12.088	0.116
FC2	←	EE2	12.025	0.114
FC2	←	EE3	4.569	0.069
FC2	←	EE4	16.786	0.132
FC2	←	PR_PR2	4.777	-0.084
FC2	←	PR_PR1	4.848	-0.087
FC3	←	FC1	8.754	0.061
FC3	←	EE4	4.14	-0.053
FC3	←	PE1	4.543	0.05
SI1	←	HM	7.578	0.051
SI1	←	HM1	8.217	0.049
SI1	←	HM2	8.105	0.049
SI1	←	HM3	6.677	0.045
SI2	←	BI	4.519	-0.035
SI2	←	TT_S	4.957	-0.043
SI2	←	TT_O	6.335	-0.045
SI2	←	BI3	4.979	-0.034
SI2	←	BI2	4.829	-0.033
SI2	←	TT_S3	6.903	-0.046
SI2	←	TT_OT3	6.655	-0.041
SI2	←	TT_OT2	6.694	-0.043
SI2	←	TT_OT1	5.532	-0.039
SI2	←	HM3	4.188	-0.031
EE1	←	BI	9.356	-0.064
EE1	←	TT_O	4.379	-0.048
EE1	←	PS	17.283	0.096

Table continued				
			M.I.	**Par Change**
EE1	←	PR_P	7.667	0.086
EE1	←	BI3	8.38	-0.057
EE1	←	BI2	11.365	-0.066
EE1	←	BI1	6.13	-0.048
EE1	←	FC1	5.524	-0.04
EE1	←	PE3	5.647	-0.043
EE1	←	TT_OT3	5.995	-0.05
EE1	←	TT_OT2	4.002	-0.043
EE1	←	PSR2	19.51	0.089
EE1	←	PSR4	13.592	0.074
EE1	←	PSR5	10.492	0.063
EE1	←	HM3	5.361	-0.045
EE1	←	PR_PR2	7.794	0.073
EE1	←	PR_PR1	5.658	0.064
EE2	←	FC1	5.75	0.04
EE2	←	FC2	5.521	0.044
EE3	←	BI	7.069	0.052
EE3	←	PE	10.915	0.066
EE3	←	PS	4.815	-0.047
EE3	←	PR_O	4.912	-0.05
EE3	←	PR_P	8.908	-0.086
EE3	←	BI3	6.75	0.047
EE3	←	BI2	8.175	0.052
EE3	←	BI1	4.638	0.039
EE3	←	PE1	16.161	0.073
EE3	←	PE2	12.108	0.062
EE3	←	PE3	11.322	0.057
EE3	←	PE4	4.684	0.037
EE3	←	TT_P3	4.584	0.047
EE3	←	PSR4	6.064	-0.046
EE3	←	PSR5	5.694	-0.043
EE3	←	HM2	4.757	0.039
EE3	←	PR_OR1	6.627	-0.053
EE3	←	PR_PR2	8.394	-0.07
EE3	←	PR_PR1	8.666	-0.073
EE4	←	PE1	4.857	-0.039
EE4	←	PE2	5.458	-0.04
EE4	←	PR_SR2	5.102	0.046
PE1	←	FC	10.15	0.082
PE1	←	EE	5.199	0.067
PE1	←	TT_P	4.228	0.067
PE1	←	TT_O	7.273	0.076
PE1	←	PS	8.682	0.084
PE1	←	INO1	7.452	0.073
PE1	←	FC1	11.746	0.072
PE1	←	FC3	13.026	0.086
PE1	←	EE3	8.761	0.079
PE1	←	PE3	4.464	-0.047

Table continued				
			M.I.	**Par Change**
PE1	←	TT_P3	4.433	0.061
PE1	←	TT_S2	4.571	0.058
PE1	←	TT_OT3	5.725	0.06
PE1	←	TT_OT2	6.856	0.068
PE1	←	TT_OT1	10.792	0.087
PE1	←	PSR2	9.578	0.076
PE1	←	PSR4	7.462	0.067
PE1	←	PSR5	7.943	0.067
PE1	←	PR_OR3	4.715	-0.057
PE3	←	FC	4.226	-0.054
PE3	←	PS	9.885	-0.091
PE3	←	INO2	5.166	0.053
PE3	←	FC1	4.974	-0.047
PE3	←	FC3	5.364	-0.056
PE3	←	EE1	5.924	-0.068
PE3	←	PE1	5.267	-0.056
PE3	←	PE4	4.944	0.052
PE3	←	PSR2	17.223	-0.104
PE3	←	PSR4	9.01	-0.075
PE4	←	PE3	4.895	0.05
TT_TCP2	←	PE2	5.127	0.035
TT_TCS1	←	EE3	4.197	-0.039
TT_OT3	←	BI	5.796	0.037
TT_OT3	←	PS	7.734	-0.047
TT_OT3	←	PR_P	4.597	-0.049
TT_OT3	←	BI3	6.601	0.037
TT_OT3	←	BI2	5.445	0.034
TT_OT3	←	BI1	4.898	0.031
TT_OT3	←	SI3	4.405	0.031
TT_OT3	←	TT_S1	4.101	0.033
TT_OT3	←	PSR2	4.482	-0.031
TT_OT3	←	PSR5	9.694	-0.045
TT_OT3	←	PR_PR2	4.138	-0.039
TT_OT3	←	PR_PR1	5.038	-0.044
TT_OT2	←	PE3	7.347	-0.033
TT_OT2	←	PR_PR1	5.709	0.042
TT_OT1	←	PS	4.038	0.033
TT_OT1	←	EE2	6.758	0.041
TT_OT1	←	PE1	4.842	0.03
TT_OT1	←	PSR5	7.893	0.039
PSR2	←	INO2	4.248	-0.049
PSR2	←	PE3	4.885	-0.052
PSR4	←	INO1	5.043	0.068
HM1	←	FC	6.284	0.047
HM1	←	EE	4.08	0.043
HM1	←	PE	4.503	0.041
HM1	←	TT_P	4.104	0.048
HM1	←	TT_O	6.307	0.051

Table continued				
			M.I.	**Par Change**
HM1	←	PR_O	13.367	-0.079
HM1	←	PR_S	5.208	-0.051
HM1	←	BI1	4.109	0.035
HM1	←	INO1	9.209	0.059
HM1	←	FC1	8.865	0.045
HM1	←	FC2	4.579	0.037
HM1	←	EE2	6.089	0.049
HM1	←	PE1	8.91	0.052
HM1	←	PE2	7.156	0.046
HM1	←	TT_P2	7	0.055
HM1	←	TT_OT2	8.25	0.055
HM1	←	TT_OT1	6.959	0.051
HM1	←	PSR4	5.696	0.043
HM1	←	PR_OR3	17.328	-0.08
HM1	←	PR_OR2	16.046	-0.077
HM1	←	PR_OR1	8.363	-0.058
HM1	←	PR_SR3	9.831	-0.062
HM2	←	SI	4.302	-0.034
HM2	←	SI2	4.977	-0.034
HM2	←	SI3	4.981	-0.034
HM3	←	FC	4.594	-0.042
HM3	←	PS	5.987	-0.053
HM3	←	PR_O	9.465	0.07
HM3	←	PR_S	8.06	0.066
HM3	←	FC1	7.203	-0.043
HM3	←	FC2	6.623	-0.046
HM3	←	FC3	4.187	-0.037
HM3	←	EE1	4.491	-0.045
HM3	←	PSR2	4.084	-0.038
HM3	←	PSR4	10.64	-0.061
HM3	←	PR_OR3	6.388	0.051
HM3	←	PR_OR2	8.388	0.058
HM3	←	PR_OR1	9.031	0.063
HM3	←	PR_SR3	10.952	0.068
HM3	←	PR_SR2	7.678	0.058
PR_OR3	←	PS	4.568	-0.061
PR_OR3	←	INO1	4.559	-0.057
PR_OR3	←	PSR4	4.788	-0.054
PR_OR3	←	PSR5	4.713	-0.052
PR_OR3	←	HM1	4.585	-0.05
PR_OR3	←	PR_SR1	4.256	-0.058
PR_OR1	←	PS	4.039	0.038
PR_OR1	←	FC3	4.65	0.034
PR_OR1	←	PSR2	5.716	0.039
PR_OR1	←	PR_PR1	8.94	0.066
PR_SR3	←	FC	4.624	-0.036
PR_SR3	←	EE	5.959	-0.048
PR_SR3	←	PR_O	7.244	0.053

Table continued				
			M.I.	**Par Change**
PR_SR3	←	BI1	4.022	-0.031
PR_SR3	←	FC1	5.501	-0.032
PR_SR3	←	EE2	8.126	-0.051
PR_SR3	←	EE3	5.602	-0.042
PR_SR3	←	EE4	5.498	-0.041
PR_SR3	←	TT_OT1	4.302	-0.036
PR_SR3	←	HM1	7.043	-0.041
PR_SR3	←	PR_OR3	15.888	0.069
PR_SR3	←	PR_OR2	8.223	0.05
PR_SR3	←	PR_OR1	6.977	0.048
PR_SR1	←	FC	4.846	0.038
PR_SR1	←	PS	5.681	0.046
PR_SR1	←	FC1	7.34	0.038
PR_SR1	←	FC3	4.221	0.033
PR_SR1	←	EE1	5.422	0.044
PR_SR1	←	PSR2	4.247	0.034
PR_SR1	←	PSR4	5.256	0.038
PR_SR1	←	PSR5	5.895	0.039
PR_SR1	←	PR_OR3	8.363	-0.052
PR_PR1	←	BI3	4.063	-0.034
PR_PR1	←	BI1	4.095	-0.033
PR_PR1	←	TT_S2	4.19	-0.039

Appendix D: Re-Estimated Measurement Model

Appendix D.1: Standardised Regression Weights

			Estimate
PR_PR1	←	PR_PR	0.891
PR_PR2	←	PR_PR	0.963
PR_SR1	←	PR_SR	0.925
PR_SR2	←	PR_SR	0.968
PR_SR3	←	PR_SR	0.936
PR_OR1	←	PR_O	0.94
PR_OR2	←	PR_O	0.955
PR_OR3	←	PR_O	0.825
HM3	←	HM	0.932
HM2	←	HM	0.971
HM1	←	HM	0.943
PSR4	←	PS	0.832
PSR2	←	PS	0.877
TT_OT1	←	TT_O	0.955
TT_OT2	←	TT_O	0.966
TT_OT3	←	TT_O	0.957
TT_S1	←	TT_S	0.916
TT_S2	←	TT_S	0.958
TT_S3	←	TT_S	0.951
TT_P1	←	TT_P	0.887
TT_P2	←	TT_P	0.944
TT_P3	←	TT_P	0.905
PE4	←	PE	0.886
PE2	←	PE	0.939
PE1	←	PE	0.866
SI3	←	SI	0.952
SI2	←	SI	0.965
SI1	←	SI	0.933
INO1	←	INO	0.861
INO2	←	INO	0.876
INO3	←	INO	0.839
BI1	←	BI	0.929
BI2	←	BI	0.956
BI3	←	BI	0.968
PE3	←	PE	0.887
PSR5	←	PS	0.882

Appendix D.2: Standardised Residual Covariances

	BI3	BI2	BI1	INO3	INO2	INO1	SI2	SI3	PE1	PE2	PE3	PE4	TT_P3	TT_P2	TT_P1	TT_S3	TT_S2	TT_S1	TT_OT3	TT_OT2	TT_OT1	PSR2	PSR4	PSR5	HM1	HM2	HM3	PR_OR3	PR_OR2	PR_OR1	PR_SR3	PR_SR2	PR_SR1	PR_PR2	PR_PR1
BI3	0																																		
BI2	0.01	0																																	
BI1	-0.018	0.002	0																																
INO3	-0.09	-0.185	-0.076	0																															
INO2	-0.01	-0.062	0.088	0.063	0																														
INO1	0.084	0.082	0.186	0.012	-0.061	0																													
SI1	0.053	0.022	0.162	-0.154	0.072	0.141																													
SI2	-0.069	-0.109	0.042	-0.147	0.075	0.068	0																												
SI3	0.033	-0.013	0.124	-0.208	0.066	0.017	0.009	0																											
PE1	0.068	-0.021	0.081	-0.039	-0.026	0.268	-0.014	-0.016	0																										
PE2	-0.057	-0.057	-0.021	-0.176	-0.068	0.09	-0.076	-0.028	0.066	0																									
PE3	0.018	-0.048	-0.003	-0.136	0.136	0.056	-0.023	0.04	-0.149	0.013	0																								
PE4	0.111	-0.024	0.139	-0.099	-0.036	0.087	0.02	0.108	-0.052	-0.053	0.141	0																							
TT_P3	0.006	-0.025	-0.038	-0.052	0.018	0.079	-0.041	0.014	0.109	-0.05	-0.015	-0.028	0																						
TT_P2	0.026	0.019	0.05	-0.095	-0.043	0.06	-0.023	0.031	0.137	0.056	-0.02	0.029	-0.011	0																					
TT_P1	-0.042	-0.064	-0.011	-0.046	0.011	0.081	-0.043	0.008	0.013	-0.107	-0.136	-0.113	0.02	0.002	0																				
TT_S3	0.046	0.013	0.028	-0.042	-0.016	0.071	-0.048	0.062	0.116	0.02	0.018	0.005	0.046	0.021	0.053	0																			
TT_S2	0.003	-0.022	0.004	-0.082	-0.009	0.067	-0.051	0.019	0.116	-0.04	-0.017	-0.078	-0.03	-0.041	-0.024	0.002	0																		
TT_S1	-0.053	-0.057	-0.004	-0.114	0.005	0.065	-0.061	0.016	0.052	-0.06	-0.036	-0.039	0	-0.015	0.057	-0.02	0.015	0																	
TT_OT3	0.083	0.052	0.128	-0.079	0.061	0.095	-0.014	0.118	0.173	-0.041	-0.009	0.032	0.046	0.055	-0.056	0.045	0.027	0.077	0																
TT_OT2	-0.034	-0.048	0.04	-0.051	-0.027	0.051	-0.091	0.029	0.125	-0.087	-0.137	-0.008	-0.028	0.042	-0.076	-0.019	-0.058	-0.019	-0.004	0															
TT_OT1	-0.05	-0.079	0	-0.105	-0.034	0.051	-0.085	0.017	0.227	0.005	-0.019	-0.012	-0.008	0.003	-0.082	0.019	-0.016	0.014	-0.019	0.018	0														
PSR2	-0.006	-0.097	-0.043	0.098	-0.292	-0.015	0.034	-0.03	0.164	0.031	-0.294	-0.12	-0.013	-0.016	0.01	-0.046	-0.065	-0.05	-0.087	0.008	0.027	0													
PSR4	0.067	0.023	0.094	0.265	-0.085	0.182	0.06	-0.008	0.14	-0.023	-0.225	-0.082	0.003	-0.031	-0.009	0.024	0.018	0.038	-0.029	0.059	0.055	-0.007	0												
PSR5	-0.029	0.021	0.049	0.149	-0.178	0.048	0.034	-0.045	0.244	0.114	-0.056	-0.024	0.014	0.001	0.068	0.05	0.021	0.046	-0.109	-0.004	0.09	-0.014	0.026	0											
HM1	0.055	0.007	0.102	-0.083	-0.009	0.265	0.03	0.003	0.213	0.126	0.004	0.01	0.018	0.116	0.024	0.052	0.038	0.037	0.111	0.073	0.119	-0.011	0.073	0.128	0										
HM2	0.01	-0.089	-0.03	-0.164	-0.042	0.127	-0.1	-0.074	0.044	-0.041	-0.082	-0.101	-0.018	-0.009	-0.023	-0.017	0.024	-0.016	0.024	-0.08	-0.01	-0.02	-0.026	0.073	0	0									
HM3	0.043	0.001	-0.004	-0.192	-0.062	0.105	-0.009	0.061	0.045	0.007	-0.003	-0.038	-0.054	-0.025	-0.064	-0.051	-0.049	-0.058	-0.019	-0.085	-0.03	-0.133	-0.178	-0.03	-0.044	0.022	0								
PR_OR3	0.018	0.054	-0.097	0.031	0.097	-0.209	-0.02	-0.08	-0.19	-0.038	-0.016	-0.05	-0.097	-0.07	-0.052	-0.012	0.036	-0.051	-0.059	-0.07	-0.098	-0.137	-0.197	-0.109	-0.271	-0.088	0.005	0							
PR_OR2	0.002	0.03	-0.056	0.05	0.071	-0.121	0	-0.01	-0.126	0.035	-0.003	-0.007	0.002	-0.009	0.084	-0.028	0.045	-0.024	0.012	0.036	0.031	-0.046	-0.075	0.051	-0.161	0.02	0.121	0.02	0						
PR_OR1	-0.004	0.035	-0.059	0.042	0.032	-0.022	0.045	-0.001	-0.029	0.081	0.001	0.027	-0.028	-0.015	0.076	-0.016	0.008	-0.012	-0.048	0.02	-0.022	0.07	0.014	0.099	-0.07	0.045	0.164	-0.019	-0.002	0					
PR_SR3	-0.087	-0.025	-0.047	0.051	0.038	-0.082	0.024	-0.031	-0.154	0	-0.107	-0.063	-0.068	0.004	-0.007	-0.062	-0.002	-0.034	-0.073	-0.03	-0.076	-0.068	-0.057	0.027	-0.187	-0.072	0.074	0.089	0.106	0.099	0				
PR_SR2	-0.022	0.06	0.068	0.04	-0.014	-0.037	0.022	-0.021	-0.084	0.065	-0.022	0.023	-0.057	0.011	0.075	-0.002	0.019	-0.021	-0.017	0.054	0.011	-0.041	-0.065	0.017	-0.049	0.016	0.139	-0.085	-0.018	-0.026	-0.008	0			
PR_SR1	-0.029	0.025	0.081	0.082	-0.024	0.005	0.02	-0.05	-0.04	0.099	-0.003	0.064	-0.054	0.014	0.073	0.008	0.056	0.008	-0.02	0.024	0.051	0.064	0.062	0.146	-0.025	0.008	0.095	-0.162	-0.054	-0.009	-0.027	0.022	0		
PR_PR2	0.011	0.038	0.044	0.074	-0.093	0.061	0.053	-0.001	0.015	0.045	-0.042	0.002	-0.03	0.01	0.01	0.005	0.048	-0.014	-0.046	0.024	0.028	-0.016	0.014	0.005	0	-0.001	0.074	-0.033	-0.031	0.03	-0.009	-0.025	0.049	0	
PR_PR1	-0.097	-0.058	-0.074	0.06	-0.176	0.031	-0.039	-0.102	0.028	-0.034	-0.13	-0.013	-0.045	0.04	-0.004	-0.057	-0.055	-0.051	-0.072	0.032	-0.012	-0.007	0.024	-0.007	-0.037	-0.071	0.002	-0.045	-0.018	0.099	0.034	-0.013	0.053	0	0

Appendix D.3: Modification Indices

			M.I.	Par Change
BI2	←	INO3	4.073	-0.033
BI2	←	PE4	5.644	-0.035
BI1	←	SI	4.026	0.041
BI1	←	INO1	4.104	0.042
BI1	←	SI1	4.415	0.04
BI1	←	SI2	4.217	0.038
BI1	←	PR_OR3	4.981	-0.045
INO3	←	SI	7.584	-0.079
INO3	←	PE	4.677	-0.062
INO3	←	PS	7.675	0.085
INO3	←	HM	5.437	-0.063
INO3	←	BI2	5.35	-0.06
INO3	←	BI1	4.24	-0.053
INO3	←	SI1	8.75	-0.078
INO3	←	SI2	5.357	-0.061
INO3	←	SI3	8.781	-0.08
INO3	←	PE2	4.472	-0.054
INO3	←	PE3	5.203	-0.055
INO3	←	PSR2	6.628	0.069
INO3	←	PSR4	7.93	0.075
INO3	←	PSR5	5.186	0.059
INO3	←	HM1	4.285	-0.052
INO3	←	HM2	5.134	-0.058
INO3	←	HM3	6.503	-0.065
INO2	←	PS	12.223	-0.112
INO2	←	PR_PR	6.545	-0.11
INO2	←	PSR2	14.084	-0.105
INO2	←	PSR4	10.117	-0.088
INO2	←	PSR5	8.917	-0.081
INO2	←	PR_OR3	5.708	0.071
INO2	←	PR_PR2	5.537	-0.085
INO2	←	PR_PR1	10.049	-0.118
INO1	←	PE	5.159	0.059
INO1	←	HM	7.907	0.07
INO1	←	BI2	4.53	0.051
INO1	←	BI1	5.19	0.053
INO1	←	SI1	4.007	0.049
INO1	←	PE1	14.075	0.089
INO1	←	PE2	4.806	0.051
INO1	←	HM1	13.88	0.086
INO1	←	HM2	6.312	0.059
INO1	←	HM3	5.365	0.054
INO1	←	PR_OR3	12.703	-0.093
INO1	←	PR_OR2	5.48	-0.061
SI1	←	HM	7.597	0.051
SI1	←	HM1	8.291	0.049

Table continued				
			M.I.	**Par Change**
SI1	←	HM2	8.192	0.05
SI1	←	HM3	6.562	0.045
SI2	←	BI	4.588	-0.035
SI2	←	TT_S	4.995	-0.043
SI2	←	TT_O	6.394	-0.045
SI2	←	BI3	5.005	-0.034
SI2	←	BI2	4.943	-0.034
SI2	←	TT_S3	6.884	-0.046
SI2	←	TT_OT3	6.775	-0.041
SI2	←	TT_OT2	6.784	-0.043
SI2	←	TT_OT1	5.5	-0.039
SI2	←	HM3	4.441	-0.031
PE1	←	TT_P	4.264	0.068
PE1	←	TT_O	7.483	0.078
PE1	←	PS	8.175	0.082
PE1	←	INO1	7.39	0.073
PE1	←	PE3	4.441	-0.048
PE1	←	TT_P3	4.637	0.063
PE1	←	TT_S2	4.802	0.06
PE1	←	TT_OT3	5.801	0.061
PE1	←	TT_OT2	7.055	0.07
PE1	←	TT_OT1	11.205	0.09
PE1	←	PSR2	9.674	0.077
PE1	←	PSR4	7.368	0.067
PE1	←	PSR5	7.617	0.066
PE1	←	PR_OR3	4.686	-0.057
PE3	←	PS	9.304	-0.088
PE3	←	INO2	4.94	0.052
PE3	←	PE1	5.424	-0.057
PE3	←	PE4	4.406	0.049
PE3	←	PSR2	16.705	-0.102
PE3	←	PSR4	8.808	-0.074
PE4	←	PE3	4.339	0.047
TT_P2	←	PE2	5.055	0.035
TT_OT3	←	BI	5.759	0.037
TT_OT3	←	PS	7.65	-0.047
TT_OT3	←	PR_PR	4.594	-0.049
TT_OT3	←	BI3	6.59	0.037
TT_OT3	←	BI2	5.435	0.034
TT_OT3	←	BI1	4.887	0.031
TT_OT3	←	SI3	4.4	0.031
TT_OT3	←	TT_S1	4.086	0.033
TT_OT3	←	PSR2	4.466	-0.031
TT_OT3	←	PSR5	9.697	-0.045
TT_OT3	←	PR_PR2	4.139	-0.039
TT_OT3	←	PR_PR1	5.035	-0.044
TT_OT2	←	PE3	7.365	-0.033
TT_OT2	←	PR_PR1	5.715	0.043

Table continued				
			M.I.	**Par Change**
TT_OT1	←	PE1	4.867	0.03
TT_OT1	←	PSR5	7.872	0.039
PSR2	←	INO2	4.422	-0.05
PSR2	←	PE3	5.171	-0.053
PSR4	←	INO1	4.932	0.068
HM1	←	PE	4.445	0.041
HM1	←	TT_P	4.103	0.048
HM1	←	TT_O	6.286	0.051
HM1	←	PR_O	13.284	-0.079
HM1	←	PR_SR	5.274	-0.051
HM1	←	BI1	4.084	0.035
HM1	←	INO1	9.066	0.059
HM1	←	PE1	9.053	0.053
HM1	←	PE2	7.147	0.046
HM1	←	TT_P2	6.928	0.055
HM1	←	TT_OT2	8.205	0.054
HM1	←	TT_OT1	6.98	0.051
HM1	←	PSR4	5.744	0.043
HM1	←	PR_OR3	17.362	-0.08
HM1	←	PR_OR2	16.092	-0.077
HM1	←	PR_OR1	8.359	-0.058
HM1	←	PR_SR3	9.933	-0.062
HM2	←	SI	4.263	-0.034
HM2	←	SI2	4.871	-0.033
HM2	←	SI3	4.869	-0.034
HM3	←	PS	5.636	-0.051
HM3	←	PR_O	9.45	0.07
HM3	←	PR_SR	8.33	0.067
HM3	←	PSR2	4.005	-0.038
HM3	←	PSR4	10.61	-0.061
HM3	←	PR_OR3	6.515	0.051
HM3	←	PR_OR2	8.538	0.059
HM3	←	PR_OR1	9.216	0.063
HM3	←	PR_SR3	11.059	0.068
HM3	←	PR_SR2	7.793	0.058
PR_OR3	←	PS	4.549	-0.061
PR_OR3	←	INO1	4.54	-0.057
PR_OR3	←	PSR4	4.799	-0.054
PR_OR3	←	PSR5	4.702	-0.052
PR_OR3	←	HM1	4.637	-0.05
PR_OR3	←	PR_SR1	4.276	-0.058
PR_OR1	←	PSR2	5.657	0.039
PR_OR1	←	PR_PR1	8.804	0.065
PR_SR3	←	PR_O	7.095	0.052
PR_SR3	←	TT_OT1	4.233	-0.036
PR_SR3	←	HM1	6.997	-0.041
PR_SR3	←	PR_OR3	15.765	0.069

Table continued				
			M.I.	**Par Change**
PR_SR3	←	PR_OR2	8.133	0.05
PR_SR3	←	PR_OR1	6.927	0.048
PR_SR1	←	PS	5.531	0.045
PR_SR1	←	PSR2	4.277	0.035
PR_SR1	←	PSR4	5.26	0.038
PR_SR1	←	PSR5	5.879	0.039
PR_SR1	←	PR_OR3	8.294	-0.051
PR_PR1	←	BI1	4.013	-0.033
PR_PR1	←	TT_S2	4.124	-0.038

Appendix E: Structural Model

Appendix E.1: Path Coefficients Including Control Variables

			Estimate	Standardised estimate	Standard error	Critical ratio	P-value
TT_O	←	TT_S	0.469	0.436	0.049	9.665	***
TT_O	←	TT_P	0.584	0.511	0.053	11.05	***
PR_O	←	PR_SR	0.674	0.658	0.037	18.363	***
PR_O	←	PR_PR	0.161	0.129	0.039	4.125	***
PR_O	←	TT_O	-0.234	-0.247	0.027	-8.793	***
BI	←	PE	0.218	0.217	0.051	4.312	***
BI	←	EE	-0.073	-0.065	0.054	-1.339	0.18
BI	←	SI	0.121	0.12	0.042	2.881	0.004
BI	←	FC	0.033	0.034	0.047	0.704	0.482
BI	←	HM	0.116	0.121	0.046	2.547	0.011
BI	←	PS	-0.216	-0.205	0.034	-6.284	***
BI	←	INO	0.21	0.172	0.047	4.427	***
BI	←	PR_O	-0.078	-0.068	0.034	-2.32	0.02
BI	←	TT_O	0.274	0.253	0.04	6.907	***
BI	←	Gender	-0.036	-0.011	0.077	-0.469	0.639
BI	←	Age	-0.017	-0.013	0.034	-0.512	0.609

Note: *** = p-value < 0.001

Appendix E.2: Re-Estimated Path Coefficients Including Control Variables

			Estimate	Standardised estimate	Standard error	Critical ratio	P-value
TT_O	←	TT_S	0.469	0.436	0.049	9.676	***
TT_O	←	TT_P	0.583	0.511	0.053	11.039	***
PR_O	←	PR_S	0.674	0.659	0.037	18.373	***
PR_O	←	PR_P	0.162	0.129	0.039	4.132	***
PR_O	←	TT_O	-0.233	-0.246	0.027	-8.783	***
BI	←	PR_O	-0.079	-0.069	0.034	-2.368	0.018
BI	←	PE	0.195	0.194	0.047	4.187	***
BI	←	SI	0.12	0.118	0.041	2.932	0.003
BI	←	HM	0.116	0.12	0.045	2.562	0.01
BI	←	PS	-0.216	-0.206	0.033	-6.64	***
BI	←	INO	0.21	0.173	0.045	4.659	***
BI	←	TT_O	0.268	0.247	0.039	6.891	***
BI	←	Gender	-0.035	-0.01	0.077	-0.452	0.651
BI	←	Age	-0.025	-0.019	0.032	-0.771	0.441

Note: *** = p-value < 0.001

List of References

Adams, D.A., Nelson, R.R. and Todd, P.A. (1992), "Perceived Usefulness, Ease of Use, and Usage of Information Technology: A Replication", *MIS Quarterly*, Vol. 16 No. 2, pp. 227–247.

Adell, E. (2009), "Driver Experience and Acceptance of Driver Support Systems - A Case Speed Adoption", *Department of Technology and Society, Lund University*.

Adell, E. (2010), "Acceptance of Driver Support Systems", *Proceedings of the European Conference on Human Centred Design for Intelligent Transport Systems*, pp. 475–486.

Adell, E., Varhelyi, A. and Nilsson, L. (2017), "The Definition of Acceptance and Acceptability", in Horberry, T. (Ed.), *Driver Acceptance of New Technology: Theory, measurement and optimisation*, Routledge, Surrey, pp. 11–23.

Agarwal, R. and Prasad, J. (1998), "A Conceptual and Operational Definition of Personal Innovativeness in the Domain of Information Technology", *Information Systems Research*, Vol. 9 No. 2, pp. 204–215.

Ajzen, I. (1985), "From Intentions to Actions: A Theory of Planned Behavior", in Kuhl, J. and Beckmann, J. (Eds.), *Action control: From cognition to behavior, Springer series in social psychology*, Springer, Berlin, pp. 11–39.

Ajzen, I. (1991), "The Theory of Planned Behavior", *Organizational Behavior and Human Decision Processes*, Vol. 50 No. 2, pp. 179–211.

Ajzen, I. and Fishbein, M. (1975), *Belief, Attitude, Intention and Behavior: An Introduction to Theory and Research*, Addison-Wesley, Reading.

Ajzen, I. and Fishbein, M. (1980), *Understanding attitudes and predicting social behavior*, Pbk. ed., Prentice-Hall, Englewood Cliffs, N.J.

Ajzen, I. and Fishbein, M. (2005), "The Influence of Attitude on Behaviour", in Albarracin, D., Johnson, B.T. and Zanna, M.P. (Eds.), *The Handbook of attititudes*, Lawrence Erlbaum Associates Publishers, Mahwah, pp. 173–221.

Al-Ajam, A.S. and Md Nor, K. (2015), "Challenges of adoption of internet banking service in Yemen", *International Journal of Bank Marketing*, Vol. 33 No. 2, pp. 178–194.

Alalwan, A.A., Baabdulla, A.M., Rana, N.P., Dwivedi, Y.K., Hudaib, F. and Shammout, A. (2018a), "Examining the Factors Affecting Behavioural Intention to

Adopt Mobile Health in Jordan", *Proceedings of the 17th Conference on e-Business, e-Services, and e-Society*, pp. 459–467.

Alalwan, A.A., Dwivedi, Y.K. and Rana, N.P. (2017), "Factors influencing adoption of mobile banking by Jordanian bank customers. Extending UTAUT2 with trust", *International Journal of Information Management*, Vol. 37 No. 3, pp. 99–110.

Alalwan, A.A., Dwivedi, Y.K., Rana, N.P. and Algharabat, R. (2018b), "Examining factors influencing Jordanian customers' intentions and adoption of internet banking: Extending UTAUT2 with risk", *Journal of Retailing and Consumer Services*, Vol. 40, pp. 125–138.

Alalwan, A.A., Dwivedi, Y.K., Rana, N.P.P. and Williams, M.D. (2016a), "Consumer adoption of mobile banking in Jordan: Examining the role of usefulness, ease of use, perceived risk and self-efficacy", *Journal of Enterprise Information Management*, Vol. 29 No. 1, pp. 118–139.

Alalwan, A.A., Dwivedi, Y.K. and Williams, M.D. (2016b), "Customers' Intention and Adoption of Telebanking in Jordan", *Information Systems Management*, Vol. 33 No. 2, pp. 154–178.

Albright, B. (2017), "Carriers, Shippers turn to Technology to Drive Down Last-Mile Logistics Costs", *Aftermarket Business World*, June, pp. 2–3.

Al-Mamary, Y.H., Al-nashmi, M., Hassan, Y.A.G. and Shamsuddin, A. (2016), "A Critical Review of Models and Theories in Field of Individual Acceptance of Technology", *International Journal of Hybrid Information Technology*, Vol. 9 No. 6, pp. 143–158.

Al-Qeisi, K.I. and Al-Abdallah, G.M. (2013), "Internet Banking Adoption in Jordan. A Behavioral Approach", *International Journal of Marketing Studies*, Vol. 5 No. 6, pp. 84–108.

Alvesson, M. and Kärreman, D. (2007), "Constructing Mystery: Empirical Matters in Theory Development", *The Academy of Management Review*, Vol. 32 No. 4, pp. 1265–1281.

Anderson, J.C. and Gerbing, D.W. (1988), "Structural equation modeling in practice: A review and recommended two-step approach", *Psychological Bulletin*, Vol. 103 No. 3, pp. 411–423.

Angelis, M. de, Puchades, V.M., Fraboni, F., Pietrantoni, L. and Prati, G. (2017), "Negative attitudes towards cyclists influence the acceptance of an in-vehicle cyclist detection system", *Transportation Research Part F: Traffic Psychology and Behaviour*, Vol. 49, pp. 244–256.

Arain, A.A., Hussain, Z., Rizvi, W.H. and Vighio, M.S. (2019), “Extending UTAUT2 toward acceptance of mobile learning in the context of higher education”, *Universal Access in the Information Society*, Vol. 94 No. 1, p. 67.

Armitage, C.J. and Conner, M. (2001), “Efficacy of the Theory of Planned Behaviour: A meta-analytic review”, *British Journal of Social Psychology*, Vol. 40, pp. 471–499.

Armstrong, G., Kotler, P., Harker, M. and Brennan, R. (2009), *Marketing: An introduction*, Financial Times Prentice Hall, Harlow.

Attewell, P. (1992), “Technology Diffusion and Organizational Learning: The Case of Business Computing”, *Organization Science*, Vol. 3 No. 1, pp. 1–19.

Backstrom, C.H. and Hursh, G.D. (1963), *Survey research, Handbooks for research in political behavior,* Northwestern University Press, Evanston.

Bagozzi, R.P. (2007), “The Legacy of the Technology Acceptance Model and a Proposal for a Paradigm Shift”, *Journal of the Association for Information Science and Technology*, Vol. 8 No. 4, pp. 244–254.

Bagozzi, R.P. and Phillips, L.W. (1982), “Representing and Testing Organizational Theories. A Holistic Construal”, *Administrative Science Quarterly*, Vol. 27 No. 3, pp. 459–489.

Baker, R., Brick, J.M., Bates, N.A., Battaglia, M., Couper, M.P., Dever, J.A., Gile, K.J. and Tourangeau, R. (2013), “Summary Report of the AAPOR Task Force on Non-probability Sampling”, *Journal of Survey Statistics and Methodology*, Vol. 1 No. 2, pp. 90–143.

Bandura, A. (1977), “Self-efficacy: Toward a Unifying Theory of Behavioral Change”, *Psychology Review*, Vol. 84 No. 2, pp. 191–215.

Bandura, A. (1982), “Self-efficacy mechanism in human agency”, *American Psychologist*, Vol. 37 No. 2, pp. 122–147.

Bandura, A. (1986), *Social foundations of thought and action: A social cognitive theory, Prentice-Hall series in social learning theory*, Prentice-Hall, Englewood Cliffs, NJ.

Bandura, A. (1988), “Organisational Applications of Social Cognitive Theory”, *Australian Journal of Management*, Vol. 13 No. 2, pp. 275–302.

Bandura, A. (1992), “On rectifying the comparative anatomy of perceived control. Comments on “Cognates of personal control””, *Applied and Preventive Psychology*, Vol. 1 No. 2, pp. 121–126.

Bandura, A. (1998), “Health promotion from the perspective of social cognitive theory”, *Psychology & Health*, Vol. 13 No. 4, pp. 623–649.

Bansal, P. and Kockelman, K. (2016), “Forecasting Amercans' long-term adoption of connected and autonomous vehicle technologies”, *Transportation Research Part A: Policy and Practice*, Vol. 95, pp. 49–63.

Bansal, P., Kockelman, K.M. and Singh, A. (2016), “Assessing public opinions of and interest in new vehicle technologies. An Austin perspective”, *Transportation Research Part C: Emerging Technologies*, Vol. 67, pp. 1–14.

Bauer, R.A. (1960), “Consumer Behavior as Risk Taking”, in Hancock, R.S. (Ed.), *Dynamic Marketing for a Changing World,*, American Marketing Association, Chicago, pp. 389–398.

Becker, F. and Axhausen, K.W. (2017), “Literature review on surveys investigating the acceptance of automated vehicles”, *Transportation*, Vol. 44 No. 6, pp. 1293–1306.

Benbasat, I. and Barki, H. (2007), “Quo vadis, TAM?”, *Journal of the Association for Information Systems*, Vol. 8 No. 4, pp. 211–218.

Bentler, P.M. and Speckart, G. (1979), “Models of attitude-behavior relations”, *Psychological Review*, Vol. 86 No. 5, pp. 452–464.

BIEK (2019), “Clever verpackt - effizient zugestellt [clever parcelled - efficently delivered]. KEP-Studie 2019 - Analyse des Marktes in Deutschland [CEP-study 2019 - analysis of the German market]”, available at: https://www.biek.de/publikationen/studien.html (accessed 28 June 2019).

Blaikie, N. (2006), *Analyzing quantitative data: From description to explanation*, Reprinted., Sage Publications, London.

Blut, M., Wang, C. and Schoefer, K. (2016), “Factors Influencing the Acceptance of Self-Service Technologies. A Meta-Analysis”, *Journal of Service Research*, Vol. 19 No. 4, pp. 396–416.

Bortz, J. and Döring, N. (2002), *Forschungsmethoden und Evaluation für Human- und Sozialwissenschaftler [Research methods and evaluations for human- and social researchers]*, 3. edition, Springer, Berlin, Heidelberg.

Bowman, C. and Fishbein, M. (1978), “Understanding Public Reaction to Energy Proposals: An Application of the Fishbein Model”, *Journal of Applied Social Psychology*, Vol. 8 No. 4, pp. 319–340.

Boyd, H.W., Westfall, R.L. and Stasch, S.F. (1991), *Marketing research: Text and cases*, 7th ed., Irwin, Homewood, Ill.

Braun, F. and Buckstegen, N. (2017), “Die Zukunft der Logistik [The future of logistics]. Wie die Deutschen über Paketroboter und Lieferdrohnen denken [How Germans think about delivery robots and delivery drones]”, available at: https://d25d2506sfb94s.cloudfront.net/r/52/YouGov_Befragungsergebnisse_Lieferroboter_.pdf (accessed 5 April 2018).

Braun, V. and Clarke, V. (2006), “Using thematic analysis in psychology”, *Qualitative Research in Psychology*, Vol. 3 No. 2, pp. 77–101.

Breakwell, G.M., Smith, J.A. and Wright, D.B. (2012), *Research Methods in Psychology*, 4th Edition, SAGE, Los Angeles.

Brislin, R.W. (1970), “Back-Translation for Cross-Cultural Research”, *Journal of Cross-Cultural Psychology*, Vol. 1 No. 3, pp. 185–216.

Brown, J.R. and Guiffrida, A.L. (2014), “Carbon emissions comparison of last mile delivery versus customer pickup”, *International Journal of Logistics Research and Applications*, Vol. 17 No. 6, pp. 503–521.

Brown, S.A. and Venkatesh, V. (2005), “Model of Asoption of Technology in Households: A Baseline Model Test and Extension Incorporating Household Life Cycle”, *MIS Quarterly*, Vol. 29 No. 3, pp. 399–426.

Browne, M.W. and Cudeck, R. (1992), “Alternative Ways of Assessing Model Fit”, *Socialogical Methods & Research*, Vol. 21 No. 2, pp. 230–258.

Bryman, A. and Bell, E. (2015), *Business research methods*, Fourth edition, Oxford University Press, Oxford.

Buckley, L., Kaye, S.-A. and Pradhan, A.K. (2018), “Psychosocial factors associated with intended use of automated vehicles: A simulated driving study”, *Accident Analysis and Prevention*, Vol. 115, pp. 202–208.

Byrne, B.M. (2016), *Structural Equation Modeling With AMOS: Basic Concepts, Applications, and Programming, Third Edition, Multivariate Applications Series*, 3rd ed., Taylor and Francis, Florence.

Cagliano, A.C., Marco, A. de and Rafele, C. (2017), “E-grocery supply chain management enabled by mobile tools”, *Business Process Management Journal*, Vol. 23 No. 1, pp. 47–70.

Carson, D., Gilmore, A., Perry, C. and Gronhaug, K. (2001), *Qualitative Marketing Research*, SAGE Publications, Ltd, London.

Cattell, R.B. (1979), *The scientific use of factor analysis in behavioral and life sciences*, 2. print, Plenum Press, New York.

Çelik, H. (2011), “Influence of social norms, perceived playfulness and online shopping anxiety on customers' adoption of online retail shopping”, *International Journal of Retail & Distribution Management*, Vol. 39 No. 6, pp. 390–413.

Chan, F.K.Y., Gong, M., Xu, Y. and Thong, J. (2008), “Examining User Acceptance of SMS: An Empirical Study in China and Hong Kong”, *12th Pacific Asia Conference on Information Systems*, pp. 1247–1258.

Chang, I.-C., Hwang, H.-G., Hung, W.-F. and Li, Y.-C. (2007), “Physicians’ acceptance of pharmacokinetics-based clinical decision support systems”, *Expert Systems with Applications*, Vol. 33 No. 2, pp. 296–303.

Chen, H. and Chen, S. (2009), “The empirical study of automotive telematics acceptance in Taiwan: comparing three technology acceptance models”, *International Journal of Mobile Communications*, Vol. 7 No. 1, pp. 50–65.

Chen, H.-K. and Yan, D.-W. (2018), “Interrelationships between influential factors and behavioral intention with regard to autonomous vehicles”, *International Journal of Sustainable Transportation*, Vol. 13, pp. 1–17.

Chen, M.-C., Wu, P.-J. and Hsu, Y.-H. (2019), “An effective pricing model for the congestion alleviation of e-commerce logistics”, *Computers & Industrial Engineering*, Vol. 129, pp. 368–376.

Chen, Y., Yu, J., Yang, S., Wei, J. and Cheung, C. (2018), “Consumer’s intention to use self-service parcel delivery service in online retailing. An empirical study”, *Internet Research*, Vol. 28 No. 2, pp. 500–519.

Childers, T.L., Carr, C.L., Peck, J. and Carson, S. (2001), “Hedonic and utilitarian motivations for online retail shopping behavior”, *Journal of Retailing*, Vol. 77 No. 4, pp. 511–535.

Chiu, Y.-T.H. and Hofer, K.M. (2015), “Service innovation and usage intention: a cross-market analysis”, *Journal of Service Management*, Vol. 26 No. 3, pp. 516–538.

Chiu Helena, Y.-T., Fang, S.-C. and Tseng, C.-C. (2010), “Early versus potential adopters: Exploring the antecedents of use intention in the context of retail service innovations”, *International Journal of Retail & Distribution Management*, Vol. 38 No. 6, pp. 443–459.

Choi, J.K. and Ji, Y.G. (2015), “Investigating the Importance of Trust on Adopting an Autonomous Vehicle”, *International Journal of Human-Computer Interaction*, Vol. 31 No. 10, pp. 692–702.

Choi, S. (2016), “The flipside of ubiquitous connectivity enabled by smartphone-based social networking service: Social presence and privacy concern”, *Computers in Human Behavior*, Vol. 65, pp. 325–333.

Chong, A.Y.-L. (2013), “A two-staged SEM-neural network approach for understanding and predicting the determinants of m-commerce adoption”, *Expert Systems with Applications*, Vol. 40 No. 4, pp. 1240–1247.

Clarke, R. (1999), “Internet privacy concerns confirm the case for intervention”, *Communications of the ACM*, Vol. 42 No. 2, pp. 60–67.

Clarke, R. (2009), “A Primer in Diffusion of Innovations Theory”, available at: http://www.rogerclarke.com (accessed 2 March 2018).

Collier, J.E. and Kimes, S. (2012), “Only if it is Convenient: Understanding How Convenience Influences Self-Service Technology Evaluation”, *Journal of Service Research*, Vol. 16 No. 1, pp. 39–51.

Collins, A.T. (2015), “Behavioural Influences on the Environmental Impact of Collection/Delivery Points”, in Fahimnia, B., Bell, M.G.H., Hensher, D.A. and Sarkis, J. (Eds.), *Green logistics and transportation: A sustainable supply chain perspective*, *Greening of industry networks studies*, Springer, Cham, pp. 15–34.

Collis, J. and Hussey, R. (2014), *Business research: A practical guide for undergraduate & postgraduate students*, 4rd ed., Palgrave Macmillan, Basingstoke.

Compeau, D. and Higgins, C.A. (1995), “Application of Social Cognitive Theory to Training for Computer Skills”, *Information Systems Research*, Vol. 6 No. 2, pp. 118–143.

Compeau, D. and Higgins, C.A. (1999), “A social cognitive theory perspective on individual reactions to computing technology: A Longitudinal Study”, *MIS Quarterly*, Vol. 23 No. 2, pp. 145–158.

Comrey, A.L. and Lee, H.B. (1992), *A First Course in Factor Analysis*, Erlbaum Lawrence, Hillsdale.

Connolly, G.J. (2017), “Applying Social Cognitive Theory in Coaching Athletes. The Power of Positive Role Models”, *Strategies*, Vol. 30 No. 3, pp. 23–29.

Continental (2013), “German Motorists Want Automated Freeway Driving”, available at: https://www.continental.com/en/press/german-motorists-want-automated-freeway-driving-7398 (accessed 13 April 2019).

Continental (2014), “Motorists Worldwide Open to Automated Driving”, available at: https://www.continental.com/en/press/motorists-worldwide-open-to-automated-driving-7460 (accessed 13 April 2019).

Cook, D., Mulrow, C. and Haynes, B. (1997), “Systematic Reviews: Synthesis of Best Evidence for Clinical Decisions”, *Annals of Internal Medicine*, Vol. 126 No. 5, pp. 376–380.

Cooper, D.R. and Schindler, P.S. (2014), *Business Research Methods, The McGraw-Hill/Irwin series in operations and decision sciences Business statistics,* 12th edition, McGraw-Hill Irwin, New York, NY.

Cowart, K.O., Fox, G.L. and Wilson, A.E. (2008), “A structural look at consumer innovativeness and self-congruence in new product purchases”, *Psychology and Marketing*, Vol. 25 No. 12, pp. 1111–1130.

Creswell, J.W. (2014), *Research design: Qualitative, quantitative, and mixed methods approaches,* 4th edition, international student edition, SAGE, Los Angeles, London, New Delhi, Singapore, Washington, DC.

Cunningham, S. (1967), “The major dimensions of perceived risk. In: D. Cox (Ed.), Risk Taking and Information Handling in Consumer Behavior. Harvard University Press, Cambridge, MA.”, pp. 82–102.

Curran, J.M. and Meuter, M.L. (2005), “Self-service technology adoption. Comparing three technologies”, *Journal of Services Marketing*, Vol. 19 No. 2, pp. 103–113.

Curtin, R., Presser, S. and Singer, E. (2005), “Changes in Telephone Survey Nonresponse over the Past Quarter Century”, *Public Opinion Quarterly,* Vol. 69 No. 1, pp. 87–98.

Dabholkar, P.A., Michelle Bobbitt, L. and Lee, E.-J. (2003), “Understanding consumer motivation and behavior related to self-scanning in retailing”, *International Journal of Service Industry Management*, Vol. 14 No. 1, pp. 59–95.

Dablanc, L. and Montenon, A. (2015), “Impacts of Environmental Access Restrictions on Freight Delivery Activities”, *Transportation Research Record: Journal of the Transportation Research Board,* Vol. 2478 No. 1, pp. 12–18.

Davis, F.D. (1985), *A Technology Acceptance Model For Empirically Testing New End-User Information Systems: Theory and Results,* Massachusetts Institute of Technology. Doctoral Thesis.

Davis, F.D. (1989), “Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology”, *MIS Quarterly,* pp. 319–340.

Davis, F.D. (1993), “User acceptance of information technology: system characteristics, user perceptions and behavioral impacts”, *International Journal of Man-Machine Studies,* Vol. 38, pp. 475–487.

Davis, F.D., Bagozzi, R.P. and Warshaw, P.R. (1989), “User Acceptance of Computer Technology: A Comparison of Two Theoretical Models”, *Management Science*, Vol. 35 No. 8, pp. 982–1003.

Davis, F.D., Bagozzi, R.P. and Warshaw, P.R. (1992), “Extrinsic and Intrinsic Motivation to Use Computers in the Workplace”, *Journal of Applied Social Psychology*, Vol. 22 No. 14, pp. 1111–1132.

Davis, F.D. and Venkatesh, V. (1996), “A Critical Assessment of Potential Measurement Biases in the Technology Acceptance Model: Three Experiments”, *International Journal of Human-Computer Studies*, Vol. 45, pp. 19–45.

Deci, E. and Ryan, R. (1985), *Intrinsic Motivation and Self-Determination in Human Behavior*, Plenum, New York, London.

Deloitte (2014), “Global Automotive Consumer Study - The changing nature of mobility. Exploring consumer preferences in key markets around the world”, available at: https://www2.deloitte.com/content/dam/Deloitte/au/Documents/manufacturing/deloitte-au-mfg-2014-global-automotive-consumer-study-changing-nature-mobility-290914.pdf (accessed 13 April 2019).

Demoulin, N.T.M. and Djelassi, S. (2016), “An integrated model of self-service technology (SST) usage in a retail context”, *International Journal of Retail & Distribution Management*, Vol. 44 No. 5, pp. 540–559.

Destatis (2017a), *Facts about the German Population*, available at: https://www.destatis.de/DE/ZahlenFakten/GesellschaftStaat/BildungForschungKultur/Bildungsstand/Aktuell.html (accessed 22 January 2019).

Destatis (2017b), *Net-Household-Income in Germany*, available at: https://www-genesis.destatis.de/genesis/online/data;sid=3B12CFAFA76647C279A01E0DBF569A86.GO_1_4?operation=abruftabelleAbrufen&selectionname=12211-0105&levelindex=0&levelid=1546422474613&index=1 (accessed 28 September 2018).

Destatis (2019a), *Number of German Citizens*, available at: https://www.destatis.de/DE/Themen/Gesellschaft-Umwelt/Bevoelkerung/Bevoelkerungsstand/_inhalt.html.

Destatis (2019b), *Number of Students Enrolled at German Universities*, available at: https://www.destatis.de/DE/ZahlenFakten/GesellschaftStaat/BildungForschungKultur/Hochschulen/Hochschulen.html (accessed 3 January 2019).

Deutsche Post AG (2012), “Einkaufen 4.0 - Der Einfluss von E-Commerce auf Lebensqualität und Einkaufsverhalten [Shopping 4.0 - The influence of e-commerce on life quality and shopping behaviour]”, available at: https://www.post-und-telekommunikation.de/PuT/1Fundus/Dokumente/Studien/Deutsche_Post/Einkaufen 4.0_E-Commerce-Studie.pdf (accessed 20 July 2019).

Deutsche Post DHL (2018a), “Logistics Trend Radar. Delievering insight today, creatin value tommorrow”, available at: https://www.logistics.dhl/content/dam/dhl/global/core/documents/pdf/glo-core-trend-radar-widescreen.pdf (accessed 29 July 2019).

Deutsche Post DHL (2018b), “Shortening the Last Mile: Winning Logistics Startegies in the Race to the Urban Consumer. A custom report complied by Euromonitor International for Deutsche Post DHL Group”, available at: https://delivering-tomorrow.com/wp-content/uploads/2018/11/dhl-whitepaper-shortening-the-last-mile.pdf (accessed 29 July 2019).

Dillman, D.A. (2007), *Mail and internet surveys: The tailored design method,* 2 ed., 2007 update with new Internet, visual, and mixed-mode guide, Wiley, Hoboken, NJ.

Dillon, A. and Morris, M.G. (1996), “User Acceptance of Information Technology: Theories and Models”, *Annual Review of Information Science and Technology,* Vol. 31, pp. 3–32.

Dimitriadis, S. and Kyrezis, N. (2010), “Linking trust to use intention for technology-enabled bank channels: The role of trusting intentions”, *Psychology and Marketing,* Vol. 27 No. 8, pp. 799–820.

Dimitriadis, S. and Kyrezis, N. (2011), “The effect of trust, channel technology, and transaction type on the adoption of self-service bank channels”, *The Service Industries Journal,* Vol. 31 No. 8, pp. 1293–1310.

Ding, L., Velicer, W.F. and Harlow, L.L. (1995), “Effects of estimation methods, number of indicators per factor, and improper solutions on structural equation modeling fit indices”, *Structural Equation Modeling: A Multidisciplinary Journal,* Vol. 2 No. 2, pp. 119–143.

Dispatch (2019), “Picture Dispatch Robot”, available at: https://www.welcome.ai/dispatch (accessed 1 July 2019).

Dodds, W.B., Monroe, K.B. and Grewal, D. (1991), “Effects of Price, Brand, and Store Information on Buyers' Product Evaluations”, *Journal of Marketing Research,* Vol. 28 No. 3, pp. 307–319.

Douglas, S.P. and Craig, S.C. (2007), “Collaborative and Iterative Translation: An Alternative Approach to Back Translation”, *Journal of International Marketing,* Vol. 15 No. 1, pp. 30–43.

Dowling, G.R. and Staelin, R. (1994), “A Model of Perceived Risk and Intended Risk-Handling Activity”, *Journal of Consumer Research*, Vol. 21 No. 1, pp. 119–134.

Dudenhöffer, K. (2013), “Why electric vehicles failed”, *Journal of Management Control*, Vol. 24 No. 2, pp. 95–124.

Dwivedi, Y.K., Rana, N.P., Jeyaraj, A., Clement, M. and Williams, M.D. (2019), “Re-examining the Unified Theory of Acceptance and Use of Technology (UTAUT): Towards a Revised Theoretical Model”, *Information Systems Frontiers*, Vol. 21 No. 3, pp. 719–734.

Eagly, A.H. and Chaiken, S. (2011), *The psychology of attitudes*, Wadsworth Cengage Learning, Belmont, CA.

Eastman, C. and Marzillier, J.S. (1984), “Theoretical and methodological difficulties in Bandura's self-efficacy theory”, *Cognitive Therapy and Research*, Vol. 8 No. 3, pp. 213–229.

Eurobarometer (2017), “Attitudes towards the impact of digitalisation and automation on daily life. Special Eurobarometer 460”, available at: https://ec.europa.eu/digital-single-market/en/news/attitudes-towards-impact-digitisation-and-automation-daily-life (accessed 1 September 2018).

Eurostat (2017), *German Population by Age and Sex*, available at: http://ec.europa.eu/eurostat/en/web/products-datasets/-/DEMO_PJAN (accessed 28 September 2018).

Everitt, B.S. (1975), “Multivariate Analysis. The Need for Data, and other Problems”, *The British Journal of Psychiatry*, Vol. 126 No. 3, pp. 237–240.

Farah, M.F., Hasni, M.J.S. and Abbas, A.K. (2018), “Mobile-banking adoption: empirical evidence from the banking sector in Pakistan”, *International Journal of Bank Marketing*, Vol. 36 No. 7, pp. 1386–1413.

Featherman, M.S. and Hajli, N. (2016), “Self-Service Technologies and e-Services Risks in Social Commerce Era”, *Journal of Business Ethics*, Vol. 139 No. 2, pp. 251–269.

Featherman, M.S. and Pavlou, P.A. (2003), “Predicting e-services adoption. A perceived risk facets perspective”, *International Journal of Human-Computer Studies*, Vol. 59 No. 4, pp. 451–474.

Festinger, L. (2009), *A theory of cognitive dissonance, The Macat Library*, Stanford University Press, Stanford, California.

Fichman, R.G. (1992), “Information technology diffusion: a review of empirical research”, *International Conference on Information Systems*, Vol. 39, pp. 195–206.

Flint, D., Larsson, E., Gammelgaard, B. and Mentzer, B. (2005), “Logistics Innovation: A Customer Value-Oriented Social Process”, *Journal of Business Logistics*, Vol. 26 No. 1, pp. 113–147.

Florio, A.M., Feillet, D. and Hartl, R.F. (2018), “The delivery problem: Optimizing hit rates in e-commerce deliveries”, *Transportation Research Part B: Methodological*, Vol. 117, pp. 455–472.

Fornell, C. and Larcker, D.F. (1981), “Evaluating Structural Equation Models with Unobservable Variables and Measurement Error”, *American Marketing Association*, Vol. 18 No. 1, pp. 39–50.

Fraedrich, E., Cynganski, R., Wolf, I. and Lenz, B. (2016), “User Perspectives on Autonomous Driving: A Use-Case-Driven Study in Germany”, *Geographisches Institut Humboldt-Universität zu Berlin*, Vol. 187, pp. 1–108.

Fu, H.-P., Chang, T.-H., Lin, A., Du, Z.-J. and Hsu, K.-Y. (2015), “Key factors for the adoption of RFID in the logistics industry in Taiwan”, *The International Journal of Logistics Management*, Vol. 26 No. 1, pp. 61–81.

Gefen, D., Karahanna, E. and Straub, D. (2003), “Trust and TAM in Online Shopping: An Integrated Model”, *MIS Quarterly*, Vol. 27 No. 1, pp. 51–90.

Gelderman, C.J., Ghijsen, P.W.T. and van Diemen, R. (2011), “Choosing self-service technologies or interpersonal services—The impact of situational factors and technology-related attitudes”, *Journal of Retailing and Consumer Services*, Vol. 18 No. 5, pp. 414–421.

Ghazizadeh, M., Lee, J.D. and Boyle, L.N. (2012), “Extending the Technology Acceptance Model to assess automation”, *Cognition, Technology & Work*, Vol. 14 No. 1, pp. 39–49.

Giovanis, A., Assimakopoulos, C. and Sarmaniotis, C. (2018), “Adoption of mobile self-service retail banking technologies”, *International Journal of Retail & Distribution Management*, Vol. 13 No. 4, p. 379.

Glasser, G.J. and Metzger, G.D. (1972), “Random-Digit Dialing as a Method of Telephone Sampling”, *Journal of Marketing Research*, Vol. 9 No. 1, p. 59.

Goldsmith, R.E., Kim, D., Flynn, L.R. and Kim, W.-M. (2005), “Price sensitivity and innovativeness for fashion among Korean consumers”, *The Journal of social psychology*, Vol. 145 No. 5, pp. 501–508.

Goldsmith, R.E. and Newell, S.J. (1997), “Innovativeness and price sensitivity. Managerial, theoretical and methodological issues”, *Journal of Product & Brand Management*, Vol. 6 No. 3, pp. 163–174.

Grawe, S.J. (2009), “Logistics innovation: a literature-based conceptual framework”, *The International Journal of Logistics Management*, Vol. 20 No. 3, pp. 360–377.

Green, P.E., Tull, D.S. and Albaum, G. (1988), *Research for marketing decisions, The Prentice Hall Series in Marketing,* 5. ed., Prentice-Hall, Englewood Cliffs, N.J.

Greenhalgh, T., Glenn, R., Macfarlane, F., Bate, P. and Kyriakidou, O. (2004), “Diffusion of Innovations in Service Organizations: Systematic Review and Recommendations”, *The Milbank Quarterly*, Vol. 82 No. 4, pp. 581–629.

Greenhalgh, T. and Peacock, R. (2005), “Effectiveness and efficiency of search methods in systematic reviews of complex evidence: audit of primary sources”, *BMJ (Clinical research ed.),* Vol. 331 No. 7524, pp. 1064–1065.

Gupta, B., Dasgupta, S. and Gupta, A. (2008), “Adoption of ICT in a government organization in a developing country. An empirical study”, *The Journal of Strategic Information Systems,* Vol. 17 No. 2, pp. 140–154.

Hair, J.F., Black, W., Babin, B. and Anderson, R. (2010), *Multivariate data analysis: A global perspective,* 7. ed., global ed., Pearson, Upper Saddle River, NJ.

Hair, J.F., Black, W.C., Babin, B.J. and Anderson, R.E. (2014a), *Multivariate data analysis,* 7th edition, new international edition, Pearson, Harlow.

Hair, J.F., Gabriel, Marcelo Luiz Dias da Silva and Patel, V.K. (2014b), “AMOS Covariance-Based Structural Equation Modeling (CB-SEM): Guidelines on its Application as a Marketing Research Tool”, *Revista Brasileira de Marketing*, Vol. 13 No. 2, pp. 44–55.

Hale, J.L., Householder, B.J. and Greene, K.L. (2002), “The Theory of Reasoned Action”, in Dillard, J.P. and Pfau, M. (Eds.), *The persuasion handbook: Developments in theory and practice*, Sage Publications, Thousand Oaks, CA, pp. 259–286.

Hammady, R., Ma, M., Strathern, C. and Mohamad, M. (2019), “Design and development of a spatial mixed reality touring guide to the Egyptian museum”, *Multimedia Tools and Applications*, Vol. 27 No. 1.

Handelsverband Deutschland (2019), “Online Monitor 2019”, available at: https://einzelhandel.de/online-monitor (accessed 1 June 2019).

HDS Consulting (2019), “Fahrermangel: Das Damoklesschwert der boomended KEP-Branche [Driver shortage: swort of Damocles of the booming CEP-sector]”, available at: http://www.hds-international.group/fahrermangel-das-damoklesschwert-der-boomenden-kep-branche/.

Hegner, S.M., Beldad, A.D. and Brunswick, G.J. (2019), “In Automatic We Trust: Investigating the Impact of Trust, Control, Personality Characteristics, and Extrinsic and Intrinsic Motivations on the Acceptance of Autonomous Vehicles”, *International Journal of Human–Computer Interaction*, Vol. 54 No. 4, pp. 1–12.

Herrero Crespo, A. and Rodriguez del Bosque, I. (2010), “The influence of the commercial features of the Internet on the adoption of e-commerce by consumers”, *Electronic Commerce Research and Applications,* Vol. 9 No. 6, pp. 562–575.

Hilton, C.E. (2017), “The importance of pretesting questionnaires: a field research example of cognitive pretesting the Exercise referral Quality of Life Scale (ER-QLS)”, *International Journal of Social Research Methodology*, Vol. 20 No. 1, pp. 21–34.

Hirschman, E.C. (1980), “Innovativeness, Novelty Seeking, and COnsumer Creativity”, *Journal of Consumer Research*, Vol. 7 No. 3, pp. 283–295.

Hochschule Heilbronn (2019), “Picture BUGA:log Vehicle”, available at: https://bugalog.se.hs-heilbronn.de/#/ (accessed 1 July 2019).

Homburg, C. and Krohmer, H. (2011), *Marketingmanagement [Marketing management]: Strategie - Instrumente - Umsetzung - Unternehmensführung [strategy - instruments - implementation - corporate management]*, 3. edition, Gabler, Wiesbaden.

Hota, J. and Mishra, S. (2018), “Development and validation of a multivendor ATM adoption model in India”, *International Journal of Bank Marketing*, Vol. 36 No. 5, pp. 884–907.

Howard, D. and Dai, D. (2014), “Public Perceptions of Self-driving Cars: The Case of Berkeley, Carlifornia”, *Annual Meeting of the Transportation Research Board*, pp. 1–21.

Hox, J. and Bechger, T.M. (2004), “An Introduction to Structural Equation Modeling”, *Family Science Review*, Vol. 11, pp. 354–373.

Hu, L.-t. and Bentler, P.M. (1999), “Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives”, *Structural Equation Modeling: A Multidisciplinary Journal*, Vol. 6 No. 1, pp. 1–55.

Hulse, L.M., Xie, H. and Galea, E.R. (2018), “Perceptions of autonomous vehicles. Relationships with road users, risk, gender and age”, *Safety Science,* Vol. 102, pp. 1–13.

Hur, H.J., Lee, H.K. and Choo, H.J. (2017), “Understanding usage intention in innovative mobile app service: Comparison between millennial and mature consumers”, *Computers in Human Behavior*, Vol. 73, pp. 353–361.

Hussein, Z. (2017), “Leading to Intention: The Role of Attitude in Relation to Technology Acceptance Model in E-Learning”, *Procedia Computer Science*, Vol. 105, pp. 159–164.

Hwang, J. and Choe, J.Y. (2019), “Exploring perceived risk in building successful drone food delivery services”, *International Journal of Contemporary Hospitality Management*, Vol. 31 No. 8, pp. 3249–3269.

Iacobucci, D. and Churchill, G.A. (2010), *Marketing research: Methodological foundations,* 10th ed., South-Western, Mason, OH.

Igbaria, M., Parasuraman, S. and Baroudi, J.J. (2016), “A Motivational Model of Microcomputer Usage”, *Journal of Management Information Systems*, Vol. 13 No. 1, pp. 127–143.

In’nami, Y. and Koizumi, R. (2013), “Review of Sample Size for Structural Equation Models in Second Language Testing and Learning Research. A Monte Carlo Approach”, *International Journal of Testing*, Vol. 13 No. 4, pp. 329–353.

IPSOS Mori (2014), “Loyalty Automotive Survey.”, available at: https://www.ipsos-mori.com/researchpublications/ researcharchive/3427/Only-18-per-cent-of-Britons-believe-driverless-cars-to-be-an-importantdevelopment-for-the-car-industry-to-focus-on.aspx (accessed 1 August 2018).

J.D. Power (2012), “Vehicle Owners Show Willingness to Spend on Automotive Infortainment Features”, available at: https://www.prnewswire.com/news-releases/jd-power-and-associates-reports-vehicle-owners-show-willingness-to-spend-on-automotive-infotainment-features-149088105.html (accessed 4 June 2018).

Jacoby, J. and Kaplan, L. (1972), “The Components of Perceived Risk”, *Third Annual Convention of the Association for Consumer Research*, Vol. 3 No. 3, pp. 1–21.

Jennings, D. and Figliozzi, M. (2019), “Study of Sidewalk Autonomous Delivery Robots and Their Potential Impacts on Freight Efficiency and Travel”, *Transportation Research Record: Journal of the Transportation Research Board*, 1-10.

Joerss, M., Schröder, A., Neuhaus, F., Klink, C. and Mann, F. (2016), “Parcel delivery. The future of last mile”, available at: https://www.mckinsey.com/publikation/parcel-delivery (accessed 1 February 2018).

Johannesson, P. and Perjons, E. (2014), *An introduction to design science*, Springer, Cham.

Johns, G. (2006), “The Essential Impact of Context on Organizational Behavior”, *Academy of Management Review*, Vol. 31 No. 2, pp. 386–408.

Johnson, B. and Christensen, L.B. (2008), *Educational research: Quantitative, qualitative, and mixed approaches*, 3rd ed., SAGE, London.

Johnson, P. and Clark, M. (Eds.) (2006), *Business and management research methodologies, SAGE library in business & management*, SAGE, London.

Kaplan, D. (2009), *Structural equation modeling: Foundations and extensions, Advanced quantitative techniques in the social sciences*, Vol. 10, 2nd ed., SAGE, London.

Kapoor, K.K., Dwivedi, Y.K. and Williams, M.D. (2015), "Empirical Examination of the Role of Three Sets of Innovation Attributes for Determining Adoption of IRCTC Mobile Ticketing Service", *Information Systems Management*, Vol. 32 No. 2, pp. 153–173.

Kapser, S. and Abdelrahman, M. (in press), "Acceptance of autonomous delivery vehicles - Applying UTAUT in the context of last-mile logistics", *Proceedings of 8th Transport Research Arena TRA 2020*.

Kapser, S. and Abdelrahman, M. (in review), "Acceptance of Autonomous Delivery Vehicles for Last-Mile Delivery in Germany - Extending UTAUT2 with Risk Perceptions", *Transportation Research Part C: Emerging Technologies*.

Kapser, S. and Abdelrahman, M. (2019), "Extending UTAUT2 to Explore User Acceptance of Autonomous Delivery Vehicles", *25th Americas Conference on Information Systems*.

Kaur, G. and Gupta, S. (2012), "Consumers' Behavioral Intentions Toward Self-Service Technology in the Emerging Markets", *Journal of Global Marketing*, Vol. 25 No. 5, pp. 241–261.

Kaur, K. and Rampersad, G. (2018), "Trust in driverless cars: Investigating key factors influencing the adoption of driverless cars", *Journal of Engineering and Technology Management*, Vol. 48, pp. 87–96.

Kaushik, A.K. and Kumar, V. (2018), "Investigating consumers' adoption of SSTs – a case study representing India's hospitality industry", *Journal of Vacation Marketing*, Vol. 24 No. 3, pp. 275–290.

Kaushik, A.K. and Rahman, Z. (2015a), "An alternative model of self-service retail technology adoption", *Journal of Services Marketing*, Vol. 29 No. 5, pp. 406–420.

Kaushik, A.K. and Rahman, Z. (2015b), "Innovation adoption across self-service banking technologies in India", *International Journal of Bank Marketing*, Vol. 33 No. 2, pp. 96–121.

Kazancoglu, I. and Kursunluoglu Yarimoglu, E. (2018), "How food retailing changed in Turkey: spread of self-service technologies", *British Food Journal*, Vol. 120 No. 2, pp. 290–308.

Kervick, A.A., Hogan, M.J., O'Hora, D. and Sarma, K.M. (2015), "Testing a structural model of young driver willingness to uptake Smartphone Driver Support Systems", *Accident; analysis and prevention*, Vol. 83, pp. 171–181.

Kim, G., Shin, B. and Lee, H.G. (2009), "Understanding dynamics between initial trust and usage intentions of mobile banking", *Information Systems Journal*, Vol. 19 No. 3, pp. 283–311.

Kim, H.-Y. (2013), "Statistical notes for clinical researchers: assessing normal distribution (2) using skewness and kurtosis", *Restorative dentistry & endodontics*, Vol. 38 No. 1, pp. 52–54.

Kim, J. and Forsythe, S. (2008), "Adoption of Virtual Try-on technology for online apparel shopping", *Journal of Interactive Marketing*, Vol. 22 No. 2, pp. 45–59.

Kim, M. and Qu, H. (2014), "Travelers' behavioral intention toward hotel self-service kiosks usage", *International Journal of Contemporary Hospitality Management*, Vol. 26 No. 2, pp. 225–245.

Kim, S.S. and Malhotra, N.K. (2005), "A Longitudinal Model of Continued IS Use: An Integrative View of Four Mechanisms Underlying Postadoption Phenomena", *Management Science*, Vol. 51 No. 5, pp. 741–755.

King, N. and Horrocks, C. (2010), *Interviews in qualitative research*, SAGE, Los Angeles.

Kline, R.B. (2011), *Principles and practice of structural equation modeling, Methodology in the social sciences,* 3rd ed., Guilford Press, New York.

Klugh, H.E. (1986), *Statistics: The essentials for research,* 3rd ed., L. Erlbaum Associates, Hillsdale, N.J.

Koenig-Lewis, N., Marquet, M., Palmer, A. and Zhao, A.L. (2015a), "Enjoyment and social influence: predicting mobile payment adoption", *The Service Industries Journal*, Vol. 35 No. 10, pp. 537–554.

Koenig-Lewis, N., Marquet, M., Palmer, A. and Zhao, A.L. (2015b), "Enjoyment and social influence: predicting mobile payment adoption", *The Service Industries Journal*, Vol. 35 No. 10, pp. 537–554.

Koenig-Lewis, N., Palmer, A. and Moll, A. (2010), "Predicting young consumers' take up of mobile banking services", *International Journal of Bank Marketing*, Vol. 28 No. 5, pp. 410–432.

Kollmann, T. (1998), *Akzeptanz innovativer Nutzungsgüter und -systeme [Acceptance of innovative goods and systems]: Konsequenzen für die Einführung von Telekommunikations- und Multimediasystemen [consequences for the introduction of telecommunications- and multimedia systems]*, Vol. 239, Gabler, Wiesbaden.

Kollmann, T. (2000), “Die Messung der Akzeptanz bei Telekommunikationssystemen [Measuring Acceptance of Telecommunication Systems]”, *Journal of Betriebswirtschaft [Journal of business management]*, Vol. 50 No. 2, pp. 68–78.

König, M. and Neumayr, L. (2017), “Users’ resistance towards radical innovations. The case of the self-driving car”, *Transportation Research Part F: Traffic Psychology and Behaviour*, Vol. 44, pp. 42–52.

Kraftfahrtbundesamt (2019), “Jahresbilanz der Neuzulassungen 2018 [annual balance new registrations 2018]”, available at: https://www.kba.de/DE/Statistik/Fahrzeuge/Neuzulassungen/n_jahresbilanz.html (accessed 7 August 2019).

Ku, E.C.S. and Chen, C.-D. (2013), “Fitting facilities to self-service technology usage: Evidence from kiosks in Taiwan airport”, *Journal of Air Transport Management*, Vol. 32, pp. 87–94.

Kulviwat, S., Bruner II, G.C., Kumar, A., Nasco, S.A. and Clark, T. (2007), “Toward a unified theory of consumer acceptance technology”, *Psychology and Marketing*, Vol. 24 No. 12, pp. 1059–1084.

Kung, F.Y.H., Kwok, N. and Brown, D.J. (2018), “Are Attention Check Questions a Threat to Scale Validity?”, *Applied Psychology*, Vol. 67 No. 2, pp. 264–283.

Kyriakidis, M., Happee, R. and Winter, J.C.F. de (2015), “Public opinion on automated driving. Results of an international questionnaire among 5000 respondents”, *Transportation Research Part F: Traffic Psychology and Behaviour*, Vol. 32, pp. 127–140.

Lai, I.K.W. (2015), “Traveler Acceptance of an App-Based Mobile Tour Guide”, *Journal of Hospitality & Tourism Research*, Vol. 39 No. 3, pp. 401–432.

LaRose, R., Maagd, K., Chew, H.E., Tsai, H.-y.S., Steinfield, C., Wildman, S. and Bauer, J. (2012), “Measuring Sustainable Broadband Adoption: An Innovative Approach to Understanding Broadband Adoption and Use”, *International Journal of Communication*, Vol. 6, pp. 2576–2600.

Lee, C., Ward, C., Raue, M., D’Ambrosio, L. and Coughlin, J.F. (2017), “Age Differences in Acceptance of Self-driving Cars: A Survey of Perceptions and Attitudes”, in Zhou, J. and Salvendy, G. (Eds.), *Human Aspects of IT for the Aged*

Population. Aging, Design and User Experience, Lecture Notes in Computer Science, Vol. 10297, Springer International Publishing, Cham, pp. 3–13.

Lee, C.K.M., Ng, Y., Lv, Y. and Taezoon, P. (2014), “Empirical Analysis of a Self-Service Check-In Implementation in Singapore Changi Airport”, *International Journal of Engineering Business Management*, Vol. 6 No. 4, p. 6.

Lee, H.-J. and Lyu, J. (2019), “Exploring factors which motivate older consumers’ self-service technologies (SSTs) adoption”, *The International Review of Retail, Distribution and Consumer Research*, Vol. 29 No. 2, pp. 218–239.

Lee, H.L., Chen, Y., Gillai, B. and Rommohan, S. (2016), “Technological Disruption and Innovation in Last-Mile Delivery. White Paper”, *Standfort Business Graduate School*.

Lee, J. and Moray, N. (1992), “Trust, control strategies and allocation of function in human-machine systems”, *Ergonomics*, Vol. 35 No. 10, pp. 1243–1270.

Lee, Y., Kozar, K.A. and Larsen, K.R.T. (2003), “The Technology Acceptance Model: Past, Present, and Future”, *Communications of the Association for Information Systems*, Vol. 12 No. 50, pp. 752–780.

Legris, P., Ingham, J. and Collerette, P. (2003), “Why do people use information technology? A critical review of the technology acceptance model”, *Information & Management*, Vol. 40, pp. 191–204.

Leicht, T., Chtourou, A. and Ben Youssef, K. (2018), “Consumer innovativeness and intentioned autonomous car adoption”, *The Journal of High Technology Management Research*, Vol. 29 No. 1, pp. 1–11.

Leimeister, J.M., Ebner, W. and Krcmar, H. (2005), “Design, implementation and evaluation of trust-supporting components in virtual communities for patients.”, *Journal of Management Information Systems*, Vol. 21 No. 4, pp. 101–135.

Lent, R. and Brown, S. (1994), “Toward a Unifying Social Cognitive Theory of Career and Academic Intrest, Choice, and Performance”, *Journal of Vocational Behavior*, Vol. 45, pp. 79–122.

Leon, S. (2018), “Service mobile apps: a millennial generation perspective”, *Industrial Management & Data Systems*, Vol. 118 No. 9, pp. 1837–1860.

Liébana-Cabanillas, F. and Alonso-Dos-Santos, M. (2017), “Factors that determine the adoption of Facebook commerce: The moderating effect of age”, *Journal of Engineering and Technology Management*, Vol. 44, pp. 1–18.

Lim, S.F.W.T., Jin, X. and Srai, J.S. (2018), "Consumer-driven e-commerce", *International Journal of Physical Distribution & Logistics Management*, Vol. 48 No. 3, pp. 308–332.

Limayem, M., Hirt, S.G. and Cheung, C.M.K. (2007), "How Habit Limits the Predictive Power of Intention: The Case of Information Systems Continuance", *MIS Quarterly*, Vol. 31 No. 4, pp. 705–737.

Lin, J.-S.C. and Chang, H.-C. (2011), "The role of technology readiness in self-service technology acceptance", *Managing Service Quality: An International Journal*, Vol. 21 No. 4, pp. 424–444.

Liu, C., Wang, Q. and Susilo, Y.O. (2019a), "Assessing the impacts of collection-delivery points to individual's activity-travel patterns. A greener last mile alternative?", *Transportation Research Part E: Logistics and Transportation Review*, No. 121, pp. 84–99.

Liu, H., Yang, R., Wang, L. and Liu, P. (2019b), "Evaluating Initial Public Acceptance of Highly and Fully Autonomous Vehicles", *International Journal of Human–Computer Interaction*, Vol. 35 No. 11, pp. 919–931.

Liu, P., Guo, Q., Ren, F., Wang, L. and Xu, Z. (2019c), "Willingness to pay for self-driving vehicles: Influences of demographic and psychological factors", *Transportation Research Part C: Emerging Technologies*, Vol. 100, pp. 306–317.

Liu, P., Yang, R. and Xu, Z. (2019d), "Public Acceptance of Fully Automated Driving: Effects of Social Trust and Risk/Benefit Perceptions", *Risk analysis an official publication of the Society for Risk Analysis*, Vol. 39 No. 2, pp. 326–341.

López-Bonilla, J.M. and López-Bonilla, L.M. (2015), "Self-consciousness profiles in the acceptance of airline e-ticketing services", *Anatolia*, Vol. 26 No. 3, pp. 447–458.

Lu, J.-L., Chou, H.-Y. and Ling, P.-C. (2009), "Investigating passengers' intentions to use technology-based self check-in services", *Transportation Research Part E: Logistics and Transportation Review*, Vol. 45 No. 2, pp. 345–356.

Lucke, D. (1995), *Akzeptanz [Acceptance]: Legitimität in der „Abstimmungsgesellschaft" [legitimation in the voting society]*, Springer, Wiesbaden.

Luhmann, N. (2017), *Trust and power*, English edition, Polity, Cambridge.

MacCallum, R.C., Widaman, K.F., Zhang, S. and Hong, S. (1999), "Sample size in factor analysis", *Psychological Methods*, Vol. 4 No. 1, pp. 84–99.

Madden, T.J., Ellen, P.S. and Ajzen, I. (1992), “A Comparison of the Theory of Planned Behavior and the Theory of Reasoned Action”, *Personality and Social Psychology Bulletin*, Vol. 18 No. 1, pp. 3–9.

Madigan, R., Louw, T., Dziennus, M., Graindorge, T., Ortega, E., Graindorge, M. and Merat, N. (2016), “Acceptance of Automated Road Transport Systems (ARTS). An Adaptation of the UTAUT Model”, *Transportation Research Procedia*, Vol. 14, pp. 2217–2226.

Madigan, R., Louw, T., Wilbrink, M., Schieben, A. and Merat, N. (2017), “What influences the decision to use automated public transport? Using UTAUT to understand public acceptance of automated road transport systems”, *Transportation Research Part F: Traffic Psychology and Behaviour*, Vol. 50, pp. 55–64.

Mandrik, C.A. and Bao, Y. (2005), “Exploring the Concept and Measurement of General Risk Aversion”, *Advances in Consumer Research*, Vol. 32, pp. 531–539.

Mangiaracina, R., Perego, A., Salvadori, G. and Tumino, A. (2017), “A comprehensive view of intelligent transport systems for urban smart mobility”, *International Journal of Logistics Research and Applications*, Vol. 20 No. 1, pp. 39–52.

Marangunić, N. and Granić, A. (2015), “Technology acceptance model. A literature review from 1986 to 2013”, *Universal Access in the Information Society*, Vol. 14 No. 1, pp. 81–95.

Marble (2019), “Picture Autonomous Robot”, available at: https://www.marble.io/ (accessed 1 July 2019).

Marler, J., Fisher, S. and Weiling, K. (2009), “Employee self-service technology acceptance: a comparison of pre-implementation and post-implementation relationships”, *Personnel Psychology*, Vol. 62, pp. 327–358.

Marsden, N., Bernecker, T., Zöllner, R., Sußmann, N. and Kapser, S. (2018), “BUGA:log - A Real-World Laboratory Approach to Designing an Automated Transport System for Goods in Urban Areas”, *IEEE on Engineering, Technology and Innovation*, pp. 72–80.

Mathieson, K. (1991), “Predicting User Intentions Comparing the Technology Acceptance Model with the Theory of Planned Behavior”, *Information Systems Research*, Vol. 2 No. 3, pp. 173–191.

Mayer, R.C., Davis, J.H. and Schoorman, D.F. (1995), “An Integrative Model of Organizational Trust”, *The Academy of Management Review*, Vol. 20 No. 3, pp. 709–734.

McKnight, D.H., Carter, M., Thatcher, J.B. and Clay, P.F. (2011), “Trust in a specific technology: An Investigation of Its Components and Measures”, *ACM Transactions on Management Information Systems*, Vol. 2 No. 2, pp. 1–25.

McKnight, D.H., Choudhury, V. and Kacmar, C. (2002), “Developing and Validating Trust Measures for e-commerce: An Integrative Typology”, *Information Systems Research*, Vol. 13 No. 3, pp. 334–359.

Meffert, H., Burmann, C. and Kirchgeorg, M. (2008), *Marketing: Grundlagen marktorientierter Unternehmensführung ; Konzepte - Instrumente - Praxisbeispiele [Basics of corporate management - concepts, instruments and practical examples]*, 10. edition, Gabler, Wiesbaden.

Mehta, A., Morris, N.P., Swinnerton, B. and Homer, M. (2019), “The Influence of Values on E-learning Adoption”, *Computers & Education*, Vol. 141 No. 103617.

Melo, S. and Macharis, C. (Eds.) (2011), *City distribution and urban freight transport: Multiple perspectives / edited by Sandra Melo and Cathy Macharis*, Edward Elgar, Cheltenham.

Meuter, M.L., Bitner, M.J., Ostrom, A.L. and Brown, S. (2005), “Choosing Among Alternative Service Delivery Modes: An Investigation of Customer Trial of Self-Service Technologies”, *Journal of Marketing*, Vol. 69, pp. 61–83.

Meuter, M.L., Ostrom, A.L., Roundtree, R.I. and Bitner, M.J. (2000), “Self-Service Technologies: Understanding Customer Satisfaction with Technology-Based Service Encounters”, *Journal of Marketing*, Vol. 64, pp. 50–64.

Midgley, D.F. and Dowling, G.R. (1978), “Innovativeness: The Concept and Its Measurement”, *Journal of Consumer Research*, Vol. 4 No. 4, p. 229.

Miller, N. and Dollard, J. (1941), *Social Learning and Imitation*, Yale University Press, New Haven.

Mohamad, M. and Cresswell, M. (2019), “Technology as tool to overcome barriers of using fitness facilities: A health behavioural perspective”, *Proceedings of the British Academy of Management Annual Conference at Aston University Birmingham (UK)*.

Moher, D., Liberati, A., Tetzlaff, J. and Altman, D.G. (2009), “Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement”, *PLoS medicine*, Vol. 6 No. 7, e1000097.

Moore, G.C. and Benbasat, I. (1991), “Development of an Instrument to Measure the Perceptions of Adopting an Information Technology Innovation”, *Information Systems Research*, Vol. 2 No. 3, pp. 192–222.

Morosan, C. (2014), “Toward an integrated model of adoption of mobile phones for purchasing ancillary services in air travel”, *International Journal of Contemporary Hospitality Management*, Vol. 26 No. 2, pp. 246–271.

Mortimer, G., Neale, L., Hasan, S.F.E. and Dunphy, B. (2015), “Investigating the factors influencing the adoption of m-banking: a cross cultural study”, *International Journal of Bank Marketing*, Vol. 33 No. 4, pp. 545–570.

Moták, L., Neuville, E., Chambres, P., Marmoiton, F., Monéger, F., Coutarel, F. and Izaute, M. (2017), “Antecedent variables of intentions to use an autonomous shuttle. Moving beyond TAM and TPB?”, *Revue Européenne de Psychologie Appliquée/European Review of Applied Psychology*, Vol. 67 No. 5, pp. 269–278.

Mulrow, C.D. (1994), “Rationale for systematic reviews”, *BMJ (Clinical research ed.)*, Vol. 309 No. 6954, pp. 597–599.

Nabih, M.I., Bloem, S.G. and Poiesz, T.B.C. (1997), “Conceptual Issues in the Study of Innovation Adoption Behavior”, *Advances in Consumer Research*, Vol. 24, pp. 190–198.

Narayanan, A. (2012), “A Review of Eight Software Packages for Structural Equation Modeling”, *The American Statistician*, Vol. 66 No. 2, pp. 129–138.

Natarajan, T., Balasubramanian, S.A. and Kasilingam, D.L. (2017), “Understanding the intention to use mobile shopping applications and its influence on price sensitivity”, *Journal of Retailing and Consumer Services*, Vol. 37, pp. 8–22.

Neufeld, D.J., Dong, L. and Higgins, C. (2007), “Charismatic leadership and user acceptance of information technology”, *European Journal of Information Systems*, Vol. 16 No. 4, pp. 494–510.

Neuman, W.L. (2010), *Social research methods: Qualitative and quantitative approaches*, 7th ed., Allyn and Bacon, Boston Mass.

Nielsen, J. (1993), *Usability engineering*, Kaufmann, Amsterdam.

Nordhoff, S., van Arem, B. and Happee, R. (2016), “Conceptual Model to Explain, Predict, and Improve User Acceptance of Driverless Podlike Vehicles”, *Transportation Research Record: Journal of the Transportation Research Board*, Vol. 2602, pp. 60–67.

Notani, A.S. (1998), “Moderators of Perceived Behavioral Control's Predictiveness in the Theory of Planned Behavior. A Meta-Analysis”, *Journal of Consumer Psychology*, Vol. 7 No. 3, pp. 247–271.

Nuro (2016), “Picture Autonomous Delivery Vehicle”, available at: https://nuro.ai/ (accessed 1 July 2018).

OC & C Strategy Consultants (2012), “Keine billigen Tricks! [No cheap tricks!]”, available at: https://www.occstrategy.com/de/our-capabilities/publications/keine-billigen-tricks (accessed 15 August 2018).

Oghazi, P., Mostaghel, R., Hultman, M. and Parida, V. (2012), “Antecedents of Technology-Based Self-Service Acceptance. A Proposed Model”, *Services Marketing Quarterly*, Vol. 33 No. 3, pp. 195–210.

Oh, H., Jeong, M., Lee, S. and Warnick, R. (2016), “AttitudinAl And SituAtionAl determinAntS of Self-Service technology uSe”, *Journal of Hospitality & Tourism Research*, Vol. 40 No. 2, pp. 236–265.

Okoli, C. and Schabram, K. (2010), “A Guide to Conducting a Systematic Literature Review of Information Systems Research”, *Sprouts: Working Papers on Information Systems*, Vol. 26 No. 10, pp. 1–49.

Oliver Wyman Consulting (2019), “Das Ende der kostenlosen Haustür-Paketzustellung naht [The end of the free home delivery is approaching]”, available at: https://www.oliverwyman.de/content/dam/oliver-wyman/v2-de/publications/2019/mar/PM_LastMileDelivery_vF.pdf (accessed 23 July 2019).

Owusu Kwateng, K., Osei Atiemo, K.A. and Appiah, C. (2018), “Acceptance and use of mobile banking: an application of UTAUT2”, *Journal of Enterprise Information Management*, Vol. 22 No. 11, p. 1652.

Panagiotopoulos, I. and Dimitrakopoulos, G. (2018), “An empirical investigation on consumers’ intentions towards autonomous driving”, *Transportation Research Part C: Emerging Technologies*, Vol. 95, pp. 773–784.

Parasuraman, A. (2000), “Technology Readiness Index (Tri)”, *Journal of Service Research*, Vol. 2 No. 4, pp. 307–320.

Pavlou, A.P. (2003), “Consumer Acceptance of Electronic Commerce. Integrating Trust and Risk with the Technology Acceptance Model”, *International Journal of Electronic Commerce*, Vol. 7 No. 3, pp. 101–134.

Payre, W., Cestac, J. and Delhomme, P. (2014), “Intention to use a fully automated car. Attitudes and a priori acceptability”, *Transportation Research Part F: Traffic Psychology and Behaviour*, Vol. 27, pp. 252–263.

Piao, J., McDonald, M., Hounsell, N., Graindorge, M., Graindorge, T. and Malhene, N. (2016), “Public Views towards Implementation of Automated Vehicles in Urban Areas”, *Transportation Research Procedia*, Vol. 14, pp. 2168–2177.

Podsakoff, P.M., MacKenzie, S.B., Lee, J.-Y. and Podsakoff, N.P. (2003), “Common method biases in behavioral research. A critical review of the literature and recommended remedies", *The Journal of applied psychology*, Vol. 88 No. 5, pp. 879–903.

Prümm, D., Kauschle, P. and Peiseler, H. (2017), "Aufbruch auf der letzten Meile - Neue Wege für die städtische Logistik [Avant-garde in last mile - new ways of urban logistics]", available at: https://www.pwc.de/de/transport-und-logistik/pwc-studie-aufbruch-auf-der-letzten-meile.pdf (accessed 4 July 2018).

Qualtrics (2014), "ESOMAR 28 - 28 Questions to help research buyers of online samples", *ESOMAR 28*, pp. 1–8.

Rahman, M.M., Lesch, M.F., Horrey, W.J. and Strawderman, L. (2017), "Assessing the utility of TAM, TPB, and UTAUT for advanced driver assistance systems", *Accident Analysis and Prevention*, Vol. 108, pp. 361–373.

Rahman, M.M., Strawderman, L., Lesch, M.F., Horrey, W.J., Babski-Reeves, K. and Garrison, T. (2018), "Modelling driver acceptance of driver support systems", *Accident Analysis and Prevention*, Vol. 121, pp. 134–147.

Raza, S.A., Shah, N. and Ali, M. (2019), "Acceptance of mobile banking in Islamic banks: evidence from modified UTAUT model", *Journal of Islamic Marketing*, Vol. 10 No. 1, pp. 357–376.

Rea, L.M. and Parker, R.A. (2014), *Designing and conducting survey research: A comprehensive guide*, Fourth edition, Jossey-Bass, San Francisco, CA.

Reynolds, N., Diamantopoulos, A. and Schlegelmilch, B. (1993), "Pre-Testing in Questionnaire Design: A Review of the Literature and Suggestions for Further Research", *Market Research Society. Journal.*, Vol. 35 No. 2, pp. 1–11.

Rödel, C., Stadler, S., Meschtscherjakov, A. and Tscheligi, M. (2014), "Towards Autonomous Cars", *University of Salzburg*, pp. 1–8.

Rogers, E.M. (1983), *Diffusion of innovations*, 3rd ed., Free Press; Collier Macmillan, New York, London.

Rogers, E.M. (2003), *Diffusion of Innovations*, 5rd ed., Free Press; Collier Macmillan, New York, London.

Rogers, E.M. and Shoemaker, F.F. (1971), *Diffusion of innovations - Communication of innovations: A cross-cultural approach*, 2nd ed., Free Press; London: Collier-Macmillan, New York.

Rohleder, B. (2016), "Aus E-Commerce wird M-Commerce [From E-Commerce to M-Commerce]", available at: https://www.bitkom.org/Presse/Anhaenge-an-PIs/2016/Oktober/Bitkom-Pressekonferenz-E-Commerce-06102016-Praesentation-FINAL-OHNE.pdf (accessed 3 July 2018).

Roldán, J.L. and Sánchez-Franco, M.J. (2012), "Variance-Based Structural Equation Modeling", in Mora, M. (Ed.), *Research methodologies, innovations, and philosophies in software systems engineering and information systems,* Vol. 35, Information Science Reference, Hershey PA, pp. 193–221.

Roy, S.K., Balaji, M.S., Quazi, A. and Quaddus, M. (2018), "Predictors of customer acceptance of and resistance to smart technologies in the retail sector", *Journal of Retailing and Consumer Services,* Vol. 42, pp. 147–160.

Ryan, R.M. and Deci, E.L. (2000), "Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being", *American Psychologist*, Vol. 55 No. 1, pp. 68–78.

Saprikis, V., Markos, A., Zarmpou, T. and Vlachopoulou, M. (2018), "Mobile Shopping Consumers' Behavior: An Exploratory Study and Review", *Journal of theoretical and applied electronic commerce research,* Vol. 13 No. 1, pp. 71–90.

Saunders, M., Lewis, P. and Thornhill, A. (2009), *Research methods for business students,* 5. ed., Financial Times Prentice Hall, Harlow.

Savelsbergh, M. and van Woensel, T. (2016), "City Logistics: Challenges and Opportunities", *Transportation Science,* Vol. 50 No. 2, pp. 579–590.

Schade, J. and Baum, M. (2007), "Reactance or acceptance? Reactions towards the introduction of road pricing", *Transportation Research Part A: Policy and Practice,* Vol. 41 No. 1, pp. 41–48.

Schäfer, C. (2011), *Patientencompliance - Messung, Typologie, Erfolgsfaktoren: Durch verbesserte Therapietreue Effizienzreserven ausschöpfen [Patents complicance - measurement, typology, success factors: through increasing therapy-loyalty scooping of efficiency reserves]*, Gabler, Wiesbaden.

Schermelleh-Engel, K., Moosbrugger, H. and Müller, H. (2003), "Evaluating the Fit of Structural Equation Models: Tests of Significance and Descriptive Goodness-of-Fit Measures", *Methods of Psychological Research,* Vol. 8 No. 2, pp. 23–74.

Schifter, D.E. and Ajzen, I. (1985), "Intention, perceived control, and weight loss. An application of the theory of planned behavior", *Journal of Personality and Social Psychology,* Vol. 49 No. 3, pp. 843–851.

Schlegel, R., D'Avernas, J., Zanna, M.P. and DeCourville, N. (1992), "Problem Drinking: A Problem for the Theory of Reasoned Action?", *Journal of Applied Social Psychology,* Vol. 22 No. 5, pp. 358–385.

Schoettle, B. and Sivak, M. (2014a), "A survey of public opinion about connected vehicles in the U.S., the U.K., and Australia", *University of Michigan Transportation Research Institute,* pp. 687–692.

Schoettle, B. and Sivak, M. (2014b), “Public Opinion about self-driving vehicles in China, India, Japan, the U.S., the U.K., and Australia”, *The University of Michigan Transportation Research Institute*, No. UMTRI-2014-30, pp. 1–31.

Schoettle, B. and Sivak, M. (2015), “Motorists' Preferences For Different Levels of Vehicle Automation”, *University of Michigan Transportation Research Institute*, Vol. 06, pp. 1–15.

Schönberg, T., Wunder, T. and Huster, S. (2018), “Gemeinsam gegen den Wilden Westen [Together against the wild west]. Urbane Logistik 2030 in Deutschland [urban logistics 2030 in Germany]”, available at: https://www.rolandberger.com/de/Publications/Wie-wird-urbane-Logistik-2030-aussehen.html (accessed 6 July 2019).

Schröder, J., Heid, B., Neuhaus, F., Kässer, M., Klink, C. and Tatomir, S. (2018), “Fast forwarding last-mile delivery - implications for the ecosystem”, available at: https://www.mckinsey.de/publikationen/fast-forwarding-last-mile-delivery (accessed 5 July 2019).

Schultz, R. and Slevin, D. (1975), “Implementation and Organizational Validity: An Empirical Investigation”, in Schultz, R. and Slevin, D. (Eds.), *Implementing Operations Research / Management Science*, American Elsevier, New York, pp. 153–182.

Schunk, D.H. (1989), “Social Cognitive Theory and Self-Regulated Learning”, in Zimmerman, B.J. and Schunk, D.H. (Eds.), *Self-regulated learning and academic achievement: Theory, research, and practice*, *Springer Series in Cognitive Development*, Springer-Verlag, New York, pp. 83–110.

Seapin Software (2014), “88 Percent of Adults Would Be Worried about Riding in a Driverless Car”, available at: https://orfe.princeton.edu/~alaink/SmartDrivingCars/PDFs/SeapineDriverlessCarHarrisPollFinal.pdf (accessed 13 April 2019).

Sekaran, U. (2003), *Research methods for business: A skill-building approach,* 4th ed., John Wiley & Sons, New York.

Shahrdar, S., Menezes, L. and Nojoumian, M. (2018), “A Survey on Trust in Autonomous Systems”, in Arai, K., Kapoor, S. and Bhatia, R. (Eds.), *Intelligent Computing: Proceedings of the 2018 Computing Conference*, *Advances in Intelligent Systems and Computing*, Vol. 857, Springer, Cham, pp. 368–386.

Shang, D. and Wu, W. (2017), “Understanding mobile shopping consumers’ continuance intention”, *Industrial Management & Data Systems*, Vol. 117 No. 1, pp. 213–227.

Sharma, S., Mukherjee, S., Kumar, A. and Dillon, W.R. (2005), “A simulation study to investigate the use of cutoff values for assessing model fit in covariance structure models”, *Journal of Business Research*, Vol. 58 No. 7, pp. 935–943.

Sheppard, B.H., Hartwick, J. and Warshaw, P.R. (1988), “The Theory of Reasoned Action: A Meta-Analysis of Past Research with Recommendations for Modifications and Future Research”, *The Journal of Consumer Research*, Vol. 15 No. 3, pp. 325–343.

Sheth, J. (1981), “Psychology of Innovation Resistence: The Less Developed Concept (LDC) in Diffusion Research”, in Sheth, J. (Ed.), *Research in Marketing*, Jai Press Inc., pp. 273–282.

Shin, D.-H. (2010), “Modeling the Interaction of Users and Mobile Payment System. Conceptual Framework”, *International Journal of Human-Computer Interaction*, Vol. 26 No. 10, pp. 917–940.

Silberg, G., Manassa, M., Everhart, K., Subramanian, D., Corley, M., Fraser, H. and Sinha, V. (2013), “Self-Driving Cars: Are We Ready?”, available at: http://www.kpmginfo.com/Reit/forms/26554NSS_CAR_FINAL.pdf (accessed 4 August 2018).

Slade, E.L., Dwivedi, Y.K., Piercy, N.C. and Williams, M.D. (2015), “Modeling Consumers’ Adoption Intentions of Remote Mobile Payments in the United Kingdom. Extending UTAUT with Innovativeness, Risk, and Trust”, *Psychology & Marketing*, Vol. 32 No. 8, pp. 860–873.

Slade, E.L., Williams, M. and Dwivedi, Y.K. (2013), “Extending UTAUT2 To Explore Consumer Adoption Of Mobile Payments”, *Proceeding of the UK Academy for Information Systems Conference*, pp. 1–23.

Starship Technology (2017), “Starship Technologies launches pilot program with Domino's Pizza Enterprises”, available at: https://www.starship.xyz/press_releases/starship-technologies-launches-pilot-program-with-dominos-pizza-enterprises/ (accessed 6 February 2018).

Statista (2018a), “Amount of Private Households in Germany with a Landline Telephone. A Comparison from 1998 - 2018”, available at: https://de.statista.com/statistik/daten/studie/2597/umfrage/ausstattungsgrad-privater-haushalte-mit-einem-stationaeren-telefon-seit-1998/ (accessed 2 January 2019).

Statista (2018b), “Inwiefern beeinflussen die Versandkosten die Bestellung? [How do delivery costs influence orders?]”, available at: https://de.statista.com/statistik/daten/studie/708176/umfrage/einfluss-der-versandkosten-auf-online-bestellungen-in-deutschland/ (accessed 1 March 2019).

Statista (2018c), “Wie viel sind Sie bereits für Versandkosten zu zahlen? [How much are you willing to pay for delivery costs?]”, available at: https://de.statista.com/statistik/daten/studie/707734/umfrage/maximale-zahlungsbereitschaft-fuer-versandkosten-in-deutschland/ (accessed 1 March 2019).

Straub, D., Bourdreau, M.-C. and Gefen, D. (2004), “Validation Guidelines for IS positivist research”, *Communications of the Association for Information Systems*, Vol. 13, pp. 380–427.

Su, P., Le Wang and Yan, J. (2018), “How users’ Internet experience affects the adoption of mobile payment: a mediation model”, *Technology Analysis & Strategic Management*, Vol. 30 No. 2, pp. 186–197.

Sun, Y., Bhattacherjee, A. and Ma, Q. (2009), “Extending technology usage to work settings. The role of perceived work compatibility in ERP implementation”, *Information & Management*, Vol. 46 No. 6, pp. 351–356.

Tamilmani, K., Rana, N.P., Dwivedi, Y., Sahu, G. and Roderick, S. (2018a), “Exploring the Role of 'Price Value' for Understanding Consumer Adoption of Technology: A Review and Meta-analysis of UTAUT2 based Empirical Studies”, *Proceeding of the Pacific Asia Conference on Information Systems (PACIS)*.

Tamilmani, K., Rana, N.P. and Dwivedi, Y.K. (2017), “A Systematic Review of Citations of UTAUT2 Article and Its Usage Trends”, Vol. 10595, pp. 38–49.

Tamilmani, K., Rana, N.P. and Dwivedi, Y.K. (2018b), “Systematic Review of UTAUT2 Studies Using Weight Analysis”, *Proceedings of the 17th Conference on e-Business, e-Services, and e-Society*.

Tamilmani, K., Rana, N.P. and Dwivedi, Y.K. (2019a), “Use of ‘Habit’ Is not a Habit in Understanding Individual Technology Adoption: A Review of UTAUT2 Based Empirical Studies”, Vol. 533, pp. 277–294.

Tamilmani, K., Rana, N.P., Prakasam, N. and Dwivedi, Y.K. (2019b), “The battle of Brain vs. Heart: A literature review and meta-analysis of “hedonic motivation” use in UTAUT2”, *International Journal of Information Management*, Vol. 46, pp. 222–235.

Tarhini, A., Alalwan, A.A., Shammout, A.B. and Al-Badi, A. (2019), “An analysis of the factors affecting mobile commerce adoption in developing countries”, *Review of International Business and Strategy*, Vol. 28 No. 2, p. 1014.

Tashakkori, A. and Teddlie, C. (2003), *Handbook of mixed methods in social & behavioral research*, 2nd ed., SAGE, Los Angeles, London.

Taylor, M. and Todd, P.A. (1995a), “Decomposition and crossover effects in the theory of planned behavior: A study on consumer adoption intentions”, *International Journal of Research in Marketing*, pp. 137–155.

Taylor, S. and Todd, P.A. (1995b), “Assessing IT Usage: The Role of Prior Experience”, *MIS Quarterly*, Vol. 19 No. 4, pp. 561–570.

Taylor, S. and Todd, P.A. (1995c), “Understanding Information Technology Usage: A Test of Competing Models.”, *Information Systems Research*, Vol. 6 No. 2, pp. 144–176.

Taylor, S. and Todd, P.A. (2001), “Understanding Information Technology Usage: A Test of Competing Models.”, *Information Systems Research*, Vol. 6 No. 2, pp. 144–176.

Thompson, C.B. (2009), “Descriptive data analysis”, *Air medical journal*, Vol. 28 No. 2, pp. 56–59.

Thompson, R.L., Higgins, C.A. and Howell, J.M. (1991), “Personal Computing: Toward a Conceptual Model of Utilization”, *MIS Quarterly*, Vol. 15 No. 1, pp. 125–143.

Tornatzky, L. and Klein, K. (1982), “Innovation Characteristics and Innovation Adoption-Implementation: A Meta-Analysis of Findings”, *IEEE Transactions on Engineering Management*, Vol. 29 No. 1, pp. 28–45.

Tranfield, D., Denyer, D. and Smart, P. (2003), “Towards a Methodology for Developing Evidence-Informed Management Knowledge by Means of Systematic Review”, *British Journal of Management*, Vol. 14, pp. 207–222.

Triandis, H. (1979), “Values, attitudes, and interpersonal behaviour”, *Nebraska Symposium on Motivation*, Vol. 27, pp. 195–259.

Tsai, H. and LaRose, R. (2015), “Broadband Internet adoption and utilization in the inner city. A comparison of competing theories”, *Computers in Human Behavior*, Vol. 51, pp. 344–355.

Urmson, C., Anhalt, J., Bagnell, D., Baker, C., Bittner, R., Clark, M.N., Dolan, J., Duggins, D., Galatali, T., Geyer, C., Gittleman, M., Harbaugh, S., Hebert, M., Howard, T.M., Kolski, S., Kelly, A., Likhachev, M., McNaughton, M., Miller, N., Peterson, K., Pilnick, B., Rajkumar, R., Rybski, P., Salesky, B., Seo, Y.-W., Singh, S., Snider, J., Stentz, A., Whittaker, W.“R.”, Wolkowicki, Z., Ziglar, J., Bae, H., Brown, T., Demitrish, D., Litkouhi, B., Nickolaou, J., Sadekar, V., Zhang, W., Struble, J., Taylor, M., Darms, M. and Ferguson, D. (2008), “Autonomous driving in urban environments. Boss and the Urban Challenge”, *Journal of Field Robotics*, Vol. 25 No. 8, pp. 425–466.

Vakulenko, Y., Shams, P., Hellström, D. and Hjort, K. (2019), “Service innovation in e-commerce last mile delivery: Mapping the e-customer journey”, *Journal of Business Research*, Vol. 101, pp. 461–468.

Vallerand, R.J. (1997), “Toward A Hierarchical Model of Intrinsic and Extrinsic Motivation”, Vol. 29, pp. 271–360.

Vallerand, R.J. (2000), “Deci and Ryan's Self-Determinantion Theory: A View From the Hierarchical Model of Intrinsic and Extrinsic Motivation”, *Psychological Inquiry*, Vol. 11 No. 4, 312-318.

Vallerand, R.J. and Lalande, D.R. (2011), “The MPIC Model. The Perspective of the Hierarchical Model of Intrinsic and Extrinsic Motivation”, *Psychological Inquiry*, Vol. 22 No. 1, pp. 45–51.

van den Putte, B. (1991), *20 years of the theory of reasoned action of Fishbein and Ajzen: A meta-analysis*, unpublished Manuscript, Amsterdam.

van der Heijden, H. (2004), “User Acceptance of Hedonic Information Systems”, *MIS Quarterly*, Vol. 28 No. 4, pp. 695–704.

Vaus, D.A. de (2014), *Surveys in social research, Social research today*, 6th edition, Routledge, Abingdon, Oxon.

Venkatesh, V. (2000), “Determinants of Perceived Ease of Use: Integrating Control, Intrinsic Motivation and Emotion into the Technology Acceptance Model”, *Information Systems Research*, Vol. 11 No. 4, pp. 342–365.

Venkatesh, V. and Davis, F.D. (1996), “A Model of the Antecedents of Perceived Ease of Use: Development and Test”, *Decision Sciences*, Vol. 27 No. 3, pp. 451–481.

Venkatesh, V. and Davis, F.D. (2000), “A Theoretical Extension of the Technology Acceptance Model: Four Longitudinal Field Studies”, *Management Science*, Vol. 46 No. 2, pp. 186–204.

Venkatesh, V., Davis, F.D. and Morris, M.G. (2007), “Dead or Alive? The Development, Trajectory And Future Of Technology Adoption Research”, *Journal of the Association for Information Systems*, Vol. 8 No. 4, pp. 267–286.

Venkatesh, V., Morris, M.G., Davis, G.B. and Davis, F.D. (2003), “User Acceptance of Information Technology: Toward a Unified View”, *MIS Quarterly*, Vol. 27 No. 3, pp. 425–478.

Venkatesh, V. and Speier, C. (1999), “Computer Technology Training in the Workplace: A Lonfitudinal Investigation of the Effect of Mood”, *Organizational Behavior and Human Decision Processes*, Vol. 79 No. 1, pp. 1–28.

Venkatesh, V., Thong, J.Y.L. and Xu, X. (2012), "Consumer Acceptance and Use of Information Technology: Extending the Unified Theory of Acceptance and Use of Technology", *MIS Quarterly*, No. 36, pp. 157–178.

Verma, J.P. (2013), *Data analysis in management with SPSS software*, Springer, New Delhi, New York.

Vieira, E.T. (2017), *Introduction to real world statistics: With step-by-step SPSS instructions / Edward T. Vieira, Jr*, Routledge, London.

Visser, J., Nemoto, T. and Browne, M. (2014), "Home Delivery and the Impacts on Urban Freight Transport. A Review", *Procedia - Social and Behavioral Sciences*, Vol. 125, pp. 15–27.

Vroom, V.H. (1995), *Work and motivation*, Jossey-Bass, San Francisco, California.

Wagner, S.M. and Sutter, R. (2012), "A qualitative investigation of innovation between third-party logistics providers and customers", *International Journal of Production Economics*, Vol. 140 No. 2, pp. 944–958.

Wang, S.W., Hsu, M.K., Pelton, L.E. and Xi, D. (2014), "Virtually Compatible or Risky Business? Investigating Consumers' Proclivity Toward Online Banking Services", *Journal of Marketing Channels*, Vol. 21 No. 1, pp. 43–58.

Wang, X., Yuen, K.F., Wong, Y.D. and Teo, C.C. (2018a), "An innovation diffusion perspective of e-consumers' initial adoption of self-collection service via automated parcel station", *The International Journal of Logistics Management*, Vol. 29 No. 1, pp. 237–260.

Wang, X., Yuen, K.F., Wong, Y.D. and Teo, C.C. (2018b), "E-consumer adoption of innovative last-mile logistics services: A comparison of behavioural models", *Total Quality Management & Business Excellence*, Vol. 28 No. 5, pp. 1–27.

Weigel, F., Hazen, B., Cegielski, C. and Hall, D. (2014), "Diffusion of Innovations and the Theory of Planned Behavior in Information Systems Research: A Metaanalysis", *Communications of the Association for Information Systems*, Vol. 34 No. 31, pp. 619–636.

Weiner, I.B. (2013), *Handbook of psychology*, Second edition / editor-in-chief, Irving B. Weiner, Wiley, Hoboken, New Jersey.

Weltevreden, J.W.J. (2008), "B2c e-commerce logistics: the rise of collection-and-delivery points in The Netherlands", *International Journal of Retail & Distribution Management*, Vol. 36 No. 8, pp. 638–660.

Werner, C. and Schermelleh-Engel, K. (2009), “Structural Equation Modeling: Advantages, Challenges, and Problems”, *Goethe University Frankfurt*, May, pp. 1–4.

Wessels, L. and Drennan, J. (2010), “An investigation of consumer acceptance of M-banking”, *International Journal of Bank Marketing,* Vol. 28 No. 7, pp. 547–568.

Williams, M.D., Dwivedi, Y.K., Lal, B. and Schwarz, A. (2009), “Contemporary trends and issues in IT adoption and diffusion research”, *Journal of Information Technology*, Vol. 24 No. 1, pp. 1–10.

Williams, M.D., Nripendra P., R., Yogesh K., D. and Banita, L. (2011), “Is UTAUT really used ir just cited for the sake óf it? A systematic review of citations of UTAUT's originating article”, *19th European Conference on Information Systems (ECIS).*

Williams, M.D., Rana, N.P. and Dwivedi, Y.K. (2015), “The unified theory of acceptance and use of technology (UTAUT). A literature review”, *Journal of Enterprise Information Management*, Vol. 28 No. 3, pp. 443–488.

Wood, R. and Bandura, A. (1989), “Social Cognitive Theory of Organizational Management”, *Academy of Management Review*, Vol. 14 No. 3, pp. 361–384.

Worthington, R.L. and Whittaker, T.A. (2006), “Scale Development Research”, *The Counseling Psychologist*, Vol. 34 No. 6, pp. 806–838.

Wu, M., Jayawardhena, C. and Hamilton, R. (2014), “A comprehensive examination of internet banking user behaviour: evidence from customers yet to adopt, currently using and stopped using”, *Journal of Marketing Management*, Vol. 30 No. 9-10, pp. 1006–1038.

Xiao, M. (2019), “Factors Influencing eSports Viewership: An Approach Based on the Theory of Reasoned Action”, *Communication & Sport*, Vol. 11, 1-31.

Xu, Z., Zhang, K., Min, H., Wang, Z., Zhao, X. and Liu, P. (2018), “What drives people to accept automated vehicles? Findings from a field experiment”, *Transportation Research Part C: Emerging Technologies*, Vol. 95, pp. 320–334.

Yahia, I.B., Al-Neama, N. and Kerbache, L. (2018), “Investigating the drivers for social commerce in social media platforms: Importance of trust, social support and the platform perceived usage”, *Journal of Retailing and Consumer Services*, Vol. 41, pp. 11–19.

Yang, K. and Banamah, A. (2014), “Quota Sampling as an Alternative to Probability Sampling? An Experimental Study”, *Sociological Research Online*, Vol. 19 No. 1, pp. 1–11.

Yang, K. and Forney, J. (2013), “The moderating role of consumer technology anxiety in mobile shopping adoption: Differential effects of facilitating conditions and social influences”, *Journal of Electronic Commerce Research*, Vol. 14 No. 4, pp. 334–347.

Yeap, J.A.L., Ramayah, T. and Soto-Acosta, P. (2016), *Electronic Markets*, Vol. 26 No. 4, pp. 323–338.

Yen, H.R. and Gwinner, K.P. (2003), “Internet retail customer loyalty. The mediating role of relational benefits”, *International Journal of Service Industry Management*, Vol. 14 No. 5, pp. 483–500.

Yousafzai, S. and Yani-de-Soriano, M. (2012), “Understanding customer-specific factors underpinning internet banking adoption”, *International Journal of Bank Marketing*, Vol. 30 No. 1, pp. 60–81.

Yousafzai, S.Y., Foxall, G.R. and Pallister, J.G. (2007), “Technology acceptance. A meta-analysis of the TAM: Part 1”, *Journal of Modelling in Management*, Vol. 2 No. 3, pp. 251–280.

Yu, C.-S. (2012), “Factors affecting individuals to adopt mobile banking: Empirical evidence from the utaut model”, *Journal of Electronic Commerce Research*, Vol. 13 No. 2, pp. 104–121.

Yuen, K.F., Wang, X., Ma, F. and Wong, Y.D. (2019), “The determinants of customers’ intention to use smart lockers for last-mile deliveries”, *Journal of Retailing and Consumer Services*, Vol. 49, pp. 316–326.

Yuen, K.F., Wang, X., Ng, L.T.W. and Wong, Y.D. (2018), “An investigation of customers’ intention to use self-collection services for last-mile delivery”, *Transport Policy*, Vol. 66, pp. 1–8.

Zaltman, G., Duncan, R. and Holbek, J. (1973), *Innovation and Organizations*, John Wiley & Sons, New York.

Zeithaml, V.A. (1988), “Consumer Perceptions of Price, Quality, and Value. A Means-End Model and Synthesis of Evidence”, *Journal of Marketing*, Vol. 52 No. 3, p. 2.

Zmud, J., Sener, I.N. and Wagner, J. (2016), “Self-Driving Vehicles: Determinants of Adoption and Conditions of Usage”, *Transportation Research Record: Journal of the Transportation Research Board*, Vol. 2565 No. 1, pp. 57–64.

Zmud, J.P. and Sener, I.N. (2017), “Towards an Understanding of the Travel Behavior Impact of Autonomous Vehicles”, *Transportation Research Procedia*, Vol. 25, pp. 2500–2519.