University of Rhode Island

DigitalCommons@URI

Open Access Master's Theses

2020

TECHNOLOGY ACCEPTANCE FOR PARTIALLY AUTOMATED VEHICLES IN THE UNITED STATES AND GERMANY

Sergio Bujanov

University of Rhode Island, s_bujanov@my.uri.edu

Follow this and additional works at: <https://digitalcommons.uri.edu/theses>

Recommended Citation

Bujanov, Sergio, "TECHNOLOGY ACCEPTANCE FOR PARTIALLY AUTOMATED VEHICLES IN THE UNITED STATES AND GERMANY" (2020). *Open Access Master's Theses*. Paper 1895.
<https://digitalcommons.uri.edu/theses/1895>

This Thesis is brought to you for free and open access by DigitalCommons@URI. It has been accepted for inclusion in Open Access Master's Theses by an authorized administrator of DigitalCommons@URI. For more information, please contact digitalcommons-group@uri.edu.

TECHNOLOGY ACCEPTANCE FOR PARTIALLY AUTOMATED VEHICLES
IN THE UNITED STATES AND GERMANY

BY

SERGIO BUJANOV

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE
REQUIREMENTS FOR THE DEGREE OF

MASTER OF SCIENCE

IN

SYSTEMS ENGINEERING

UNIVERSITY OF RHODE ISLAND

2020

MASTER OF SCIENCE THESIS

OF

SERGIO BUJANOV

APPROVED:

Thesis Committee:

Major Professor Valerie Maier-Speredelozzi

Jyh-Hone Wang

Christopher Hunter

Nasser H. Zawia
DEAN OF THE GRADUATE SCHOOL

UNIVERSITY OF RHODE ISLAND
2020

ABSTRACT

Autonomous Driving (AD) is no longer a part of a science fiction film but is going to be soon becoming a reality. The Society of Automotive Engineers (SAE) have defined six levels of automation. There are six defined levels by the Society of Automotive Engineers (SAE), ranging from no automation (SAE-0) to full automation (SAE-5). Officially, Autonomous Vehicles (SAE-5) and vehicles with a high degree of automation (SAE-3, SAE-4) are not fully available for purchase on the market yet, although it would be technologically possible. Vehicles with automation level SAE-2 have already penetrated the market and SAE-3 is not far away. For constantly growing technologies such as higher automation levels of vehicles to successfully dominate the market, they must be accepted by consumers. People's acceptance plays an essential role, usually even more than the technological aspect. Regardless of how well a technology is developed, if it is not accepted and used by the consumer, it is of very little use.

Based on the literature, SAE-4 has received the least investigation but is not far away from being available on the market. Thus, study aims to investigate public acceptance of vehicles with SAE-4 in the countries USA and Germany which are both well-prepared for Autonomous Driving (AD).

In order to gather data from the public and make conclusions from it, an online survey with Qualtrics was prepared and conducted in both countries. The survey consists of 35 questions and took a maximum of 15 minutes. To investigate the user's acceptance, a technology acceptance model (TAM) was extended by incorporating four additional constructs, namely initial trust (INT), perceived benefit (PB), perceived safety risk (PSR), and perceived financial risk (PFR). The acceptance of both countries was found to be very

similar. A rather positive trend towards higher automation level can be clearly identified in both countries. This study provides an important overview of the preferable automation level of the people. By consideration that vehicles with SAE-3, SAE-4, and SAE-5 are not fully available on the market yet, these findings show that a significantly high amount of people would prefer to use higher automation levels. By consideration of the limitations in this study, these empirical findings could provide an important evidence for car manufacturers, governments, insurance agencies, and marketing agencies in order to adapt technology on market to users' acceptance.

ACKNOWLEDGEMENTS

First, I would like to thank my major professor Valerie Maier-Speredelozzi for all her help, recommendations, and time she put into my work. She gave always wise advice and helped me if questions have been arising. It was always a pleasure to work with her and I am thankful that I was guided by such a strong woman in the academic area.

I also would like to thank my co-major professor Dr. Jyh-Hone Wang. Before I visited Dr. Wang's class, I have never before learned advanced statistics and he taught me a lot that I could apply in my thesis. Also if I had questions or something was incomprehensible in terms of statistical analysis, Dr. Wang was always available and could help me.

Furthermore, I would like to thank Dr. Gretchen Macht and her SIS-Lab. Dr. Macht taught me in subject Human Factors & Ergonomics and gave me an important guideline about the creation of surveys, which helped me a lot with my research. Also, the students from her SIS-Lab were always very courteous and helpful with any kind of questions.

Moreover, I would like to thank my committee member Professor Christopher Hunter and Defense Chair Professor Christopher Baxter that they decided to be a part of my research.

I also would like to thank Dr. Uwe Becker from the Technische Universität Braunschweig (TUBS). He was my supervisor from the TUBS and was always available to help me with any questions.

Finally, I would like to thank to URI IRB office, especially Mary Riedford and Heather Paskalides. They were always very courteous and helpful and provided me with all information about the IRB application and approvals.

TABLE OF CONTENTS

ABSTRACT	ii
ACKNOWLEDGEMENTS	iv
TABLE OF CONTENTS	v
LIST OF FIGURES.....	ix
LIST OF TABLES.....	xi
LIST OF ABBREVIATIONS.....	xiii
1 CHAPTER 1 – INTRODUCTION	1
1.1 BACKGROUND	1
1.2 PROBLEM AND OBJECTIVE	6
2 CHAPTER 2 – REVIEW OF LITERATURE.....	8
2.1 EVOLUTION OF AUTONOMOUS VEHICLES	8
2.2 ACCEPTANCE RESEARCH	11
2.3 ACCEPTANCE MODEL.....	12
2.4 REVIEW OF PREVIOUS STUDIES	16
3 CHAPTER 3 – METHODOLOGY	28
3.1 HYPOTHESES AND RESEARCH MODEL	28
3.1.1 HYPOTHESES AND CONSTRUCTS	29
3.1.2 TECHNOLOGY ACCEPTANCE MODEL.....	36
3.2 ITEMS (SURVEY QUESTIONS)	36
3.3 STUDY DESIGN	38
3.3.1 TARGET GROUP	39
3.3.2 DEFINITION MINIMUM CRITERIA	39

3.3.3	RECRUITMENT & DISTRIBUTION	42
3.3.4	MOTIVATION FOR PARTICIPATION	42
3.3.5	DURATIONS	42
3.3.6	QUESTIONNAIRE DESIGN.....	43
3.3.7	IRB APPROVAL.....	45
3.4	SURVEY TESTING	45
3.5	SURVEY LAUNCHING	46
3.6	SURVEY EVALUATION AND STATISTICAL ANALYSIS	47
3.6.1	DESCRIPTIVE STATISTICS.....	47
3.6.2	DATA DISTRIBUTION CHECK.....	48
3.6.3	RELIABILITY CHECK	48
3.6.4	FACTOR ANALYSIS	50
3.6.5	STRUCTURAL EQUATION MODELING	54
4	CHAPTER 4 – RESULTS & DISCUSSION	59
4.1	RESULTS SURVEY	59
4.1.1	DEMOGRAPHICS.....	59
4.1.2	DESCRIPTIVE STATISTICS.....	66
4.1.3	CORRELATION & REGRESSION ANALYSIS.....	68
4.1.4	RELIABILITY.....	70
4.1.5	CORRELATIONS	70
4.1.6	EXPLANATORY FACTOR ANALAYSIS	77
4.1.7	TECHNOLOGY ACCEPTANCE MODEL.....	86
4.2	DISCUSSION.....	88

5	CHAPTER 5 – CONCLUSION	94
6	LIMITATIONS AND FUTURE WORK	98
7	APPENDICES	102
7.1	APPENDIX A – SURVEY USA	102
7.2	APPENDIX B – SURVEY GERMANY	117
7.3	APPENDIX C – RECRUITMENT	132
7.4	APPENDIX D - IRB DOCUMENTS.....	133
7.4.1	IRB APPLICATION FORM	133
7.4.2	IRB AMENDMENT FORM/ CHANGES TO RESEARCH	154
7.4.3	IRB APPENDIX B – EXPEDITED REVIEW	158
7.4.4	IRB APPENDIX J – NON-ENGLISH PARTICIPANTS	160
7.4.5	IRB APPENDIX M1 – WAIVER OR ALTERATION OF C.P..	161
7.4.6	IRB APPENDIX M2 – WAIVER SIGNED CONSENT	163
7.4.7	IRB APPENDIX O – RESEARCH IN INT. SETTINGS	164
7.4.8	IRB APPENDIX T – CHANGED PARTICIPANTS NUMBER	167
7.5	APPENDIX E - R STUDIO PROGRAMS	168
7.5.1	DEMOGRAPHICS USA.....	168
7.5.2	DEMOGRAPHICS GERMANY.....	171
7.5.3	ANOVA USA	175
7.5.4	ANOVA GERMANY	179
7.5.5	CORRELATION AND REGRESSION ANALYSIS USA	183
7.5.6	CORRELATION AND REGRESSION ANALYSIS	185
7.5.7	EXPLANATORY FACTOR ANALYSIS USA	187

7.5.8	EXPLANATORY FACTOR ANALYSIS GERMANY	189
7.5.9	RELIABILITY AND CORRELATIONS USA	192
7.5.10	RELIABILITY AND CORRELATIONS GERMANY	195
7.5.11	STRUCTURAL EQUATION MODELLING USA.....	198
7.5.12	STRUCTURAL EQUATION MODELLING GERMANY	202
8	BIBLIOGRAPHY	206

LIST OF FIGURES

Figure 1: SAE-0 -2 Automation Level/ Source: [22]	9
Figure 2: SAE-3 -5 Automation Level/ Source: [22]	9
Figure 3: Original TAM presented in Davis,1989/ Source:[6]; [26]; [22]	13
Figure 4: TPB presented by Icek Ajzen,1991/ Source: [27]	14
Figure 5: UTAUT presented by Venkatesh, 2003/ Source: [28].....	15
Figure 6: Previous Studies referring to automation level/ Source:[Or].....	16
Figure 7: Countries Best Prepared for Autonomous Driving/ Source: [33].....	18
Figure 8: Technology Acceptance Model/ Source:[Or]	36
Figure 9: Structural Equation Modelling/ Source: [67].....	56
Figure 10: Participants of the US Survey/ Source: [Or].....	61
Figure 11: Participants of the German Survey/ Source: [Or]	61
Figure 12: Nationality of Participants/ Source:[Or]	62
Figure 13: Residence of Participants/ Source:[Or].....	62
Figure 14: Vehicle Ownership/ Utilization/ Source:[Or]	63
Figure 15: Possession of Driver's License/ Source:[Or]	64
Figure 16: Length Daily Commute/ Source:[Or]	64
Figure 17: Perceived Road Accidents Causes/ Source:[Or].....	65
Figure 18: Preferable SAE Automation Level / Source:[Or]	65
Figure 19: Multiple Regression of Constructs; USA/ Source:[Or]	68
Figure 20: Multiple Regression of Constructs; GE/ Source:[Or].....	69
Figure 21: Correlation Plot; USA/ Source:[Or]	74
Figure 22: Correlation Plot; Germany/ Source:[Or].....	74

Figure 23: Scree Plot; USA/ Source:[Or]	79
Figure 24: Eigenvalues; USA/ Source:[Or]	80
Figure 25: Scree Plot; Germany/ Source:[Or]	80
Figure 26: Eigenvalues; Germany/ Source:[Or]	80
Figure 27: Factor Diagram; USA/ Source:[Or]	81
Figure 28: Factor Loadings; USA/ Source:[Or]	82
Figure 29: Factor Diagram; Germany/ Source:[Or]	83
Figure 30: Factor Loadings; Germany/ Source:[Or]	84
Figure 31: TAM USA/ Source:[Or]	86
Figure 32: TAM Germany/ Source:[Or]	86

LIST OF TABLES

Table 1: Previous research of technology acceptance/ Source:[Or].....	17
Table 2: Survey minimum criteria/ Source:[Or]	40
Table 3: Range of Cronbach's Alpha (CR)/ Source: [75], [76]	49
Table 4: KMO value/ Source: [77], [79]	51
Table 5: Bartlett-test/ Source: [77], [80]	52
Table 6: Factor Analysis Correlation Power/ Source: [77], [79].....	52
Table 7: Minimum Criteria: Factor Loading & Commonality/ Source: [77], [79] ...	53
Table 8: EFA Suggested MFV/ Source: RMSR [83]; TLI, RMSEA,CR [84]	54
Table 9: Effect of path coefficient SEM/ Source:[86].....	56
Table 10: PLS-SEM Model Fit Indices/ Source [82]	57
Table 11: CB-SEM vs. PLS-SEM Comparison/ Source:[85]	58
Table 12: Demographics of the survey/ Source:[Or]	60
Table 13: Descriptive Statistics of items; USA/ Source:[Or].....	66
Table 14: Descriptive Statistics of constructs; USA/ Source:[Or]	66
Table 15: Descriptive Statistics of items; Germany/ Source:[Or].....	67
Table 16: Descriptive Statistics of Constructs; Germany/ Source:[Or]	67
Table 17:Reliability of the survey/ Source:[Or].....	70
Table 18: Bartlett-test/ Source: [77], [80]	71
Table 19: Significance test of correlations; Germany/ Source:[Or].....	71
Table 20: Significance test of correlations; US/ Source:[Or].....	72
Table 21: Inverse correlation matrix; USA/ Source:[Or]	73
Table 22: Inverse correlation matrix; Germany/ Source:[Or]	73

Table 23: Item by scale correlation; USA/ Source:[Or]	75
Table 24: Item by scale correlation; Germany/ Source:[Or]	76
Table 25: Bartlett-Test/ Source:[Or]	77
Table 26: Kaiser-Meyer-Olkin (KMO) Adequacy/ Source:[Or]	78
Table 27: EFA model fit indices/ Source:[Or]	85
Table 28: TAM fit indices/ Source:[Or]	87
Table 29: Results from hypotheses testing/ Source:[Or]	88

LIST OF ABBREVIATIONS

AAM	-	Automation Acceptance Model
ACC	-	Adaptive Cruise Control
ADAS	-	Advanced Driver Assistance System
AEB	-	Automatic Emergency Braking
AEV	-	Autonomous Electric Vehicle
AD	-	Autonomous Driving
ANOVA	-	Analysis of Variance
AI	-	Artificial Intelligence
ARTS	-	Automated Road Transport System
AT	-	Autonomous Transportation
ATB	-	Attitude towards behavior
ATT	-	Automation Towards Using a Technology
APA	-	Automatic Parking Assist
AS	-	Autonomous Shuttle
AV	-	Automated Vehicle = Partially Automated/ Autonomous
α	-	Significance Level
BEV	-	Battery Electric Vehicle
BI	-	Behavioral Intention
BMW	-	Bayrische Motorenwerke
bpb	-	Bundeszentrale für Politische Bildung
β	-	Path Coefficient
CB	-	Covariance Based

CBM	-	Covariance Based Modeling
CFA	-	Confirmatory Factor Analysis
CFI	-	Comparative Fit Index
Chisq	-	Chi-Square
Coeff.	-	Coefficient
CR	-	Cronbach's Alpha
CS	-	Car Sharing
CTAM	-	Car Technology Acceptance Model
DC	-	Driverless Car
DCT	-	Driverless Car Technology
df	-	Degree of Freedom
Dr.	-	Doctor
e	-	Euler's Number
EC	-	Environmental Concern
EE	-	Effort Expectancy
EFA	-	Explanatory Factor Analysis
e.g.	-	for example
et al.	-	`and others`
etc.	-	`Et Cetera`
F	-	F value (from ANOVA, ratio between two variances)
FAV	-	Fully Automated Vehicle = Autonomous Vehicle
FC	-	Facilitating Conditions
GE	-	Germany

GPU	-	Green Perceived Usefulness
H	-	Hypothesis (e.g. H1 = Hypothesis 1)
H ₀	-	Null Hypothesis
H ₁	-	Alternative Hypothesis
h ²	-	Commonality
INT	-	Initial Trust
IRB	-	Institutional Review Board
Km	-	Kilometer
KMO	-	Kaiser-Meyer-Olkin
KPMG	-	Klynveld Peat Marwick Goerdeler
Lab	-	Laboratory
LKA	-	Lane Keeping Assist
mad	-	Median Absolut Deviation
max	-	Maximum
MFV	-	Model Fit Values
min	-	Minimum
MS	-	Microsoft (Software)
MSA	-	Measure of Sample Adequacy
NHTSA	-	The National Highway Traffic Safety Administration
n	-	number
n.s.	-	non-significant
OEM	-	Original Equipment Manufacturer
Or	-	Own representation

p	-	Probability (p-value)
PA1	-	Factor 1
PA2	-	Factor 2
PA3	-	Factor 3
PB	-	Perceived Benefit
PBC	-	Perceived Behavioral Control
PCA	-	Principal Component Analysis
PDF	-	Portable Document Format
PE	-	Performance Expectancy
PEOU	-	Perceived Ease of Use
PFR	-	Perceived Financial Risk
PLS	-	Partial Least Square
PO	-	Perceived Ownership
PPR	-	Perceived Privacy Risk
PR	-	Perceived Risk
PS	-	Perceived Safety
PSR	-	Perceived Safety Risk
PT	-	Perceived Trust
PU	-	Perceived Usefulness
R	-	R Studio (Software)
r	-	Correlation Coefficient
RA	-	Relative Advantage
RMSEA	-	Root Mean Square Error of Approximation

RMSR	-	Root Mean Square Residual
r^2	-	Coefficient of Determination
SAE	-	Society of Automotive Engineers
SBN	-	Subject Norm
sd	-	Standard Deviation
SDC	-	Self-Driving Car
SDV	-	Self-Driving Vehicle
se	-	Standard Error
SE	-	Self Efficacy
SEM	-	Structural Equation Modeling
SI	-	Social Influence
skew	-	Skewness
SIS	-	Sustainable Innovative Solutions
SN	-	Social Norm
ss	-	Sum of Squared (loadings)
std	-	Standard
TAM	-	Technology Acceptance Model
TLI	-	Tucker Lewis Index
TPB	-	Theory of Planned Behavior
TUBS	-	Technische Universität Braunschweig
UA	-	User Acceptance
UB	-	Use Behavior
URI	-	University of Rhode Island

USA	-	United States of America (the same like US)
US	-	United States (the same like USA)
UTAUT	-	Unified Theory of Acceptance and Use of Technology
UX	-	User Experience
Var	-	Variance
vars	-	Consecutive number
VB	-	Variance Based
VBM	-	Variance Based Modeling
V2I	-	Vehicle-to-Infrastructure Communication
V2V	-	Vehicle-to-Vehicle Communication
WHO	-	World Health Organization
Y	-	Latent Variable
=	-	Equal
<	-	Less Than
>	-	Greater Than
$\leq$	-	Less than or Equal to
$\geq$	-	Greater than or Equal to
*	-	Confidence Level α : 1% (***), 5% (**), 10% (*)
%	-	Percent

1 CHAPTER 1 – INTRODUCTION

1.1 BACKGROUND

Through the advanced development of automotive technology, Autonomous Driving (AD) vehicles where the vehicle's central processing unit has full responsibility for control, will be a reality in the next years and is not a paradigm from a science fiction movie anymore [1]. There are six defined levels by the Society of Automotive Engineers (SAE), ranging from no automation (SAE-0) to full automation (SAE-5). In the coming years, fully Automated Vehicles, also called Autonomous Vehicles (FAVs) (Autonomous Vehicles = Fully Automated Vehicles = FAV = SAE-5), should be available on the market in full scale [2]. The development of technology for AD is progressing rapidly, despite the remaining obstacles still preventing its complete spread, and it has already affected the political, economic, industrial, and social circle of influence [3]. FAVs are still not allowed to operate in most locations, but some vehicles are already equipped with hardware that would theoretically allow them to operate autonomously [4]. Automated Vehicles (AVs) (Automated Vehicles = Partially Autonomous = AV = SAE-2 - 4) with partial and high automation stages such as SAE-3 and SAE-4, and FAVs with SAE-5 automation where no human operator is required, are not yet available for purchase except for trials in closed environments with a trained driver behind the wheel [5]. The National Highway Traffic Safety Administration (NHTSA) predicts that the years 2016 to 2025 and beyond will see a progression through various levels of partially automated safety features that move the technology towards FAVs [1]. Based on the SAE standard, vehicles with conditional automation (SAE-3) and high automation (SAE-4) are equipped with technology capable

of monitoring the driving environment and therefore can theoretically work in automated driving mode, however, only in certain conditions. FAVs with full automation (SAE-5) are provided with systems and can theoretically operate in all conditions without any human intervention [5], [6]. It is also estimated that by 2030 in Europe, FAVs with automation level SAE-5 may represent more than 30% of the automotive fleet on the road. In the year 2022, in the European Union and the US, all new vehicles will be assisted by automated features, such as Adaptive Cruise Control (ACC), Lane Keep Assistant (LKA), Automatic Parking Assistant (APA) or Autonomous Emergency Braking (AEB) [7]. However, AVs with Advanced Driver Assistance Systems (ADASs) e.g. ACC, LKA, or APA are already available for consumers. AVs, as defined in the study from Zhang et al., 2019 [5] refer to vehicles that are capable of sensing their environment and navigating without human input. Several Original Equipment Manufacturers (OEMs) including Tesla, Audi, BMW, Kia, Nissan, and Mercedes Benz already provide vehicles with SAE-2 for sale [8]. Vehicles with SAE-3 are soon expected and not far from penetrating the market [5]. In fact, in the current mass vehicle market, there are also AVs that can perform AD up to a certain level in particular conditions [9]. The constant evolution of vehicle safety systems contributes to significant decreases in accidents, deaths and, injuries on the road [3], [1], [10]. Different studies have already agreed that FAVs will transform transportation. AD promises many advantages and will be associated with several benefits that will be profitable for humans worldwide. Potential benefits of AD consist of crash prevention, enhanced mobility for people who cannot drive due to age or disabilities, emission reduction, and increased safety for cyclists and pedestrians. Nowadays, ADASs technology in motor vehicles already helps to save lives and prevent injuries on the road [3]. AVs will also offer sustainable profits to

the community, including better transport dynamization. AVs increase the driver's safety and extensively decrease injuries and deaths caused by human-factor-related accidents [3], [11].

At the current stage, the number of deaths due to road traffic is unacceptably high. According to a report by the World Health Organization (WHO), in the year 2016, the estimated number of worldwide road traffic deaths was 1.35 million people [12], [13]. Road traffic injuries are currently the leading cause of death for children and young adults aged 5-29 years. The global rate of road traffic death is 198.2 per 100,000 population. 94% of all serious crashes are due to human error. More than half of the global vehicular deaths are represented by vulnerable road users – cyclists, pedestrians, and motorcyclists; pedestrians and cyclists make up 26% of global deaths while users of two or three-wheeled vehicles comprise another 28%. Car occupants make up 29% of all deaths and 17% are undefined road users. Considering the human aspect, many road traffic injuries can be prevented. A list from the WHO shows the biggest risks of road traffic. These are speeding, driving under the influence of alcohol and other psychoactive substances, nonuse of motorcycle helmets, seat-belts, child restraints, distracted driving, unsafe road infrastructure, unsafe vehicles, inadequate post-crash care, and inadequate law enforcement of traffic laws. In order to prevent the above-mentioned issues and avoid accidents and road injuries, the road system must be created in a holistic manner. The “Safe system approach” explained by the WHO aims for a safe transportation system for all road users. The pillars of a safe system must be safe vehicles, safe roads, safe speed limits, and informed users. To eliminate human error and avoid crashes and serious injuries it is necessary that all of these issues must be addressed [12].

FAVs have the potential to eliminate the factor of human error from the equation and make the roads safer and prevent injuries for vehicle users, pedestrians, and cyclists. More than 31,177 people died by motor vehicle-related crashes in the US in 2017. An NHTSA study revealed that motor vehicle crashes cause billions of US dollars in economic activity, including \$594 billion due to loss of life and decreased quality of life due to injuries, and \$57.6 billion in lost workplace productivity. These costs could be significantly decreased by eliminating the majority of vehicle crashes. A further benefit is that roads filled with FAVs would ensure smoother traffic flow and can reduce traffic congestion [1]. In 2014 Americans spent 6.9 billion hours in traffic delays, which increases fuel costs and vehicle emissions. A recent study from the McKinsey Group [14] shows that, through AVs, drivers were able to save as much as 50 minutes each day that had previously been dedicated to driving. FAVs could also provide new mobility options to millions more Americans and other nations, especially for older people or people with disabilities. Today there are 49 million Americans over 65 years old and 53 million people who have some form of disability. Furthermore, because employment and independent living often depend on the ability to drive, FAVs could extend that kind of freedom for millions of people in many different places across the country [1]. Moreover, FAVs can create new employment opportunities for approximately 2 million people with disabilities [15].

AVs with a high stage of automation and FAVs with ADAS technology at high levels that are not available yet will only become a success if the technology is accepted by the users. It is important to examine preliminary automation stages before the technology penetrates the market in full automation versions. Such acceptance can only be reached if the users feel comfortable with the technology and have trust in it [5], [7]. Public

acceptance can significantly affect the distribution of AVs [16]. Therefore, user acceptance is an important determinant and will decide whether the technology will succeed or fail [10].

It is necessary to study user acceptance at an early stage before the technology is publicly available. Currently, people are already confronted with the technology of partially Automated Vehicles with SAE-2, and SAE-3 is expected soon [5], [8]. Gauging and understanding public opinion about FAVs and AVs can help prepare society for their rollout in several ways, and can provide important information about mistrust to provide benefits for industry (e.g. to help car manufacturers to design and tailor their products according to customer needs), academia (e.g. for future research) and governments (e.g. for future infrastructure/ traffic planning and decision making). Furthermore, all predicted benefits related to FAVs and AVs as mentioned above will never be realized unless the technology achieves societal and driver acceptance [6].

This study will focus on vehicles where high automation features are present, but the system still relies on a driver who may need to take over in response to a critical event, namely SAE-4. A vehicle with a high degree of automation (SAE-4) still has pedals and a steering wheel for those situations when the driver needs to resume control. However, the resumption of control can be problematic, as a driver in such a vehicle is likely to be occupied with tasks that are not related to driving [17]. The goal of this project is to provide a comprehensive approach to understand, assess, and evaluate public acceptance to the previous stage of FAVs. Several studies (e.g. [7], [18], [17]), have shown that acceptance of technology with different stages of automation varies between countries and cultures. Different acceptance research approaches found many different factors in various

combinations which impact the behavioral intention (BI) of users. The results show that the factors which impact the BI and technology acceptance are very different and this area needs more research. To fill this gap of acceptance research in terms of AD, this study will survey public opinion from the US and Germany to gauge their acceptance for the technology of partially AVs with a high stage of automation (SAE-4).

1.2 PROBLEM AND OBJECTIVE

Several studies have been conducted in terms of acceptance of AD technology, however, gaps still exist in this field of research. Moreover, the efforts to understand public acceptance of FAVs and AVs are still very limited and the explicit psychological determinants remain largely unknown [5],[7],[19].

Despite the advantages of FAVs and AVs, the public acceptance or intention to use it is generally low [5]. The fast development of technology for AD requires public acceptance [20]. On the one hand, the technology is still in development in order to complete tasks with 100% reliability. On the other hand, if an accident occurs with an AV on the road, then there may be human skepticism and low trust in technology. There are several examples e.g. in 2018 a Tesla Model S in “Autopilot” mode crashed into the back of a fire truck; several months later in Arizona, a pedestrian was killed by an Uber car operating in self-driving mode. Such accidents increased the public’s concern and reduced trust in AVs [21]. Accessibility to transport, traffic flow, emissions, safety, fuel use, and comfort are many sustainable benefits expected in the long term. All of these societal benefits can only be achieved if the technology is accepted by a certain amount of people [2]. To understand the public’s acceptance it is necessary to understand which factors influence the BI for such

vehicles. Efforts to make the public acceptance of AVs understandable are still limited and its psychological determinants remain largely unknown [5], [7], [19]. High-level AVs have not been widely used yet, and this study is an effort to improve understanding the public acceptance [20].

The specific objective of this study is to gauge public acceptance with a Technology Acceptance Model (TAM) for partially Automated Vehicles with a high automation stage, SAE-4.

2 CHAPTER 2 – REVIEW OF LITERATURE

For the investigation of driver acceptance for AVs, a literature review using public sources has been conducted. The most recent research based on psychological models were ranked according to the number of citations. The articles with the most citations have been taken as a reference. Based on this literature a TAM was created. The TAM consists of four constructs from the original TAM [22] and was extended with additional four constructs which should help to predict human acceptance in terms of partially Automated Vehicles with a high automation stage. The constructs and reasons for selection will be explained in more detail in chapter 3 under Hypotheses.

2.1 EVOLUTION OF AUTONOMOUS VEHICLES

The National Highway Traffic Safety Administration (NHTSA) defined an Automated Vehicle as one which has the “ability to operate at least some mission-critical controls without human intervention”. In order to differentiate the level of automation and the presence of direct human control, the NHTSA categorized mobility automation in six levels (level 0-5) [1]. The Society of Automotive Engineers (SAE) International Standard J3016 (2020) also categorized vehicle automation into six levels (0-5) where level zero indicates no automation and requires full human intervention and level 5 indicates Autonomous Vehicles (FAVs) with the highest stage of automation without any human intervention. By comparing both sets of definitions for each stage, both categorization systems match each other and could be considered to have the same meaning [1], [23].

Figure 1 and Figure 2 show the automation levels according to SAE.

Figure 1: SAE-0 -2 automation level/ Source: [24]

Figure 2: SAE-3 -5 automation level/ Source: [24]

The term “Autonomous Vehicle” is a common misunderstanding among people because it only refers to the highest level of automation (SEA-5), or a vehicle that can operate fully in self-driving mode independent from any human intervention [9].

There is also a lack of clarity in terms of using the abbreviation AV for Automated and Autonomous Vehicles. Several studies use the abbreviation AV for either Automated Vehicles or Autonomous Vehicles. For example, Zhang et al., 2019 [5] use the abbreviation AV for Automated Vehicles, while Wu et al., 2019 [20] use the abbreviation AV for Autonomous Vehicles.

The concepts of Autonomy and Automation differ from each other. Autonomous Vehicles differ from a cooperative because a fully Automated Vehicles because they can operate cooperatively. This means that a fully Automated Vehicle is working with local information provided from sensors, but does not communicate with either vehicle-to-vehicle (V2V) or vehicle-to-infrastructure (V2I) methods. In turn, Autonomous Vehicles are able to communicate V2V or V2I and are only valuable for transport performance if they are cooperative. Based on this statement, fully Automated Vehicles can only be Autonomous if they are able to communicate V2V or V2I. The distinction between Autonomy and Automation is made because it influences the conversation of societal and individual benefits of the technology. In this study, it is assumed that fully Automated Vehicles are cooperative and thus Autonomous Vehicles because this is the direction of adopting the technology [9].

To avoid confusion between the abbreviations FAV and AV, for this research, the definitions will be created and used as follows:

Automated Vehicles = AV (referring only to automation level SAE-2 - 4)

Autonomous Vehicles = FAV (referring only to automation level SAE-5)

For this study, a definition has been made in order to clarify the terms and keep Autonomous and Automated Vehicles apart. In that case, FAV stands for Fully Automated Vehicle which is equal to an Autonomous Vehicle which only refers to the full automation stage SAE-5. Also, the letter “F” in the abbreviation FAV can be seen as a mnemonic device, where the “F” can be associated with the first letter of “Five” so that FAV is the abbreviation for Autonomous or fully Automated Vehicles and stands for SAE-5.

2.2 ACCEPTANCE RESEARCH

The term “acceptance” is associated with recognition, approval, or confirmation. The term “accepting” is commonly understood to mean agreeing with something. The field of acceptance research is diverse and can refer to many fields (material or immaterial), i.e. from the acceptance of persons or groups to the acceptance of politics or policies, legal regulations or court decisions or strategies of nature, environment or climate protection up to technologies and technical artifacts. This field of acceptance research, which spans numerous disciplines, is correspondingly broad.

For this work, technology acceptance is of great importance. The development of technology acceptance began in the late 1960s and early 1970s and became over the years more interested in understanding the factors influencing the adoption of new technologies

in different settings. At this time much of the new technology that arose was responsible for social change. For that reason, researchers investigated the causes of the usage or avoidance of technologies. Technology acceptance can be defined as a users' willingness to employ technology for the tasks for which it is designed [25], [26]. Thus, According to a citation from Bernhard et al., 2020 [27] user acceptance is defined as "the demonstrable willingness within a user group to employ information technology for the tasks it is designed to support [27]". In this context, both terms are very close and can stand for the same in this context.

To influence the design and implementation process in ways to avoid or minimize resistance or rejection when users interact with technology, factors must be known which influences the behavioral intention to use the technology. In most of the acceptance research, researchers have sought to identify and understand the forces that form users' acceptance. The goal of acceptance research for new technologies is the avoidance of technological failures. Technological failures are considered technological developments which despite a high level of technical maturity, ultimately encountered a lack of interest or even user rejection and as a result have to withdraw from the market. In order to avoid such technological failures, it is necessary to seek reasons that explain users' acceptance or rejection of the new technology. Acceptance research analyzes the interface between human and machine, but the focus lies on the human or user side of technology [25], [26].

2.3 ACCEPTANCE MODEL

In the last years, many conceptually psychological models have been developed in order to explain human behavior and their acceptance of new technologies. These include

the Technology Acceptance Model (TAM, Davis, 1989 [22]), Theory of Planned Behavior (TPB, Ajzen, 1991 [28]), Unified Theory of Acceptance and Use of Technology (UTAUT, Venkatesh et al., 2003 [29]), and those expanded from the above models such as UTAUT2 (Venkatesh et al., 2012 [30]) and TAM2 (Venkatesh and Davis, 2000 [31]). These models are based on a theoretical framework in which people's beliefs and perceptions of technology can influence acceptance. BI to use a technology and the actual usage behavior can be set as a measure for the acceptance [5], [32].

Technology Acceptance Model (TAM):

TAM (as seen in Figure 3) was first suggested by Davis 1989 [22], and based on the Theory of Reasoned Action of Fischbein and Ajzen 1975 [28], [5], [33]. It proposes that perceived ease of use (PEOU), perceived usefulness (PU), and attitude towards using technology (ATT), are antecedents of BI [5], [34]. This model assumes that an individual's BI is determined by the individual's ATT. In turn, ATT has two predictors, i.e., PU and PEOU. In addition, PU is also influenced by PEOU. PU has a direct effect on BI [5]. The TAM is beneficial because among various types of users and systems it has a high explanatory power and is easy to understand [35]. TAM is a broad framework that can be applied to various technologies [32]. Based on the cognitive mechanism underlying human behavior, TAM provided a basic theoretical framework and explains user attitude and acceptance [5],[34].

Figure 3: Original TAM presented in Davis,1989/ Source:[6]; [26]; [22]

Theory of Planned Behavior (TPB):

The Theory of Planned Behavior (as seen in Figure 4) was presented by Ajzen 1991 [28] as an explanation for human behavior in general. In comparison to TAM, it predicts that behavior is influenced by BI and BI is influenced by three constructs: attitudes (ATT) (i.e. favorable or unfavorable beliefs), subject norms (SBN) (i.e., perceptions others that influence an individual) and perceived behavioral control (PBC) (i.e., ease or difficulty of performing that behavior) [5], [36], [17]. According to Buckley et al., 2018 [13], the TPB standard constructs of ATT, SBN, and PBC accounted for 46% of the variance in BI for SAE-3 AVs [17].

Figure 4: TPB presented by Icek Ajzen, 1991/ Source: [27]

The Unified Theory of Acceptance and Use of Technology (UTAUT):

The Unified Theory of Acceptance and Use of Technology (as seen in Figure 5) was designed to incorporate other theoretical models of acceptance. UTAUT was developed by Venkatesh et al., 2003 [29]. UTAUT integrated 32 significant factors from research on the use and intention to derive 4 core elements. The UTAUT proposes that performance expectancy (PE) (i.e., the degree to which an individual perceives that using a system will help), effort expectancy (EE) (i.e., ease of use), and social influence (SI) (perceptions of others that would bring an individual to use) have a direct link to behavioral intention (BI) which in turn influences the behavior. Furthermore, a fourth construct for facilitating conditions (FC) (i.e., the availability of support for the system) suggests to be directly linked with Use Behavior (UB) [17], [35]. UTAUT is very useful in many contexts of technology acceptance and adoption of Automated Road Transport Systems [34].

Figure 5: UTAUT presented by Venkatesh, 2003/ Source: [28]

2.4 REVIEW OF PREVIOUS STUDIES

A review and comparison of previous studies has been done to see the current state of the art in terms of technology acceptance. Many experiments have been conducted to investigate human acceptance regarding different automation levels as shown in Figure 6. Although they have almost the same goal, to investigate human acceptance of technology, they differ in many points, like country, applied model, automation level, sample size, etc. The most cited [5], [20], [19], [2], [37] on 03/02/2020 will be used as a guide for this study. Figure 6 is based on the most recent studies from Table 1 with psychological models. Most studies investigated the user acceptance for vehicles with SAE-3 and SAE-5 or called them fully Autonomous Vehicles by using abbreviation “AVs”, Autonomous Driving (AD), and Autonomous Shuttle(AS). The research for SAE-4 has been done in one study in three different countries: Sweden, France, and Australia. In the US, studies were conducted for Autonomous Vehicles, BEVs, CSs, Driverless Car Technology (DCT), SAE-3, Self-Driving Cars (SDC), and SAE-1- 2. In Germany, only research for Autonomous Vehicles has been conducted.

Figure 6: Previous studies referring to automation level/ Source:[Or]

Year	Country	C	Study	Model	Automation Level	AV introduction method	n
1 2020	Australia;France; Sweden	0	Kaye, Lewis, Forward, and Delhomme	UTAUT, TPB	SAE-4	Verbal description (online Survey)	1563
2 2020	China	1	Zhang et al.	TAM	SAE-3	Verbal description (online Survey)	647
3 2019	Korea	3	Lee, Lee, Park, Lee, and Ha	TAM	Autonomous Vehicle	Verbal description	303
4 2019	China; Europe; USA		Mueller	TAM	Autonomous Vehicle, BEV, CS	Verbal description	1077
5 2019	China	27	Zhang et al.	TAM	SAE-3	Verbal description	216
6 2018	China	10	Wu et al.	TAM	Autonomous Electric Vehicle	Verbal description (online survey)	470
7 2018	China	37	Xu et al.	TAM	SAE-5	Field experience	300
8 2018	Germany		Hein et al.	TAM	Autonomous Vehicle	Verbal description	642
9 2018	USA		Koul and Eydgahi	TAM	Driverless Car Technology	Verbal description	377
10 2018	Greece	22	Panagiotopoulos and Dimitrakopoulos	TAM (MR)	Autonomous Driving	Verbal description (Survey)	483
11 2018	Australia	35	Kaur & Rampersad	UTAUT (TPB)	SAE-5	Verbal description	101
12 2018	USA	23	Buckley et al.	TAM (TPB)	SAE-3	TA	74
13 2018	Dep.: Malaysia; U.S.; Saudi Arabia	13	Adnan et al.	TAM/ UTAUT	Autonomous Vehicle	Verbal description	Lit Rev.
14 2017	USA		Ward et al.	TAM (MR)	Self-Driving Cars	Verbal description (Survey)	1765
15 2017	Greece	47	Medigan et al.	UTAUT	SAE-3 (Public Transportation)	Field experience	315
16 2017	France	15	Motak et al.	TAM; TPB	Autonomous Shuttle	Verbal description	467
17 2017	U.S.		May et al.	TAM (AAM)	SAE-1 - 2	Field experience	202
18 2017	Korea		Cho et al.	TAM	NHTSA-1 - 4	Simulator experience	68
19 2017	Germany; USA		Benleumi and Blecker	UTAUT	Fully Autonomous Vehicle	Verbal description	313
20 2015	Korea	127	Choi and Ji	TAM	Autonomous Vehicle	Verbal description	552
21 2012	USA	73	Osswald et al.	(CTAM) UTAUT	Information Technology	Verbal description	21

Table 1: Previous research of technology acceptance/ Source:[Or]

A study from KPMG (Figure 7) shows a ranking of the top ten countries which are best prepared for AD. The countries are ranked by 26 variables within 4 pillars: policy and legislation, technology and innovation, infrastructure, and consumer acceptance. To achieve the full score it is necessary to get 30 points. The results show that the US, in third place, is well prepared for AD. Europe is not attracting as much attention as the US. Germany, which placed sixth, is also well prepared but has a lower score [38].

Figure 7 shows the countries best prepared for Autonomous Driving:

Figure 7: Countries best prepared for Autonomous Driving/ Source: [38]

Several studies have developed psychological models to explain human behavior and their acceptance of technologies. Despite the different ways of creation for such TAM models, their purpose is literally the same, to examine and explain human BI to use FAVs or AVs. Because acceptance is broad research and depends on many factors, e.g. cultures, countries, gender, etc., the models were created in slightly different ways but always using the same principles. Perceived Usefulness (PU) and Perceived Ease of Use (PEOU) are constructs that emerge from the original TAM and are used in each model. Although the

constructs play a significant role in many studies that investigate technology acceptance, their influence was sometimes assumed differently (e.g. Xu et al., 2018 [19]). Zhang et al., 2019 [5] extended the original TAM and found out that initial trust is the most critical factor in order to promote a positive attitude towards technology (ATT) for vehicles with SAE-3.

A research article from Lee et al., 2019 [34] says that these reports have been inconsistent because different assumptions have been used for the effects of other factors. For example, some studies reported that all of the relationships were significant (e.g., Wu et al., 2019 [20]; Panagiotopoulos and Dimitrakopoulos, 2018 [2]) but other studies reported that only some relationships were significant (e.g., Buckley et al., 2018 [37]; Choi and Ji, 2015 [39]). Moreover, Wu et al., 2019 [20] show that environmental concern (EC) is a significant factor. However, except Xu et al. 2018 [19], most studies related to TAM followed the basic assumptions of the original TAM: PEOU positively affects PU, and both factors positively affect the BI to use (Davis et al., 1989 [22]). This suggests that studies of AVs based on TAM should start by examining TAM's basic assumptions. Although many of the available studies have integrated trust, the ways that the trust construct (e.g. direct effect, indirect effect or mediation effect) influences acceptance has been modeled differently (e.g. Kaur and Rampersad, 2018 [40]; Xu et al., 2018 [19]; Panagiotopoulos and Dimitrakopoulos, 2018 [2]). The acceptable path for the trust construct is still underdetermined. After all, perceived risk was repeatedly reported as one of the most common concerns.

Osswald et al., 2012 [41], proposed a car technology acceptance model (CTAM) by incorporating constructs from UTAUT for drivers' acceptance of in-car technology. They

suggest addressing the key moderators, gender, age, experience, and voluntariness of use because they might influence the severity of technology acceptance.

May et al., 2017 [32] investigated user acceptance for SAE-1 - 2 in the US with 202 participants (participants were a combination of paid mechanical truck contractors and volunteers found through snowball sampling) using the online survey software by Qualtrics. They used the automation acceptance model (AAM) developed by Ghazizadeh, Lee and Boyle (2012) [42]. Compatibility has the strongest impact on PU and were more heavily loaded by SAE-2. BI to use was more loaded by SAE-2. Loadings were highest for intention to use in urban environments. But they missed two important constructs in their model, trust, and PEOU because they stated “there is not yet a widely accepted method for measuring use-based trust”. They suggest adding this construct to the model would be helpful for model fit. PEOU is difficult to measure without a driving simulator [32]. But in the last years, there have been several research studies without driving simulators where the constructs trust and PEOU were measured and found to be a significant factor that influenced the BI to use Automated and Autonomous Vehicles (e.g. Zhang et al, 2019/ 2020 [5], [43]).

Cho et al., 2017 [35] conducted an experiment on a driving simulator with 68 participants and designed a technology acceptance model (TAM) for four stages of automation (NHTSA-1 - 4). They used the constructs performance expectancy (PE), Social Influence (SI), Perceived Safety (PS), Anxiety (AX), Trust, and Affective Satisfaction (AS) which influenced BI. They used User Experience (UX) and User Acceptance (UA) scores. According to the automation steps of Autonomous Vehicles, the results shows that the UX/UA score has a significant difference statistically. The score of UX/UA tends to move

up until level 2. At level 3 it goes down to the lowest level and increases a little. At level 4 it increases a little or stays steady.

Other recent studies (i.e., Zhang et al., 2019/ 2020 [5], [43]; Buckley et al., 2018 [37]; Madigan et al., 2017 [44]) investigated the driver acceptance only focusing on SAE-3. Zhang et al., 2019 [5] extended the original TAM with the constructs initial trust (IT), which in turn was influenced by perceived safety risk (PSR) and perceived privacy risk (PPR). They randomly surveyed 216 participants from parking lots in Shenzhen, China, and found out that initial trust was the most critical factor for promoting a positive attitude towards technology (ATT). A study by Zhang et al. (2020) [43] extended TAM incorporating social and personal factors, i.e., social influence, initial trust, and the big five personality and sensation-seeking traits. Their results revealed that social influence and initial trust contributed the most to explain whether users would accept Automated Vehicles or not. SI not only directly influences BI but also trust, PU, and PEOU. One reason could be that vehicles with SAE-3 are not commercialized yet and through the lack of first-hand experience, the cognitive evaluation of such vehicles can be unstable or inaccurate or could be influenced by media, friends, or other opinions. Moreover, the place where a study is conducted also could affect results. China is a collectivistic culture. In such cultures, the opinion is likely influenced by others. Regarding technology acceptance, SI is expected to have a stronger influence in collectivistic cultures compared with western cultures. The results showed that initial trust and social influence played the most important role in determining users' BI to use AVs.

Buckley et al., 2018 [37] did research for SAE-3 with a simulated experimental drive in which 74 participants experienced automated drive and manual control. The theory of

planned behavior (TPB) constructs of attitude towards behavior (ATB), subject norms (SN), and perceived behavioral control (PBC) were found to be important predictors for the intention to use an Automated Vehicle.

Madigan et al., 2016 [33] conducted a survey with 315 participants by using the UTAUT located in two different places, La Rochelle France, and Lausanne Switzerland. They focused on users' expectancies which may influence BI regarding the use of an Automated Road Transport System (ARTS). Their finding shows that social influence (SI), Effort Expectancy (EE), and Performance Expectancy (PE) were useful determinants of BI to use an ARTS. PE has the strongest impact on BI.

The most recent research for SAE-4 was conducted by Kaye et al., 2020 [17] in three different countries, namely Australia, France, and Sweden with 1563 participants. They applied the UTAUT in combination with constructs from TPB in order to investigate individuals a priori acceptance of, and BI to use, highly automated vehicles across three different countries. Their results show pre-existing knowledge is a significant factor. For Sweden and France, people who had pre-existing knowledge of automated cars indicated a higher BI to use automated cars when they will be available in the future than people without pre-existing knowledge. Compared to Australia and Sweden, people residing in France reported a higher BI to use highly automated vehicles when they will become publicly available. The findings highlighted differences in prior acceptance and intention to use when highly automated vehicles when they become publicly available across different countries and cultures.

Based on Figure 6, most research has been done considering Autonomous Vehicles (AVs) (SAE-5) or Self-Driving Cars (SDC) (i.e., Lee et al., 2019 [34]; Wu et al., 2018

[20]; Hein et al., 2018 [45] ;Panagiotopoulos and Dimitrakopoulos, 2018 [2]; Kaur and Rampersad, 2018 [40]; Adnan et al., 2018 [9]; Xu et al., 2018 [19]; Ward et al., 2017 [46]; Motak et al., 2017 [47]; Benleulmi and Blecker, 2017 [48]; Choi & Ji, 2015 [39]).

Lee et al., 2019 [34] restructured the TAM and investigated factors that can influence the BI, especially the feeling of ownership. They suggest, by redesigning the TAM to a new research model, that psychological ownership, in combination with other psychological factors from previous studies, should be investigated from a technology acceptance perspective. According to this study, the relationship between perceived safety risk (PSR), PEOU, and BI remains unclear. To examine factors influencing the BI of AVs, this study, by redesigning the relationships of factors in a new model, focuses on three factors related to TAM (i.e., the PEOU, PU, and BI) and four factors related to the usage of Autonomous Vehicles (i.e., psychological ownership (PO), relative advantage (RA), self-efficacy (SE), and perceived safety risk (PSR)). This combination provides different results related to the impacts of psychological factors. Their findings revealed that PU, SE, and PO can be significant factors that affect BI. Especially PO was presented as not related to PU but was related to BI. Another limitation of previous studies is that they were not considering the concept of ownership from the perspective of technology acceptance. Autonomous Vehicles are able to perform without any human intervention. That means the passengers are able to spend their attention on their own things such as reading, watching a movie, or using mobile phones while driving. Moreover, they can use the Autonomous Transportation (AT) for carrying cargo. This suggests that people may be interested in the use of Autonomous Vehicles without ownership but with a feeling of ownership. This can be explained as psychological ownership [34].

Wu et al., 2019 [20], considered the environmental benefits of Autonomous Electric Vehicles (AEVs). The TAM was redesigned and PU changed to green perceived usefulness (GPU). In their study GPU is defined as the extent to which users believe that using new products will increase the environmental performance of their life. They found GPU and PEOU are closely related to BI of AEVs. Furthermore, PEOU illustrates a significant relationship with the GPU. Environmental Concern (EC) is related to public awareness of environmental problems, which can be indicated by attitude, recognition, and response towards environmental issues and can not only affect BI directly, it also affect BI indirectly through GPU and PEOU. Considering of total effects, GPU plays a bigger role than PEOU. EC is an important determinant to influence AEV adoption. By improving living conditions, people expect higher environmental quality. Therefore they will pay more attention to environmental-related topics.

Panagiotopoulos and Dimitrakopolous, 2018 [2] conducted a survey and researched with an extended TAM. Their findings show that constructs of PU, PEOU, perceived trust (PT), and social influence (SI) are useful determinants of BI to have or use an AV. PU has the strongest impact on BI. This survey also found differences in genders. In comparison to other studies, this study shows that females are more likely to have or use AVs than males when they become available in the market. SI has a positive effect on BI. Individuals would use AVs if they find that they can trust the technology in terms of safety, data privacy, and security protection concerns.

Kaur and Ramsapersad, 2018 [40] investigated the key factors influencing the adoption of Self-Driving Vehicles (SDVs). Their research is based on a case study in a closed environment, a university campus. They hypothesized that trust and performance

expectancy (PE) were the two factors that directly impact AV adaption. They also hypothesized reliability, security, and privacy were antecedents of trust. These three factors could only indirectly influence adoption through trust. The model was tested with 101 participants. Data were collected from university staff and students. The fitness and the explanatory power of this model was not reported [5].

Adnan et al., 2018 [9] did research based on literature using sources from Scopus and Web of Science. Their results show that the level may vary based on the sociodemographic profile of the users. Moreover, trust has been studied as one of the factors for user acceptance. EE, PE, and SI were shown to have a positive influence on BI. PE has the strongest impact and is the most significant.

Xu et al., 2018 [19] surveyed 300 students in China in a driving experience with a test car SAE-3 to understand the influence of direct experience for Self-Driving Vehicles (SDVs, SAE-5). Participant trust, PU, PEOU, and BI were recorded before they experienced the test. The psychological model was recorded after the experiment. The results showed that the AV experience was found to increase their trust, PU, and PEOU, but not BI. Trust can also indirectly affect AV acceptance through other determinants.

Wardt et al., 2017 [49] conducted an online national survey in the US and investigated the effect of the perceived benefits (PB) on BI. They found that perceived risk (PR) has a significant effect on BI to use AVs. Their findings show that prior knowledge as well as perceived benefit, risk, and trust play an important role in the acceptance of AVs. Among these four factors, perceived benefit was presented as the primary factor.

Motak et al., 2017 [47] investigated the effects of TAM by extending it with TPB and other factors on the intention to use an Autonomous Shuttle (AS). The results revealed that the majority of the variance in the BI was described by the factors in the TAM and TPB.

Benleulmi et al., 2018 [48] conducted an online survey with 313 participants in the US and Germany in order to investigate factors that influence the usage of fully Autonomous Vehicles across cultures. Their focus lies especially on the different risks that might deter consumers from using highly Automated and/or Autonomous Vehicles. Their research model is based on UTAUT. They proposed a research model comprised of constructs from UTAUT2. Their findings have serious implications both on the academic field as well as the industry, especially in regards to the roles that risks, culture, and gender play in the acceptance of fully Autonomous Cars. Lack of control and risks were found as the consumers' key inhibitors to Autonomous Cars' acceptance. The risk of the car being unsafe and the risk of the car malfunction were reported to have a great influence on the consumer trust of a car. Surprisingly, the PE of AVs as well as their convenience were found not to be significant. This could be explained by consumers being more influenced by the negative aspect i.e. the car malfunctioning as well as the unavailability of the car in the market at the present time. Financial risk as well as the privacy risk were proven to not be significant as many people do not find them to be 'deal breakers'.

Choi and Ji, 2015 [39] surveyed 552 drivers and demonstrated that PU and trust were necessary antecedents for using AVs, but also had a weak effect on BI to use an AV. They found a significant moderate relationship between trust and intention to adopt AVs. They support the proposition that trust is the major factor in influencing the acceptance for Automated Vehicles and a major construct determining consumers' willingness to adopt.

Other studies surveyed the acceptance between different slightly technologies or for Driverless Car Technology. Mueller, 2019 [50] compared technology acceptance between Autonomous Vehicles and Battery Electric Vehicles as well as Car Sharing in three different markets across the world, namely Europe, the US, and China. His research contributes to comprehension of cross-cultural differences in technology adoption. He found that the positive influence of PEOU on PU and ATT is stronger for AVs in North America. In comparison with Europe and China, PEOU has a higher influence on ATT for AVs and BEVs. Car sharing has a stronger positive relationship between PEOU and ATT in Europe.

Koul and Eydgahi, 2018 [51] used a TAM to determine user acceptance for Driverless Car Technology (DCT). As consumers' years of driving experience increased, the intention of potential consumers to use Driverless Car (DC) decreased slightly. Also, it was shown that with an increase in users' age, the intention of potential users to use DCs decreased slightly. The acceptance of DCT is lower in users with more driving experience and with older users.

The studies show that the field of acceptance research in terms of technology is not finally clarified. Results differed based on different assumptions, models, times, countries and cultures. Based on that literature review and the remaining existing gaps in acceptance research for SAE-4, the next chapter 3 aims to present the methodology used for investigating public acceptance of automation level SAE-4 in the US and Germany.

3 CHAPTER 3 – METHODOLOGY

In this chapter, all necessary steps and procedures to investigate acceptance of partially Automated Vehicles are explained. This begins with the creation of the model based on the literature review, followed by the hypothesized relationships between the constructs and the experimented design and concludes with the applied statistical methods for the evaluation.

3.1 HYPOTHESES AND RESEARCH MODEL

This research investigates consumers' acceptance referring to partially Automated Vehicles with a high automation stage, namely SAE-4, in the US and Germany. For this experiment, the Technology Acceptance Model (TAM) has been chosen. Over the years, researchers have successfully applied TAM in the context of mobility, and it has been shown to be a suitable method to examine acceptance (see Table 1). Therefore in this study, it is argued that TAM is a suitable model to investigate technology acceptance for Automated Vehicles. Furthermore, it was found that the proposed models TAM, TPB, and UTAUT are fit to explain the acceptance of technology for Autonomous Vehicles in terms of BI. In comparison to TAM and TPB, UTAUT is the model that generally shows the lowest performance [9]. Moreover, in the study from Rahman et al., 2017 [52] where they assessed TAM, TPB, and UTAUT for ADASs, TAM was found to be best in modelling driver performance followed by TPB. Their findings not only confirm that these models can be applied to ADAS technologies but also provide a basis for understanding driver acceptance [52]. The TAM for this study is based on four constructs from the original TAM

and further added constructs, namely initial Trust (INT), Perceived Safety Risk (PSR), Perceived Financial Risk (PFR), and Perceived Benefit (PB).

3.1.1 HYPOTHESES AND CONSTRUCTS

The hypothesis testing will show whether the hypotheses meet the assumptions are made regarding the relationships between the constructs. Hypothesis testing is a statistical test based on two hypotheses. The assumption of the null hypothesis (H_0) is that there is no significant effect or difference within the specified sample size. The alternative hypothesis (H_1) is always the opposite assumption of H_0 . The goal is to test if H_1 is likely true. The p-value which is provided from the hypothesis test is essential for the decision-making process and determines whether H_0 should be rejected or not. If H_0 is rejected, the alternative hypothesis H_1 will be assumed [53]. The confidence level for the hypothesis testing is provided automatically from the SEM analysis and is indicated by stars at the levels of: 0.1% (***), 1% (**), 5% (*), and 10% (). A partial least squares structural equation modeling (PLS-SEM) method will be applied to test the assumed hypotheses.

Criteria for p-value, H_0 , and H_1 [53]:

p-value $\leq \alpha$ = Reject H_0

p-value $> \alpha$ = Fail to reject H_0

To comprehend how the assumptions with the respective constructs were made, the following paragraphs about each construct contain a more detailed explanation of why these constructs have been chosen or added, and the assumptions that have been made.

Behavioral Intention (BI): *(construct from original TAM)*

BI conveys the effect of other potential antecedents of actual usage behavior and is associated with the degree to which an individual will use a technology. Therefore, when technology acceptance is investigated early driving the development stages, BI is often used as a dependent variable in place of actual usage [43].

Attitude Towards Technology (ATT): *(construct from original TAM)*

The determinant ATT explains an individual's positive or negative feelings towards using technology. Consumers tend to have a higher intention to use technology if they have a positive attitude towards a technology. In the original TAM, the relationship between ATT and BI has been confirmed as the most stable one [5]. Due to that confirmation in this research, it will be assumed that:

H1.0 = H_0 : ATT has no positive effect on BI

H1 = H_1 : ATT has a positive effect on BI

Perceived Ease of Use (PEOU): *(construct from original TAM)*

PEOU explains the extent to which an individual believes that using an Automated Vehicle will be free of effort. Its relevance should not be undervalued in Automated Vehicle adoption, considering that using Vehicles with automation technology is a new experience and therefore requires some efforts of learning. Through previous studies, it was recognized that PEOU has a direct impact on PU and ATT. BI can also be influenced by PEOU, but indirectly through PU and ATT [5].

Perceived Usefulness (PU): *(construct from original TAM)*

According to the definition from Davis et al.,1989 [22] , Perceived Usefulness (PU) refers to the extent to which an individual believes that using an Automated Vehicle will improve his or her performance. Automated Vehicles promise to be beneficial for users to improve road safety, reduce energy consumption, decrease congestion, and promote flexibility for doing non-driving tasks. All of these benefits might promote a positive attitude towards technology and increase the intention to use Automated Vehicles [5], [19], [39]. Hypotheses regarding PEOU and PU are assumed as follows:

H2.0 = H_0 : PU has no positive effect on ATT

H2 = H_1 : PU has a positive effect ATT

H3.0 = H_0 : PU has no positive effect on BI

H3 = H_1 : PU has a positive effect BI

H4.0 = H_0 : PEOU has no positive effect on PU

H4 = H_1 : PEOU has a positive effect PU

H5.0 = H_0 : PEOU has no positive effect on ATT

H5 = H_1 : PEOU has a positive effect ATT

Initial Trust (INT): *(added construct)*

Trust is defined as “the attitude that an agent will help achieve an individual’s goals in a situation characterized by uncertainty and vulnerability [5].” Over-trust can result in misuse or abuse. Distrust towards an automated system could lead to disuse. Several studies have reported that trust is a positive and significant predictor of drivers’ positive attitudes towards AVs and has been identified as a key determinant that determines human-

automation interaction [37], [39], [54]. This has received empirical support from the driving automation field. It should be noted that because the majority of consumers have no chance to interact with highly Automated Vehicles yet, trust is more precisely referred to as initial trust (contrary to dynamic trust formulated during an interaction with a system [5]).

In order to increase the acceptance for such technology, efforts should be made to not only broadcast its PU and PEOU but also to increase the users' initial trust towards the technology [43], [55]. Especially in the early phase of marketing such technologies, it is important that potential consumers create trust and overcome the risk threshold in order to develop a positive attitude towards the product. Therefore, the initial trust is considered particularly important to contribute to the success of a positive attitude, which ultimately leads to behavioral intentions. Furthermore, the results from Zhang et al., 2019 [5] revealed that initial trust was the most critical factor to promote a positive ATT in terms of AVs with SAE-3. Based on these findings, in this study it is assumed that:

H6.0 = H_0 : INT has no positive effect on ATT

H6 = H_1 : INT has a positive effect ATT

Trust in automation always behaves relative to the task the operator wants to perform. Thus, the operators must consider the automation first as useful in order for trust to be established. Many commerce studies have confirmed the significant role of usefulness in developing trust but little such research has been done in the context of driving. A study from Dikmen and Burns, 2017 [56] found through an experiment that initial trust towards the Tesla Autopilot system was positively related to PU. Another construct that has an

impact on trust is PEOU. In the context of driving, PEOU has been investigated indirectly. There has been, however, evidence that improving the saliency of feedback of AV technology, visualizing the system's interpretation of current situations, or providing the rationale for the feedback, all of which a higher level of ease of use, helps users build higher trust towards the technology [5]. Based on the above results, in this study it is hypothesized that:

H7.0 = H_0 : PEOU has no positive effect on INT

H7 = H_1 : PEOU has a positive effect INT

H8.0 = H_0 : PU has no positive effect on INT

H8 = H_1 : PU has a positive effect INT

Perceived Safety Risk (PSR): *(added construct)*

Many surveys have revealed that while perceiving the potential benefits of AVs participants have also expressed great concerns about risks associated with the adoption of AVs [42]. Recent evidence showed that trust and perceived risk also played important roles in shaping the public's acceptance in terms of AVs [5], [17], [28], [38]. Potential safety risk was the top concern. The most frequent reason cited for being unlikely to ride an AV was worrying about safety risk due to system or equipment failure. Moreover, another concern that has raised the users' attention is the safety risk in terms of privacy. Privacy risk originates from the possibility that behavioral data or travel data of passengers could be transmitted to the government, vehicle developers, and insurance companies without notice, or be used against the users or be hacked by others. Therefore, perceived risk in terms of technical failure and privacy will put together as one construct. A fundamental

safety risk is examined in this study to see whether people are concerned about the safety of AVs. The construct PSR consists of questions about safety in terms of the technology and privacy [5]. Therefore it is assumed that:

H9.0 = H_0 : PSR has no negative effect on ATT

H9 = H_1 : PSR has a negative effect on ATT

Perceived Financial Risk (PFR): *(added construct)*

Financial burden was recognized as a significant issue of concern for individuals [57].

The financial burden can arise from purchasing a new vehicle or from higher costs for insurance and taxes. According to a study about FAVs from Benleulmi et al., 2018 [48] financial risk was proven to not be significant as many people do not find these issues to be 'deal breakers'. In that case, it can be assumed that people use such SAE-5 vehicles without ownership, such as in shuttle and taxi services. Vehicles with SAE-4 might have more personal ownership despite high cost technical systems. Another financial burden can also appear if an accident has happened. Who is liable for the crash? In most cases, the guilty person has to be liable for the crash and cover the expenses through their insurance or personally. However, with AVs, it might also raise difficult problems. "For example, if an autonomous vehicle which is fully operated by a system that could control its running without intervention of a human being collides with a traditional vehicle which is being driven by a person, and as a result, another person who was just walking nearby was killed, who is to be liable for the tragic result [58]?" This question is particularly difficult to answer when it is determined that the driver of the traditional vehicle (e.g. human) was not neglectful in this scenario. Is the manufacturer of the AV not only liable under civil as well

as criminal law without taking its low predictability for the result into account? Can the AV (i.e. the machine or artificial intelligence (AI) be held responsible for the result? Such a scenario, where no entity to which liability should be ascribed can be found, is an important open issue which needs attention worldwide [58]. For that reason, because such questions have not yet been exactly clarified, it is hypothesized that Perceived Financial Risk consists of cost of technology along with, cost of maintenance, insurance and liability. Thus, it is assumed that:

H10.0 = H_0 : PFR has no negative effect on INT

H10 = H_1 : PFR has a negative effect on INT

Perceived Benefit (PB): *(added construct)*

Users consider AVs from a competitive perspective, relative to traditional vehicles [34]. Perceived trust and benefit play an important role in the acceptance of AVs. Among these factors, PB was presented as the primary factor INT and ATT [46]. Many people perceived lower risk values and higher comfort and innovation values for AVs than for conventional vehicles [34]. Thus, it is hypothesized that PB of high AVs has a direct positive effect on ATT and INT for indirectly promoting a positive Attitude Towards Technology:

H11.0 = H_0 : PB has no positive effect on INT

H11 = H_1 : PB has a positive effect on INT

H12.0 = H_0 : PB has no positive effect on ATT

H12 = H_1 : PB has a positive effect on ATT

3.1.2 TECHNOLOGY ACCEPTANCE MODEL

Figure 8 represents the TAM for this research. Black Lines represent the original TAM. Red Lines represent the added constructs. H1 – H12 are the assumed hypotheses.

Figure 8: Technology Acceptance Model (TAM)/ Source:[Or]

3.2 ITEMS (SURVEY QUESTIONS)

The TAM, as seen in Figure 8, consists of eight constructs PEOU, PU, PSR, PFR, INT, PB, ATT, and BI. Each construct consists of survey questions which are also called items that measure the construct. The items were taken from previous studies and adapted to this study accordingly. The items for the respective construct are as follows:

PEOU 1: Learning to use partially Automated Vehicles will be easy for me [5]

PEOU 2: I will find it easy to get partially Automated Vehicles to do what I want it to do [5]

PEOU 3: It will be easy for me to become skillful at using partially Automated Vehicles [5]

PEOU 4: I will find partially Automated Vehicles easy to use [5]

- PU 1: Using partially Automated Vehicles will reduce my stress of driving [5]
- PU 2: Using partially Automated Vehicles will let me do other tasks, such as eating, watching a movie, or making cell phone calls [5]
- PU3: Using partially Automated Vehicles will be useful in meeting my driving needs [5]
- PU4: Using partially Automated Vehicles will decrease my accident risk [5]
- PSR1: I am concerned about the difficulty in responding appropriately when avoidable or unexpected situations arise [57]
- PSR2: I am concerned about the difficulty in interacting with conventional vehicles or bicycles on the road [57]
- PSR3: I am concerned that partially Automated Vehicles will collect too much personal information about me [5]
- PSR4: I am concerned about occurrences about system failures, errors, or problems from hacking [57]
- PFR1: I am concerned that purchasing a new partially Automated Vehicle will have additional costs due to the installation of electronic equipment and intelligent systems [57]
- PFR2: I am concerned about that increased costs of operating and maintaining a partially Automated Vehicle, such as system upgrades, map upgrades, network usage costs, higher insurance costs, etc. [57]
- PFR3: I am concerned about the uncertainty of legal responsibility due to an unavoidable crash situation where decisions have been made by the vehicle [57]

- PFR4: I am concerned about the liability if an accident occurs when a partially Automated Vehicle operates in self-driving mode [57]
- PB1: Partially Automated Vehicles prevent collisions between vehicles and pedestrian, using environmental recognition, automatic control, etc. [57]
- PB2: Partially Automated Vehicles reduce fatigue and difficulties in driving due to self-driving and finding the optimal path [57]
- PB3: Partially Automated Vehicles reducing traffic congestion during commute times or in certain areas [57]
- PB4: Partially Automated Vehicles reduce parking stress through automatic parking or parking assistance [57]
- INT1: High Automated Vehicles are reliable [5]
- INT2: Overall, I can trust high Automated Vehicles and its technology [5]
- ATT1: Using partially Automated Vehicles is a wise idea [5]
- ATT2: Using partially Automated Vehicles is pleasant [5]
- BI1: I predict I would use partially Automated Vehicles in the future [5]
- BI2: I will purchase a partially Automated Vehicle with my next car [5]

3.3 STUDY DESIGN

After the model was developed, an online survey with the software Qualtrics was created to collect data from public to prove the assumed hypotheses with the method PLS-SEM. The study design consists of seven main sections that are considered for the creation of the experiment, such as target group, the definition of minimum criteria, recruitment & distribution, durations, motivation, questionnaire design, and IRB approval.

3.3.1 TARGET GROUP

People from 18 years old with a valid driver's license in from the US and Germany, were recruited to investigate public acceptance of AVs in both countries. This experiment was designed to gauge public opinion referring to partially Automated Vehicles with a high Automation Stage, namely SAE-4. To achieve a representative sample size, the sample size was set to 100 responses per country.

3.3.2 DEFINITION MINIMUM CRITERIA

The minimum criteria is an essential characteristic that is relevant for a decision making process in terms of whether the experiment has achieved the data expected and can continue with analysis. If the minimum participation criteria are not achieved, more runs will be continued until the minimum criteria are met. Table 2 shows a summary of the defined minimum criteria with the following explanation. The minimum criteria apply to each survey per country and refers to a sample size of 100 useable responses. The minimum criteria were determined from the point of view that two countries, male & female, and different age groups will be compared in terms of acceptance of the technology of Autonomous Driving. Therefore, it is important that the minimum limits are reached. For continuing the data analysis only the minimum limits will be considered. If the specified limits are exceeded, the data that is actually available will continue to be used (see Appendix D - IRB documents).

Table 2 shows the minimum criteria for the surveys.

1. Useable responses per Country	≥ 100
2. Nationality per Country	$\geq 90\%$
3. Useable responses per State	$\geq 50\%$
4. Useable responses per Male/ Female per Country	$\geq 30\%$

Table 2: Survey minimum criteria/ Source:[Or]

Description of minimum criteria:

1. At least 100 useable responses per Country (100 from US/ 100 from Germany).
The minimum sample size was with the Qualtrics sample size calculator. Settings were used based on the population of the US (329 million [59]) and Germany (82 million [60]) with a 95% confidence level and the highest margin of error at 10%. According to the Qualtrics calculator, the ideal sample size is 97 [61]. A rounded up value of 100 was chosen. Furthermore, based on previous studies, as shown in Table 1, sample sizes (n) between 74 and 470 were given to conduct similar experiments in the literature.
2. At least 90% of Nationality per country. According to the social situation in 2018 from Bundeszentrale für Politische Bildung (bpb), 12.1% of the German population are foreigners [60]. The foreign-born size and share of the US population was 13.7% in 2018 [62]. Because of the comparison of two countries, the achieved responses per country must be nationals from that country respectively to be able to map the results on the country.
3. At least 50% useable responses from Rhode Island (US sample size), and at least 50% useable responses from Lower Saxony (German sample size). The population

of Rhode Island makes up around 0.6% of the whole US population [63] while Lower Saxony makes up around 10% of the whole German Population [64]. Due to the fact that only 100 responses are expected, a minimum amount of 50% is set to represent both States. Because this research is conducted at the University of Rhode Island (URI) in cooperation with the Technische Universität Braunschweig (TUBS), the results will focus on the comparison between the US and Germany within the states of Rhode Island and Lower Saxony where both Universities are located. Furthermore, a country such as the US and Germany consists of many regions with different economics, laws, rules, cultures, and subcultures, so in that case, it can be assumed that people think and perceive technologies differently.

4. At least 30% each from males and females. In such a study, it is important to compare males and females because the perception of gender is different. Based on the population, the difference between males and females in the US is 0.4% and in Germany 3%, and hence for this study is considered negligible [65], [66]. Therefore, the optimal case would be approximately 50 of each gender from a sample size of 100. Previous studies show a significant higher amount of males than females in the participation of such experiment (e.g. 70.8% male [2], 67.1% male [5], 66.8%, 58.1%, 61.8% male [17], 57.1% male[43], 68.44% male [51]). Therefore a minimum lower limit is formed in order to maintain a tolerance range. It is expected to get at least 30% of responses from male and female.

3.3.3 RECRUITMENT & DISTRIBUTION

The survey distribution is done digitally via a link with an associated recruitment text through personal contacts, chat groups, and University Facebook accounts. The recruitment script (see Appendix C – Recruitment) consists of the most important briefly listed information such as project title, motivation text, purpose, anonymity, durations, Institutional Review Board (IRB) Approval, and the link for participation.

3.3.4 MOTIVATION FOR PARTICIPATION

To convince people to participate in this experiment and then reward them for their time, an opportunity for winning an Amazon Gift Card is given, and a raffle will be held for all participants who complete the survey. The message about the gift card is listed on the recruitment text (as shown in Appendix C – Recruitment). The amount of the gift card is 20 Dollars for the US citizen and 20 Euros for the German citizen. In order to participate in the gift card contest, the participants have to provide their E-Mail address with the survey. The raffle winner will be selected by the researcher and the principal investigator in a MS Excel file using a random number generator. In the field where the e-mail addresses are entered, the participants are expressly reminded that the e-mail addresses will be deleted and will not be associated with survey responses.

3.3.5 DURATIONS

The first run of the survey was set from 09th April 2020, 6:00 am – 25th April 2020, 11:59 pm (17 days). The survey was designed so that there is a buffer period to reopen in case the first survey does not meet the minimum criteria for the number of participants.

The duration for the survey itself was estimated be a maximum of 15 minutes in total, including reading the consent form, reading the definitions, and answering the questions. Basically, the shorter the survey, the easier it is to convince people to participate and spend their time on it.

3.3.6 QUESTIONNAIRE DESIGN

The survey is created with the online software Qualtrics, to which the URI subscribes. The Survey consists of 40 question fields in total. The first 2 question fields provide the project title, URI logo, and the consent form. The survey is divided into 3 separate Blocks in Qualtrics .

The first block starts with two questions fields for the project title and the URI logo, and the consent form where participants have the choice to accept the consent form if they agree to participate or to skip it. The next 3 question fields are for entering the E-Mail address for participation in the gift card contest. After the consent form and gift card message, 7 demographic questions follow with questions such as gender, age, length of commute, time since first driver's license, etc.

The second block consists of 26 items in a randomized order and refers only to partially Automated Vehicles with a high automation stage. Before the participants get to these items they will get a brief definition of an SAE-4 vehicle. The definition is as follows:

“A high automation vehicle is designed to perform all aspects of the driving task, even if the human driver does not respond appropriately to request to intervene. The operator of the high automation car can undertake non- driving activities (e.g., responding to emails, viewing scenery, reading a book) when the vehicle is in control of all driving tasks. Automation mode may not be suitable in poor weather

conditions (e.g., heavy storms, snow) and may only be supported in specific geographic areas. A high automation car will still include a steering wheel and pedals to allow a human driver to take over when required (e.g., in an emergency, or by choice) [17].”

German definition: (see Appendix B – Survey Germany)

These 26 questions are items which assess different constructs such as perceived ease of use or perceived usefulness, etc. The items are provided with a five-point Likert-Scale ranging from “Strongly agree” = 1 – “Strongly disagree” = 5. A Likert Scale has a range and measures how people feel about something. An effective Likert-scale consists of a 5-7 response range where people can describe their feeling about the item. Providing an odd number of response options ensures that a neutral point is given for those who are neither for nor against. This is important for people who are neutral on the subject, or cannot or do not want to decide immediately [67]. The items in that block were set in a randomized order because of two main points. Using a randomized order can help to reduce bias and improve the quality of the data. Moreover, by using randomized order it is possible to make sure that the order does not affect the responses given. This is the reason why the questions in Qualtrics were created in separate Blocks. Qualtrics can only randomize questions that are within the same Block. Without creating a block, a randomization can only be done manually. One point to consider by creating blocks is that the command “Add Page Break” is not possible within the block. In other words, the participant can see the whole block with all of questions in it and can make changes in responses. Depending on the survey acceptance that is desired, this point is important to consider [68].

The third block consists of two final questions where the participants are asked about what they think causes the most road accidents and which level of automation (SAE-0 –

SAE-5) they would prefer for the future of vehicles they own or use. These questions provide important information about whether people think that most accidents are due to human error or due to technical failure. Furthermore, the result of the last question indicates which automation stage people prefer in the future for vehicles that they will own or use. The final question fields for the “Thank you for participation” message (see Appendix A – Survey USA and Appendix B – Survey Germany).

3.3.7 IRB APPROVAL

Because human test subjects are involved in this experiment the study must be approved by the University of Rhode Island Institutional Review Board (IRB) (see Appendix D - IRB documents). After IRB approval of the experiment, every change in the survey or recruitment materials, must be submitted the IRB again. Also if the amount of participants increases then the IRB must approve the increase.

3.4 SURVEY TESTING

Survey testing is an important step in the survey development process before launching the survey. Through testing, the adequacy of the questionnaire can be checked and improved including alternative versions, adequacy of the survey instructions, and organization of the survey. The survey testing consists of two main types: Qualitative testing and Quantitative testing. Qualitative testing involves techniques such as skirmishing, focus groups, presenting, and observational studies. Pilot testing and dress rehearsals are quantitative tests. Each type of testing aims to test different aspects of the survey and is used at different stages of the survey’s development [69].

Considering the time frame and the fact that these questions were taken from the literature, in this study only a quantitative test phase was conducted. After the questionnaire was designed, 4 pilot tests were conducted with a total of 11 people. The focus of the test runs was on the structure of the survey, understanding of the questions, grammatic errors, execution time, confirming mobile & tablet friendliness, and formulation approaches. According to the feedback of the test participants, the survey was adjusted several times. The execution time was recorded 4 times, two times in each country, and the results (8 minutes, 11 minutes, 10 minutes, 11 minutes) corresponded to the suggested time of 12 minutes of Qualtrics. After the pilot tests, the recorded results from the test people were deleted so that these test results were not included in the full study.

3.5 SURVEY LAUNCHING

After receiving IRB approval, the first run of the survey was launched 9th April valid to 25th April in the US and Germany. The time frame until 25th April was chosen to have a buffer zone for potential additional runs if the minimum criteria are not met. While the survey is active the response rate is monitored daily in order to have an overview of participation. The data check from the first run will provide information about whether more runs are necessary. Any changes in the survey wording or recruitment materials due to additional runs must be submitted and approved by the IRB again. The re-launching of the survey will be continued until the minimum criteria (Table 2) is reached.

3.6 SURVEY EVALUATION AND STATISTICAL ANALYSIS

Once the data is gathered, the analysis of the collected data will be done by applying different statistical methods. This involves interpreting the data, breaking it down, and manipulating it to answer the survey objectives. The data will be cleaned, summarized, and sorted into categories to obtain information like descriptive statistics, frequencies, percentages, correlations, and measures of both locations and spread. This information is useful to make inferences and formulate hypotheses about the population data by testing the hypotheses to determine significances and trends and estimating confidence intervals in the data.

Statistical Analysis is the cornerstone for presenting the results of a survey. In this experiment, the free software "R Studio" is used for interpretation of the data. The programmed final codes can be knitted to a PDF or Word document for a presentable version of the results and explanations. Further research could apply the codes, load the program in an updated version, and reconstruct as needed.

3.6.1 DESCRIPTIVE STATISTICS

Descriptive statistics are summary measures that provide important information about the gathered data set. It gives an overview of what the data set includes and is a necessary internal step to understand the data before determining suitable analysis. Descriptive statistics visualize simple although highly informative statistics such as sample size, minimum, maximum, standard deviation, and arithmetic standardized means of conducted observations [69].

3.6.2 DATA DISTRIBUTION CHECK

A Sharipo-Wilks Normality Test will be applied to check if the data fit the normal distribution. The test checks the null Hypothesis H_0 and rejects H_0 if the p-value ≤ 0.05 . Rejecting the H_0 , it can only be stated that with an confidence level of 95% the data does not fit the normal distribution. Fail to reject H_0 , it can only be stated that no significant departure from normality occurred [70], [71].

Criteria for Sharipo-Wilks Normality test:

H_0 = The data do follow a normal distribution

H_1 = The data do not follow a normal distribution

The Kolmogorov-Smirnov Goodness-of-Fit test is used to decide if the sample data set follows a specific distribution. The test also checks the H_0 and rejects H_0 if the p-value ≤ 0.05 . Rejecting the H_0 means that with a confidence level of 95% the data does not follow the specified distribution. Failure to reject H_0 means that the data does not follow a specified distribution [72], [73].

Criteria for Kolmogorov-Smirnov Goodness-of-Fit test::

H_0 = The data follow a specified distribution

H_1 = The data do not follow a specified distribution

3.6.3 RELIABILITY CHECK

The internal consistency of a psychological experiment such as a survey can be measured with an indicator of consistency named Cronbach's Alpha (CR). It is one of the most widely used measures of reliability in the social and organizational sciences and is a

tool for assessing the reliability scales. CR is a popular method to quantify the reliability of a score to summarize the information of several items in questionnaires. The results of alpha range from 0 - 1. The higher the coefficient of CR, the more the items have shared covariance and probably measure the same underlying concept. The standards for what makes a good CR coefficient are not always clearly defined. Many methodologists recommend a CR between 0.65 and 0.8 or higher to estimate good to excellent. A CR coefficient of less than 0.5 is usually unacceptable [74], [75], [76].

Table 3 shows the range of CR for internal consistency.

Cronbach's Alpha (CR)	Internal Consistency
$CR \geq 0.9$	Excellent
$0.8 \geq CR \geq 0.9$	Good
$0.7 \geq CR \geq 0.8$	Acceptable
$0.6 \geq CR \geq 0.7$	Questionable
$0.5 \geq CR \geq 0.6$	Poor
$CR < 0.5$	Unacceptable

Table 3: Range of Cronbach's Alpha (CR)/ Source: [75], [76]

The calculation and programming of CR with “R Studio” is included in Appendix E - R Studio Programs.

3.6.4 FACTOR ANALYSIS

The Factor Analysis summarizes groups of internal-scaled items into meaningful and mutually independent factors and is primarily used for data structuring and data reduction. On the one hand, a single factor or a few factors can be used in further analyses instead of a large number of items. On the other hand, combining variables into factors facilitates interpretation. Factor Analysis can examine whether many observed variables can be explained by a few latent variables behind them which are, thus called factors. Such analysis makes sense if the observed variables are related to each other so that they include more or less the same information. A distinction is made between Explanatory Factor Analysis (EFA) which is a structure discovery procedure and the Confirmatory Factor Analysis (CFA) which is a structure checking procedure. Due to the fact that this survey is being conducted for the first time, a structure discovery procedure EFA will be applied. Only the 26 items of the 8 constructs (PEOU, PU, PSR, PFR, PB, INT, ATT, BI) will be considered for the EFA. Items such as demographics will be kept out for this analysis. For the Explanatory study, the method principal component analysis (PCA) is used with the rotation 'promax'. The suitability of the selected items is usually checked by considering the following aspects: the KMO value and Bartlett-Test.

Kaiser, Meyer, and Olkin have developed standard test procedures for the suitability of the data for factor analysis ("Measurement of Sampling Adequacy" (MSA)). However, the MSA values refer to individual variables. The KMO value is a measure of whether the partial correlations between the variables are small. The smaller these are, the higher the KMO. The KMO value ranges from 0 - 1. The rule of thumb is that the KMO value should be at least 0.60 to continue with the EFA. The value of 0.50 is the lower acceptable limit,

but a value above 0.80 is desirable [77], [78]. A KMO value will be given for each item. If an item has a KMO value < 0.5 , the item cannot be considered for further calculation and needs to be removed [77], [79].

Table 4 shows the range of KMO value:

KMO value	Meaning Corresponding
≥ 0.9	marvelous
≥ 0.8	meritorious
≥ 0.7	middling
≥ 0.6	mediocre
≥ 0.5	miserable
< 0.5	unacceptable

Table 4: KMO value/ Source: [77], [79]

In addition, a further important criterion for whether the items do correlate with each other is the Bartlett-Test which can be used to test the null hypothesis H_0 . The statistical test, the analysis of variance assumes that the variance is equal across the sample. The Bartlett test can be used to support and verify the assumption. The data check with the Bartlett-test to show the homogeneity of the variances is given in Table 5 [77], [80]. The criteria is as follows:

H_0 = The variance is not equal across the sample

H_1 = The variance is equal across the sample

Table 5 shows the condition for the Bartlett-test:

Bartlett-test	Meaning Corresponding
$p\text{-value} \leq \alpha$	Reject H_0
$p\text{-value} > \alpha$	Fail to reject H_0

Table 5: Bartlett-test/ Source: [77], [80]

Furthermore, a correlation matrix is a helpful tool that provides a first impression of the suitability of items for a factor analysis. The initial position is ideal if there are separated groups of highly correlating items. This would be interpreted as an indication of the existence of factors. There are different ways to evaluate the power of correlation. The correlation coefficient (r) lies between 0 (no effect) and 1 (maximum effect) and is very suitable as a measure for the effective power [77], [79]. A correlation can be positive or negative which is represented through the sign of the correlation. There are no hard and fast rules for describing correlation power [81]. Cohan, 1992 [77] used a classification scheme of the effect size which can be assessed as shown in Table 6:

Table 6 shows the effect of the correlation coefficient:

Correlation Coefficient [r]	Value	Meaning Corresponding
$r =$	0.10 – 0.30	Weak effect
$r =$	0.30 – 0.50	Medium effect
$r =$	> 0.50	Strong effect

Table 6: Factor Analysis Correlation Power/ Source: [77], [79]

However, on the basis of the correlation matrix alone, it cannot be decided whether the relationships between the items can be explained by underlying factors. It only serves as a first clue. In addition, a correlation structure is suitable for a factor analysis if the inverse correlation matrix represents a diagonal matrix. A matrix is diagonal if the values outside the diagonal are close to 0, while the values on the diagonal are significantly higher. However, this is only an optical aid for assessing suitability [77].

If the data set proves to be suitable by the KMO value ≥ 0.6 for each item and the Bartlett test turns out to be significant, the EFA can proceed. The factor loadings and the commonalities will provide information on whether items have to be deleted in order to create a suitable model.

There is a lot of existing literature about the power of factors and commonalities. Based on Cohan, 1992 [77], factor loadings ± 0.2 should not be considered and factor loading between ± 0.3 and ± 0.4 are minimally acceptable. Young and Pearce, 2013 [79] says that with larger sample sizes, smaller loadings are allowed for a factor to be considered significant. To consider a factor as statistically meaningful, a rotated factor loading by using $\alpha = 0.01$ for a sample size of at least 300 needs to be at least 0.32. Often times items with low commonalities, factor loadings of less than 0.2 are eliminated from the analysis. Based on these findings, for this factor analysis a minimum criteria were set as shown in Table 7.

Factor Loading	≥ 0.36
Commonality (h^2)	≥ 0.2

Table 7: Minimum Criteria: Factor Loading & Commonality/ Source: [77], [79]

The model fit indices will give an overview of how good the model fits. The suggested model fit values are listed in Table 8. The model fit indices consist of the Root Mean Square Residual (RMSR), Tucker-Lewis Index (TLI), Root Mean Square Error of Approximation (RMSEA), and Cronbach's Alpha (CR). The RMSR is an index of standardized residuals between the observed and hypothesized covariance matrices. TLI is an incremental fit index. RMSEA is an index and stands for the difference between the observed covariance matrix per degree of freedom and the hypothesized covariance matrix which denotes the model. CR is the index for the reliability and measures the internal consistency [82].

Table 8 shows the model fit indices for the EFA:

Indices	Model Fit Values
RMSR	< 0.10
TLI	≥ 0.9
RMSEA	≤ 0.8
CR_{Factor}	≥ 0.7

Table 8: EFA Suggested MFV/ Source: RMSR [83]; TLI, RMSEA, CR [84]

3.6.5 STRUCTURAL EQUATION MODELING

Structural equation model (SEM) is a statistical model that is helpful to estimate and test correlation relationships between dependent and independent items in a complex model. By explaining the variance in the dependent items, the focus lies on the predictive ability of the model. SEM is a second generation multivariate method which can be used to develop a theory (explanatory) or to test the hypothesized assumptions of existing

theories and concept (confirmatory). It can be proven whether the hypotheses assumed for the model fit the given values. A distinction is made between two SEM approaches, covariance-based (CB-SEM) and variance-based (VB-SEM/ “Partial Least Square” PLS-SEM) methods. The goal of PLS-SEM is to predict the relationship and target constructs [85]. Figure 9 shows the basic principle of structural equation modeling. The model consists of latent variable scores called constructs, blue colored, and items yellow-colored. A distinction is made between the ‘Formative model’ and ‘Reflective model’ and at the first view, it can be seen that the direction of the arrows is different between both models. The arrows from items to construct are called ‘weights’ and from construct to item ‘loadings’. This connection is called the outer model of the exogenous variable. The inner model is also connected with arrows that represent the inner model weight and show path coefficients (β). In a linear structural equation model [86], path coefficients describe the strength of the relationship between two variables. The decision of whether to measure a construct reflectively or formatively is not clear-cut. For the formative measure, indicators can have +, - or 0 correlation. For the reflective, indicators must be highly correlated [85], [87], [88]. Due to the fact that different constructs included in this study relate to risks and benefits, negative correlations are expected, and therefore the formative model will be considered.

Table 9 shows the effect of path coefficient:

Path Coefficient [β]	Value	Meaning Corresponding
$\beta =$	0.01 - 0.19	Weak effect
$\beta =$	0.2 - 0.49	Medium effect
$\beta =$	≥ 0.50	Strong effect

Table 9: Effect of path coefficient SEM/ Source:[86]

Figure 9: Structural Equation Modelling/ Source: [85]

The goodness of fit between the theoretical and practical model can be proved with the model fit indices.

Chi-square (Chisq)/degree of freedom (df) is an index found by dividing the test statistics value by the degrees of freedom. The value of this ratio provides information on the fit between the model and the data. The smaller the value of the ratio the better is the consistency. The ratio indicates a good fit if the ratio produces a value smaller than 2.0 while an acceptable ratio is when the ratio produces a value of 3 [82].

The SRMR can be interpreted as the indicator of a good fit when it produces a value smaller than 0.05. It indicates an acceptable fit when it produces a value of less than 0.1 [82].

Since RMSEA reflects the degrees of freedom it takes model complexity into account. Is the value is smaller than 0.05, it indicates a convergence fit to the analyzed data of the model. It is close to good if it produces a value between 0.05 and 0.08. A value between 0.08 and 1.0 is stated to represent a fit that is neither good nor bad [82].

The bigger the TLI index the better the fit of the model. Although a value of 0.97 is accepted as the cut-off value in many research studies, values larger than 0.95 are interpreted as acceptable [82].

The Comparative Fit Index (CFI) is relatively independent of sample size and yields better performance for studies with a small sample size. It produces values between 0 – 1 and high values are the indicators of a good fit. An acceptable fit is provided when the value is greater than 0.95 [82]. Based on this research the model fit indices for the PLS-SEM are set as seen in Table 10.

Index	Level of acceptance
Chisq/df	< 3.0
SRMR	< 0.1
RMSEA	< 0.1
TLI	> 0.95
CFI	> 0.95

Table 10: PLS-SEM Model Fit Indices/ Source [82]

Table 11 shows the comparison and criteria between both approaches. PLS-SEM minimizes the error terms and maximizes the coefficient of determination (r^2) values of the endogenous constructs [85]. The coefficient of determination (r^2) is the square of the coefficient of correlation and quantifies the proportion of the variance of one variable “described” by the other [81]. In turn, CB-SEM reproduced the covariance matrix and does not focus on explained variance. Because this experiment meets most of the criteria of Variance-Based Modeling e.g. objective or distribution, a PLS-SEM is chosen for the study [85].

Table 11 represents the distinction between VBM and CBM

Criteria	Variance-Based Modeling (VBM)	Covariance-Based Modeling (CBM)
Objective	Prediction oriented	Parameter oriented
Distribution Assumptions	Non-parametric	Normal distribution (parametric)
Required Sample Size	Small (min. 30 – 100)	High (min. 100 – 800)
Model complexity	Large models OK	Large models problematic (50+ indicator variables)
Indicators per construct	One - two OK Large number OK	Typically 3 – 4 minimum to meet indification requirements
Measurement Model	Formative and Reflective indicators OK	Typically only Reflective indicators

Table 11: CB-SEM vs. PLS-SEM Comparison/ Source:[85]

4 CHAPTER 4 – RESULTS & DISCUSSION

In this chapter, the results will be presented according to the statistical methods described in chapter 3. Conclusions are then derived from the resulting data.

4.1 RESULTS SURVEY

The survey was conducted 4 times in total. The first run was from April 09th until April 25th in the US and Germany. All minimum criteria (Table 2) for the surveys were met. Due to the small sample size for the higher age groups (40 - 50; 50 - 60; > 60) in Germany, the survey was prepared and conducted two more times in Germany by focusing on the higher age groups to make the results more attractive. The second run was from April 27th until May 5th, which yielded 14 more responses for the higher age groups. A third run was conducted because one distribution source in Germany was found from May 7th until May 13th. The third run, however, was unsuccessful and yielded 0 responses

4.1.1 DEMOGRAPHICS

Demographics show the amount and characteristics of people who participated in this experiment. In the US, 163 people participated in the survey. Only 126 participants (77.3%) finished the survey. The total number of participants in Germany after three runs was 135 in total (first survey n=121, second survey n=14, third survey n=0). Only 117 (87%) completed the survey. For the survey evaluation and further calculations, a total number of useable responses n=126 for the US and n=117 for Germany will be considered. The representation of the results and the percentages in the following charts refer to useable responses from each country.

Table 12 shows the demographics of the participants from the US and Germany. The demographics include the useable responses of participants, gender, age groups, nationality, residence, car ownership/ utilization, duration of driver's license, and daily commute. The difference is calculated as follows: $n_{USA} - n_{Germany} = n_{Difference}$

	USA		Germany		Difference
	[n]	[%]	[n]	[%]	[n]
Useable Responses					
	126	100%	117	100%	9
Gender:					
Male	52	41%	80	68%	-28
Female	74	59%	37	32%	37
Age Groups:					
< 20	0	0%	0	0%	0
20 - 30	38	30%	64	55%	-26
30 - 40	20	16%	34	29%	-14
40 - 50	10	8%	9	8%	1
50 - 60	35	28%	8	7%	27
> 60	23	18%	2	2%	21
Nationality					
	117	93%	112	96%	5
Residence					
Rhode Island	73	58%	-	-	-
Lower Saxony	-	-	82	70%	-
Car Ownership/ Utilization					
Own Car	106	84%	72	62%	34
Leasing	8	6%	11	9%	-3
Borrow from Others	10	8%	22	19%	-12
No Car usage	2	2%	12	10%	-10
Duration of Driver's License					
< 1 year	0	0%	1	1%	-1
1 - 2 years	10	8%	1	1%	9
2 - 6 years	24	19%	13	11%	11
> 6 years	92	73%	102	87%	-10
Daily Commute; USA [Miles]; GE[Km]					
< 5	32	25%	27	23%	5
5 - 20	53	42%	39	33%	14
20 - 40	30	24%	22	19%	8
40 - 60	8	6%	14	12%	-6
> 60	3	2%	15	13%	-12

Table 12: Demographics of the survey/ Source:[Or]

Figure 10 and Figure 11 show the number of participants for each age group from the surveys. The age groups in the US are better distributed than in Germany. Most participants from Germany are between 20 and 40. The age group <20 yielded 0 responses for both.

Figure 10: Participants of the US Survey/ Source: [Or]

Figure 11: Participants of the German Survey/ Source: [Or]

The pie chart in Figure 12 shows the nationality of the participants. It was only taken into account whether the participants have a US or German nationality or another one.

Figure 12: Nationality of participants/ Source:[Or]

The pie charts in Figure 13 represent the residency of the participants from both countries. Most participants are from Rhode Island and Lower Saxony.

Figure 13: Residence of participants/ Source:[Or]

Figure 14 shows the vehicle utilization of the participants. The bar chart shows that most people are using a vehicle. Most of them own their own car. In the US only 2% do not use a car while in Germany 10% do not use a car. The higher percentage of non-use of car could be related to the fact that in the US more older people participated compared to Germany. Moreover, younger people in Germany maybe using bikes or the public transport network which has a higher density in Lower Saxony than in Rhode Island, which could especially be true for students who have a semester ticket for free utilization of public transportation e.g. bus, train.

Figure 14: Car Ownership/ Utilization/ Source:[Or]

Figure 15 shows the possession of the driver's license of the participants. Based on this chart it can be assumed that the participants in both countries have driving experience.

Figure 15: Possession of driver's license/ Source:[Or]

Figure 16 shows the length of the daily commute. The numbers for both countries remain the same, but the units, miles for the US and kilometers for Germany, have been chosen for each country.

Figure 16: Length daily commute/ Source:[Or]

Figure 17 shows what the participants think that the cause is for most road accidents.

Figure 17: Perceived road accidents causes/ Source:[Or]

Figure 18 illustrates the preferred automation level according to SAE. A great distinction between both countries cannot be seen. Both countries are very similar in terms of the preferable automation level. SAE-2 is most preferable while SAE-0 is the lowest.

Figure 18: Preferable SAE automation level / Source:[Or]

4.1.2 DESCRIPTIVE STATISTICS

Table 13 and Table 15 show the descriptive statistics of each item. Table 14 and Table 16 show the descriptive statistics of the constructs.

USA:

items	vars	n	mean	sd	median	trimmed	mad	min	max	range	skew	kurtosis	se
PEOU1	1	126	2.18	1.16	2	2.04	1.48	1	5	4	0.88	-0.06	0.1
PEOU2	2	126	2.47	1.06	3	2.41	1.48	1	5	4	0.24	-0.44	0.09
PEOU3	3	126	2.15	0.99	2	2.03	1.48	1	5	4	0.88	0.55	0.09
PEOU4	4	126	2.26	1.04	2	2.15	1.48	1	5	4	0.79	0.34	0.09
PU1	5	126	2.6	1.33	2	2.5	1.48	1	5	4	0.52	-0.87	0.12
PU2	6	126	2.87	1.43	2.5	2.84	2.22	1	5	4	0.25	-1.33	0.13
PU3	7	126	2.47	1.23	2	2.34	1.48	1	5	4	0.67	-0.46	0.11
PU4	8	126	2.41	1.09	2	2.31	1.48	1	5	4	0.64	-0.05	0.1
PSR1	9	126	2.11	1.08	2	1.99	1.48	1	5	4	0.87	-0.14	0.1
PSR2	10	126	2.12	1.1	2	1.99	1.48	1	5	4	0.8	-0.18	0.1
PSR3	11	126	2.54	1.11	2	2.46	1.48	1	5	4	0.49	-0.33	0.1
PSR4	12	126	1.71	0.96	1	1.52	0	1	5	4	1.56	2.16	0.09
PFR1	13	126	1.87	1.07	2	1.68	1.48	1	5	4	1.31	1.16	0.09
PFR2	14	126	1.89	1.03	2	1.74	1.48	1	5	4	1.05	0.45	0.09
PFR3	15	126	1.73	0.81	2	1.61	1.48	1	4	3	1.05	0.69	0.07
PFR4	16	126	1.87	0.99	2	1.7	1.48	1	5	4	1.15	0.72	0.09
PB1	17	126	2.22	0.89	2	2.17	1.48	1	5	4	0.56	0.23	0.08
PB2	18	126	2.23	1.02	2	2.11	1.48	1	5	4	0.92	0.63	0.09
PB3	19	126	2.56	1.11	3	2.5	1.48	1	5	4	0.36	-0.47	0.1
PB4	20	126	1.97	0.97	2	1.84	1.48	1	5	4	0.89	0.31	0.09
INT1	21	126	2.55	0.97	3	2.5	1.48	1	5	4	0.47	0.2	0.09
INT2	22	126	2.71	1.18	2.5	2.65	0.74	1	5	4	0.44	-0.69	0.11
ATT1	23	126	2.35	1.13	2	2.24	1.48	1	5	4	0.73	-0.17	0.1
ATT2	24	126	2.4	1.01	2	2.34	1.48	1	5	4	0.37	-0.29	0.09
BI1	25	126	2.27	1.2	2	2.1	1.48	1	5	4	0.98	0.17	0.11
BI2	26	126	3.26	1.36	3	3.32	1.48	1	5	4	-0.13	-1.21	0.12

Table 13: Descriptive Statistics of items; USA/ Source:[Or]

constructs	vars	n	mean	sd	median	trimmed	mad	min	max	range	skew	kurtosis	se
PEOU	1	126	2.27	0.85	2.125	2.19	0.93	1	5	4	1.06	1.37	0.08
PU	2	126	2.59	0.99	2.5	2.51	1.11	1	5	4	0.64	-0.33	0.09
PSR	3	126	2.12	0.73	2	2.06	0.74	1	4.25	3.25	0.75	0.02	0.07
PFR	4	126	1.84	0.66	1.75	1.78	0.74	1	4	3	0.76	0.35	0.06
PB	5	126	2.25	0.78	2.125	2.2	0.93	1	5	4	0.7	0.47	0.07
INT	6	126	2.63	0.99	2.5	2.59	0.74	1	5	4	0.44	-0.25	0.09
ATT	7	126	2.38	0.95	2	2.32	0.74	1	5	4	0.51	-0.36	0.08
BI	8	126	2.77	1.12	2.5	2.7	0.74	1	5	4	0.5	-0.51	0.1

Table 14: Descriptive Statistics of constructs; USA/ Source:[Or]

Germany:

items	vars	n	mean	sd	median	trimmed	mad	min	max	range	skew	kurtosis	se
PEOU1	1	117	1.91	1.11	2	1.73	1.48	1	5	4	1.21	0.58	0.1
PEOU2	2	117	2.35	1.04	2	2.29	1.48	1	5	4	0.51	-0.6	0.1
PEOU3	3	117	2	1.07	2	1.85	1.48	1	5	4	0.99	0.16	0.1
PEOU4	4	117	1.91	1.01	2	1.77	1.48	1	5	4	0.96	0	0.09
PU1	5	117	2.19	1.15	2	2.04	1.48	1	5	4	0.94	0.08	0.11
PU2	6	117	3.03	1.46	3	3.04	1.48	1	5	4	-0.01	-1.42	0.13
PU3	7	117	2.74	1.18	3	2.68	1.48	1	5	4	0.3	-0.88	0.11
PU4	8	117	2.21	1.07	2	2.08	1.48	1	5	4	0.93	0.24	0.1
PSR1	9	117	2.27	1.22	2	2.16	1.48	1	5	4	0.76	-0.6	0.11
PSR2	10	117	2.54	1.34	2	2.43	1.48	1	5	4	0.47	-1.1	0.12
PSR3	11	117	2.45	1.42	2	2.33	1.48	1	5	4	0.53	-1.18	0.13
PSR4	12	117	2.18	1.22	2	2.05	1.48	1	5	4	0.81	-0.58	0.11
PFR1	13	117	1.85	1.04	2	1.68	1.48	1	5	4	1.17	0.52	0.1
PFR2	14	117	2.07	1.22	2	1.91	1.48	1	5	4	0.96	-0.23	0.11
PFR3	15	117	1.94	1.1	2	1.76	1.48	1	5	4	1.27	0.87	0.1
PFR4	16	117	2.03	1.19	2	1.86	1.48	1	5	4	1.04	-0.06	0.11
PB1	17	117	1.81	0.82	2	1.68	0	1	5	4	1.57	3.55	0.08
PB2	18	117	2.34	1.26	2	2.22	1.48	1	5	4	0.68	-0.74	0.12
PB3	19	117	2.34	1.19	2	2.22	1.48	1	5	4	0.72	-0.4	0.11
PB4	20	117	1.8	1.04	2	1.6	1.48	1	5	4	1.5	1.73	0.1
INT1	21	117	2.63	1.02	2	2.63	1.48	1	5	4	0.24	-0.77	0.09
INT2	22	117	2.41	1.05	2	2.35	0	1	5	4	0.72	-0.33	0.1
ATT1	23	117	1.91	1.06	2	1.73	1.48	1	5	4	1.28	1.14	0.1
ATT2	24	117	1.94	0.97	2	1.8	1.48	1	5	4	1.02	0.64	0.09
BI1	25	117	2.18	1.21	2	2.02	1.48	1	5	4	0.88	-0.16	0.11
BI2	26	117	3.17	1.29	3	3.21	1.48	1	5	4	-0.1	-1.14	0.12

Table 15: Descriptive Statistics of items; Germany/ Source:[Or]

constructs	vars	n	mean	sd	median	trimmed	mad	min	max	range	skew	kurtosis	se
PEOU	1	117	2.04	0.86	2.00	1.95	1.11	1.00	5.00	4.00	0.83	0.25	0.08
PU	2	117	2.54	0.85	2.50	2.52	0.74	1.00	5.00	4.00	0.30	0.06	0.08
PSR	3	117	2.36	0.91	2.25	2.30	1.11	1.00	5.00	4.00	0.52	-0.22	0.08
PFR	4	117	1.97	0.80	1.75	1.88	0.74	1.00	4.50	3.50	1.00	0.66	0.07
PB	5	117	2.07	0.70	2.00	2.02	0.74	1.00	5.00	4.00	1.15	2.16	0.06
INT	6	117	2.52	0.89	2.50	2.49	0.74	1.00	5.00	4.00	0.40	-0.08	0.08
ATT	7	117	1.93	0.90	2.00	1.79	0.74	1.00	5.00	4.00	1.22	1.44	0.08
BI	8	117	2.68	1.09	2.50	2.62	1.48	1.00	5.00	4.00	0.35	-0.59	0.10

Table 16: Descriptive Statistics of Constructs; Germany/ Source:[Or]

Note in Table 13 - Table 16: vars = consecutive number, n = number of observations, sd = standard deviation, trimmed = trimmed mean, mad = mean absolute deviation, min = minimum, max = maximum, skew = skewness, se = standard error`

4.1.3 CORRELATION & REGRESSION ANALYSIS

The correlation and regression analysis (Figure 19, Figure 20) provides a first overview of the data distribution and their correlations. On the diagonal are the constructs, the above triangle the correlations and the lower triangle is the linear regression of the data. On the diagonal, it can be seen the data distribution from both countries is very left-skewed. The highest correlation effect for the US survey was perceived usefulness with attitude towards technology.

Figure 19: Correlation & regression of Constructs; USA/ Source:[Or]

For the German survey, the strongest correlation effect is also between perceived usefulness and attitude towards technology. What is striking is that the correlations between the construct in the US survey are correlating stronger than the constructs from the German survey. Except the correlation between PEOU and PSR is for both countries the same.

Figure 20: Correlation & regression of constructs; Germany/ Source:[Or]

4.1.4 RELIABILITY

Table 17 shows the internal consistency of the constructs of both surveys. The internal consistency for the US survey is in overall acceptable, for Germany either questionable.

	PEOU	PU	PSR	PFR	PB	INT	ATT	BI
CR_{USA}	0.81	0.78	0.62	0.60	0.78	0.82	0.73	0.70
CR_{GE}	0.83	0.64	0.65	0.66	0.52	0.63	0.73	0.70

Table 17: Reliability of the survey/ Source: [Or]

4.1.5 CORRELATIONS

Significance Test of Correlation Coefficient (r):

The coefficient of correlation (r) describes the direction and the strength of the linear relationship between x and y. The significance test of r (Table 19, Table 20) shows whether the constructs have a significant correlation with each other. The test is performing to prove and to decide whether the linear relationship in the sample data has a strong enough power to use to model the relationship in the data set. If r is significantly different from zero then it can be stated that r is 'significant'. On the other hand, if r is not significantly different from zero it can be said that r is 'not significant' [89]. It assumes with $\alpha = 0.05$ the following hypotheses:

H_0 = There is no significant relationship between x and y.

H_1 = There is a significant relationship between x and y.

Table 18 shows the condition for the Bartlett-test:

Significance of Correlation Coefficient (r)	Meaning Corresponding
$p\text{-value} \leq \alpha$	Reject H_0
$p\text{-value} > \alpha$	Fail to reject H_0

Table 18: Bartlett-test/ Source: [77], [80]

USA	PEOU	PU	PSR	PFR	PB	INT	ATT	BI
PEOU	0							
PU	0	0						
PSR	0	0.05	0					
PFR	0	0	0	0				
PB	0	0	0	0	0			
INT	0	0	0	0	0	0		
ATT	0	0	0	0	0	0	0	
BI	0	0	0	0	0	0	0	0

Table 19: Significance test of correlations; Germany/ Source:[Or]

GE	PEOU	PU	PSR	PFR	PB	INT	ATT	BI
PEOU	0							
PU	0	0						
PSR	0	0	0					
PFR	0	0	0	0				
PB	0	0	0	0	0			
INT	0	0	0	0	0	0		
ATT	0	0	0	0	0	0	0	
BI	0	0	0	0	0	0	0	0

Table 20: Significance test of correlations; US/ Source:[Or]

Inverse Correlation Matrix:

The Inverse matrix (Table 21, Table 22) serves as an optical aid for assessing the suitability of performing an EFA. A correlation structure is suitable for factor analysis if the inverse matrix represents a diagonal matrix. A matrix is diagonal if the values outside the diagonal axis are close to 0, while the values on the diagonal are significantly higher [77].

USA	PEOU	PU	PSR	PFR	PB	INT	ATT	BI
PEOU	2.30							
PU	-0.25	4.38						
PSR	0.51	-0.70	1.71					
PFR	0.03	0.22	-0.80	1.61				
PB	-0.37	-1.25	0.22	-0.17	3.37			
INT	-0.04	-0.88	0.11	0.20	-0.86	3.16		
ATT	-0.99	-1.37	0.08	-0.21	-0.59	-0.31	4.28	
BI	0.06	-0.71	0.18	0.32	-0.06	-0.67	-1.10	3.04

Table 21: Inverse correlation matrix; USA/ Source:[Or]

GE	PEOU	PU	PSR	PFR	PB	INT	ATT	BI
PEOU	1.58							
PU	-0.29	2.23						
PSR	0.23	-0.05	1.74					
PFR	0.05	0.00	-0.65	1.38				
PB	-0.03	-0.71	-0.03	0.09	1.74			
INT	-0.55	-0.40	0.40	0.01	0.00	2.16		
ATT	-0.09	-0.59	0.07	0.05	-0.62	-0.35	2.44	
BI	0.06	-0.17	0.26	0.00	0.20	-0.41	-0.72	1.75

Table 22: Inverse correlation matrix; Germany/ Source:[Or]

Correlation Plot:

The color-coded correlation plots (Figure 21, Figure 22) provide an optical view and indicate in which direction and how strongly the constructs correlate with each other.

Values closer to 1 or -1 show stronger correlations.

Figure 21: Correlation plot; USA/ Source:[Or]

Figure 22: Correlation Plot; Germany/ Source:[Or]

Item by construct (scale) Correlation:

Table 23 and Table 24 show how strong the items correlate to each construct (scale). For each item, the strongest correlations effect should lie on its construct, highlighted in yellow.

Item by scale correlations: corrected for item overlap and scale reliability								
	PEOU	PU	PSR	PFR	PB	INT	ATT	BI
PEOU1	0.80	0.39	-0.42	-0.23	0.43	0.38	0.57	0.33
PEOU2	0.57	0.72	-0.25	-0.39	0.74	0.75	0.67	0.69
PEOU3	0.80	0.42	-0.50	-0.29	0.49	0.42	0.57	0.47
PEOU4	0.83	0.64	-0.46	-0.38	0.60	0.55	0.69	0.64
PU1	0.54	0.81	-0.27	-0.40	0.71	0.71	0.82	0.80
PU2	0.44	0.55	0.02	-0.10	0.51	0.49	0.46	0.42
PU3	0.64	0.89	-0.25	-0.35	0.83	0.80	0.91	0.82
PU4	0.45	0.62	-0.20	-0.22	0.68	0.65	0.62	0.58
PSR1	-0.39	-0.19	0.59	0.52	-0.28	-0.25	-0.22	-0.29
PSR2	-0.24	-0.09	0.62	0.43	-0.13	-0.13	-0.17	-0.20
PSR3	-0.24	-0.04	0.45	0.33	-0.23	-0.20	-0.19	-0.16
PSR4	-0.35	-0.21	0.58	0.55	-0.21	-0.35	-0.31	-0.37
PFR1	-0.32	-0.12	0.49	0.57	-0.22	-0.31	-0.23	-0.36
PFR2	-0.19	-0.09	0.52	0.62	-0.06	-0.11	-0.14	-0.18
PFR3	-0.28	-0.35	0.58	0.63	-0.33	-0.35	-0.36	-0.37
PFR4	-0.19	-0.34	0.29	0.50	-0.26	-0.33	-0.20	-0.31
PB1	0.50	0.60	-0.30	-0.20	0.69	0.60	0.64	0.53
PB2	0.70	0.81	-0.33	-0.31	0.78	0.69	0.77	0.68
PB3	0.42	0.63	-0.18	-0.32	0.67	0.65	0.58	0.52
PB4	0.50	0.62	-0.27	-0.20	0.68	0.64	0.64	0.66
INT1	0.53	0.71	-0.31	-0.36	0.71	0.80	0.69	0.69
INT2	0.63	0.81	-0.36	-0.42	0.81	0.86	0.81	0.82
ATT1	0.74	0.81	-0.39	-0.37	0.78	0.79	0.85	0.83
ATT2	0.58	0.74	-0.22	-0.25	0.70	0.64	0.74	0.69
BI1	0.64	0.74	-0.49	-0.45	0.73	0.71	0.80	0.78
BI2	0.46	0.68	-0.22	-0.37	0.59	0.70	0.70	0.77

Table 23: Item by scale correlation; USA/ Source:[Or]

Item by scale correlations:

corrected for item overlap and scale reliability

	PEOU	PU	PSR	PFR	PB	INT	ATT	BI
PEOU1	0.69	0.33	-0.24	-0.20	0.17	0.41	0.27	0.16
PEOU2	0.71	0.42	-0.46	-0.28	0.27	0.59	0.27	0.39
PEOU3	0.80	0.53	-0.47	-0.26	0.43	0.59	0.55	0.39
PEOU4	0.79	0.54	-0.40	-0.30	0.49	0.63	0.55	0.43
PU1	0.41	0.75	-0.34	-0.09	0.66	0.55	0.69	0.45
PU2	0.32	0.45	-0.09	-0.14	0.34	0.33	0.27	0.17
PU3	0.40	0.56	-0.34	-0.25	0.55	0.53	0.63	0.51
PU4	0.28	0.61	-0.40	-0.32	0.62	0.54	0.54	0.48
PSR1	-0.27	-0.07	0.47	0.31	-0.13	-0.32	-0.17	-0.33
PSR2	-0.25	-0.34	0.57	0.43	-0.19	-0.34	-0.41	-0.37
PSR3	-0.31	-0.31	0.58	0.38	-0.22	-0.51	-0.34	-0.31
PSR4	-0.44	-0.41	0.77	0.57	-0.33	-0.54	-0.34	-0.43
PFR1	-0.07	-0.16	0.26	0.53	-0.28	-0.30	-0.18	-0.22
PFR2	-0.17	-0.26	0.40	0.64	-0.16	-0.30	-0.27	-0.25
PFR3	-0.34	-0.20	0.43	0.68	-0.20	-0.17	-0.15	-0.23
PFR4	-0.25	-0.18	0.60	0.56	-0.14	-0.29	-0.29	-0.17
PB1	0.24	0.50	-0.28	-0.15	0.37	0.33	0.39	0.16
PB2	0.24	0.60	-0.20	-0.20	0.56	0.38	0.58	0.40
PB3	0.26	0.42	-0.13	-0.18	0.60	0.23	0.36	0.19
PB4	0.19	0.32	-0.15	-0.10	0.47	0.30	0.32	0.13
INT1	0.51	0.63	-0.46	-0.30	0.40	0.69	0.57	0.49
INT2	0.52	0.52	-0.54	-0.31	0.44	0.71	0.57	0.63
ATT1	0.35	0.69	-0.36	-0.25	0.75	0.62	0.79	0.66
ATT2	0.49	0.67	-0.47	-0.33	0.51	0.64	0.75	0.61
BI1	0.41	0.53	-0.46	-0.27	0.42	0.58	0.67	0.75
BI2	0.25	0.43	-0.41	-0.24	0.22	0.57	0.52	0.69

Table 24: Item by scale correlation; Germany/ Source:[Or]

4.1.6 EXPLANATORY FACTOR ANALYSIS

Data distribution check:

A Shapiro-Wilks normality test and a Kolmogorov-Smirnov Goodness-of-Fit test were conducted and revealed that the data is not normally distributed and does not follow a special pattern (see Appendix E - R Studio Programs). According to the correlation and regression analysis (as seen in Figure 19, Figure 20) the data distribution can be described as left skewed and with outliers.

Table 25 shows the Bartlett-Test:

The p-value is less than $\alpha = 0.05$. The Bartlett-Test is significant. That means H_0 (=The variance is not equal across the sample) is rejected and H_1 (=The variance is equal across the sample) is accepted.

	<i>Bartlett – test_{USA}</i>	<i>Bartlett – test_{Germany}</i>
p-value	0	0

Table 25: Bartlett-Test/ Source:[Or]

Table 26 shows the Kaiser-Meyer-Olkin Factor Adequacy:

The KMO values show the data quality of the items. The data quality of the US survey results was better with an overall MSA of 0.90 which is marvelous. The overall MSA of 0.83 for Germany is slightly worse in comparison to the US but still meritorious. The KMO values meet the minimum criteria (Table 4). Due to passing the Bartlett-Test and the KMO values, an EFA can proceed.

	MSA_ USA	MSA_ Germany
Overall	0.90	0.83
PEOU1	0.79	0.69
PEOU2	0.93	0.84
PEOU3	0.83	0.89
PEOU4	0.92	0.82
PU1	0.90	0.86
PU2	0.88	0.76
PU3	0.94	0.93
PU4	0.92	0.87
PSR1	0.86	0.76
PSR2	0.71	0.75
PSR3	0.76	0.78
PSR4	0.86	0.86
PFR1	0.71	0.64
PFR2	0.66	0.74
PFR3	0.79	0.75
PFR4	0.71	0.70
PB1	0.93	0.82
PB2	0.92	0.87
PB3	0.93	0.69
PB4	0.94	0.69
INT1	0.96	0.89
INT2	0.96	0.90
ATT1	0.95	0.87
ATT2	0.94	0.90
BI1	0.95	0.88
BI2	0.87	0.83

Table 26: Kaiser-Meyer-Olkin (KMO) Adequacy/ Source:[Or]

Number of Factors with Scree Plot and Eigenvalues:

A common issue in factor analysis is deciding how many factors should be used for analysis. There are various ways to address the problem. The scree plot (as seen in Figure 23 & Figure 25) shows the maximum number of four factors for the US analysis and seven factors for the German analysis. The scree plot is not a clear solution and only shows an overview of the maximum number of factors that would be possible. Therefore, a parallel analysis with eigenvalues (as seen in Figure 24 & Figure 26) is a helpful method to see how many meaningful factors should exist in the analyses. The eigenvalues analyses suggests three factors for both analyses. Furthermore, test runs from the maximum number of factors until three factors have been done to see which model fits best. All models, except the three factors models, had one factor with two items. According to the paper from the Yong and Pearce, 2013 [79], for something to be labeled as a factor it should have at least three variables. Rotated factors that consist of less than three items should be interpreted with caution. Therefore, for both analyses, a three-factor model has been chosen.

Figure 23: Scree plot; USA/ Source:[Or]

[1]	10.0741908	2.5942540	1.6619141	1.3847518	1.0344830	0.9349510	0.8803810	0.7997895	0.7157298	0.6030735	0.5874491
[12]	0.5475588	0.4964697	0.4682505	0.4465764	0.4182721	0.3545560	0.3007463	0.2960715	0.2776926	0.2501918	0.2235731
[23]	0.2157355	0.1639647	0.1504375	0.1189360							

Figure 24: Eigenvalues; USA/ Source:[Or]

Figure 25: Scree plot; Germany/ Source:[Or]

[1]	7.4751305	2.2030390	1.7863821	1.6035720	1.3643435	1.2039722	1.1431263	0.8876446	0.8063526	0.7552024	0.7228698	0.6544340
[13]	0.6223779	0.5722095	0.5189204	0.5108773	0.4591508	0.4264804	0.4185303	0.3784350	0.3116527	0.2718671	0.2707863	0.2337789
[25]	0.2302153	0.1686492										

Figure 26: Eigenvalues; Germany/ Source:[Or]

The proposed model in Figure 27 shows the diagram of the model after removing the item “PSR3 with $h^2 < 0.2$ ”. It illustrates which items follow which factor with which loading power. Moreover, it can be seen how strong the factors correlate with each other.

Figure 27: Factor Diagram; USA/ Source:[Or]

Figure 28 shows the three factors for the US model (PA1, PA2, PA3) with their related items and loadings. The greyed out loadings are less than 0.36 and thus should not be considered for the factors. The yellow-colored 'h2' represent the commonalities. PEOU4 has a loading on factor PA1 and PA2. All other items are assigned to a factor with one load respectively.

	PA1	PA2	PA3	h2	u2	com
PEOU1	0.02	-0.03	0.86	0.77	0.23	1.0
PEOU2	0.76	-0.03	-0.06	0.56	0.44	1.0
PEOU3	0.06	-0.14	0.78	0.75	0.25	1.1
PEOU4	0.39	-0.09	0.48	0.61	0.39	2.0
PU1	0.75	-0.09	-0.02	0.61	0.39	1.0
PU2	0.57	0.19	0.06	0.29	0.71	1.2
PU3	0.88	0.06	0.05	0.77	0.23	1.0
PU4	0.68	0.06	-0.02	0.42	0.58	1.0
PSR1	0.07	0.56	-0.19	0.38	0.62	1.3
PSR2	0.17	0.56	-0.16	0.32	0.68	1.4
PSR4	-0.03	0.55	-0.07	0.34	0.66	1.0
PFR1	-0.02	0.51	-0.03	0.28	0.72	1.0
PFR2	0.16	0.56	0.01	0.37	0.63	1.1
PFR3	-0.18	0.57	0.13	0.40	0.60	1.3
PFR4	-0.27	0.36	0.22	0.23	0.77	2.6
PB1	0.58	0.05	0.14	0.40	0.60	1.1
PB2	0.68	0.04	0.26	0.64	0.36	1.3
PB3	0.73	0.02	-0.15	0.45	0.55	1.1
PB4	0.66	0.07	0.06	0.44	0.56	1.0
INT1	0.74	-0.07	-0.06	0.56	0.44	1.0
INT2	0.85	-0.06	-0.04	0.73	0.27	1.0
ATT1	0.70	-0.04	0.25	0.73	0.27	1.3
ATT2	0.69	0.08	0.13	0.52	0.48	1.1
BI1	0.61	-0.19	0.17	0.63	0.37	1.4
BI2	0.73	-0.09	-0.15	0.51	0.49	1.1
			PA1	PA2	PA3	
SS loadings			8.14	2.33	2.26	
Proportion Var			0.33	0.09	0.09	
Cumulative Var			0.33	0.42	0.51	
Proportion Explained			0.64	0.18	0.18	
Cumulative Proportion			0.64	0.82	1.00	
With factor correlations of						
			PA1	PA2	PA3	
PA1	1.00	-0.41	0.42			
PA2	-0.41	1.00	-0.30			
PA3	0.42	-0.30	1.00			

The factors can be interpreted as follows:

Factor 1 (PA1) – Positive Attitude

- The items for factor 1 include topics such as benefits, attitudes, and trust.

Factor 2 (PA2) – Perceived Risk

- The items in factor 2 consist of perceived risks.

Factor 3 (PA3) – Ease of Use

- The items for factor 3 are about ease of use the technology.

Figure 28: Factor Loadings; USA/ Source:[Or]

The proposed model in Figure 29 shows the diagram of the model after removing the item “PSR3 with $h^2 < 0.2$ ”. To fit a suitable model according to the minimum criteria, six questions, e.g. “PU2 with $h^2 < 0.2$ ”, “PB1 with $h^2 < 0.2$ ”, “PB3 with $h^2 < 0.2$ ”, “PB4 with $h^2 < 0.2$ ”, “PSR1 with $h^2 < 0.2$ ”, “PSR2 with loading < 0.36 ” have been eliminated. It illustrates which items follow which factor with the associated loading power. Moreover, it can be seen how strong the factors correlate with each other.

Figure 29: Factor Diagram; Germany/ Source:[Or]

Figure 30 shows the three factors for the German model (PA1, PA2, PA3) with their related items and loadings. The greyed out loadings are less than 0.36 and thus should not be considered for the factors. All items are assigned to one factor with one loading respectively.

	PA1	PA3	PA2	h2	u2	com
PEOU1	-0.16	0.78	0.05	0.46	0.54	1.1
PEOU2	-0.11	0.71	-0.16	0.54	0.46	1.1
PEOU3	0.16	0.79	0.14	0.69	0.31	1.2
PEOU4	0.20	0.71	0.09	0.64	0.36	1.2
PU1	0.74	0.11	0.26	0.51	0.49	1.3
PU3	0.53	0.08	-0.04	0.37	0.63	1.1
PU4	0.57	-0.10	-0.17	0.37	0.63	1.3
PSR3	-0.12	-0.08	0.40	0.27	0.73	1.3
PSR4	-0.03	-0.18	0.59	0.50	0.50	1.2
PFR1	-0.02	0.25	0.67	0.36	0.64	1.3
PFR2	0.02	0.13	0.69	0.39	0.61	1.1
PFR3	0.17	-0.15	0.58	0.34	0.66	1.3
PFR4	-0.01	-0.10	0.39	0.20	0.80	1.1
PB2	0.67	-0.10	0.12	0.33	0.67	1.1
INT1	0.46	0.21	-0.08	0.42	0.58	1.5
INT2	0.38	0.21	-0.19	0.43	0.57	2.1
ATT1	0.91	-0.12	0.10	0.65	0.35	1.1
ATT2	0.68	0.11	-0.01	0.55	0.45	1.1
BI1	0.61	0.00	-0.10	0.44	0.56	1.1
BI2	0.55	-0.10	-0.13	0.33	0.67	1.2
	PA1	PA3	PA2			
SS loadings	4.11	2.61	2.09			
Proportion Var	0.21	0.13	0.10			
Cumulative Var	0.21	0.34	0.44			
Proportion Explained	0.47	0.30	0.24			
Cumulative Proportion	0.47	0.76	1.00			
With factor correlations of						
	PA1	PA3	PA2			
PA1	1.00	0.56	-0.49			
PA3	0.56	1.00	-0.47			
PA2	-0.49	-0.47	1.00			

The factors can be interpreted as follows:

Factor 1 (PA1) – Positive Attitude

- The items for factor 1 include topics such as benefits, attitudes, and trust

Factor 2 (PA2) – Perceived risk

- The items in factor 2 consist of perceived risks.

Factor 3 (PA3) – Ease of Use

- The items for factor 3 are about ease of use the technology.

Figure 30: Factor Loadings; Germany/ Source:[Or]

EFA Model Fit Indices:

After processing an EFA and removing items that are not meaningful, the model fit indices show a suitable model (as seen in Table 27). According to Table 8, the model fit indices meet the suggested criteria. The factors are labeled as suitable. Also, the internal consistency measured with Cronbach's Alpha improved by the factors. All factors have an acceptable – excellent internal consistency.

Table 27 shows the model fit indices for the Explanatory Factor Analysis.

	Suggested [83] [84]	USA	Germany
RMSR	< 0.10	0.05	0.05
TLI	≥ 0.9	0.903	0.94
RMSEA	≤ 0.8	0.062	0.043
CR_{Factor1}	≥ 0.7	0.94	0.87
CR_{Factor2}	≥ 0.7	0.75	0.83
CR_{Factor3}	≥ 0.7	0.86	0.74

Table 27: EFA model fit indices/ Source:[Or]

4.1.7 TECHNOLOGY ACCEPTANCE MODEL

Figure 31 and Figure 32 show the results from structural equation modeling and illustrates the TAMs for the US and Germany. The black lines represent the relationship from the original TAM. The red lines represent newly suggested relationships. Dotted lines indicate the non-significant (n.s.) pathways. The path coefficients show the power. The significance level α is provided automatically from SEM analysis and is indicated by stars at the levels of: 1% (***), 5% (**), 10% (*).

TAM model fit indices:

Table 28 shows the model fit indices for both TAMs. Based on the suggested model fit indices from Table 10, the model fit indices do not perfectly fit the criteria. In comparison to the US model, the German model has a better fit with the value of 4.38 (Chisq/df), 0.115 (SRMR), 0.170 (RMSEA), 0.734 (TLI), and 0.879 (CFI).

Indices	Suggested [82]	USA	Germany
Chisq/df	< 3.0	8.84	4.38
SRMR	< 0.1	0.118	0.115
RMSEA	< 0.1	0.249	0.170
TLI	> 0.95	0.691	0.734
CFI	> 0.95	0.859	0.879

Table 28: TAM fit indices/ Source:[Or]

Results from hypotheses testing:

Table 29 shows the hypotheses and the standardized path coefficients. The regressions of SEM provide a p-value (as seen in Appendix E - R Studio Programs/ 7.5.11 & 7.5.12) that shows whether a path regression between two constructs is significant or not. The hypotheses which indicates as statistically significant got a 'yes' for support. Hypotheses indicated as non-significant path are provide with a bold 'no' for support. The non-significant hypotheses between both countries differ slightly from each other.

Table 29 shows the which Hypotheses are supported.

Hypothesis	Std. Path Coeff. USA	Supported ? USA	Std. Path Coeff. Germany	Supported ? Germany
H1: ATT -> BI	0.56***	yes	0.55***	yes
H2: PU -> ATT	0.39***	yes	0.45***	yes
H3: PU -> BI	0.40***	yes	0.24***	yes
H4: PEOU -> PU	0.73***	yes	0.45***	yes
H5: PEOU -> ATT	0.29***	yes	0.07	no
H6: INT -> ATT	0.14	no	0.23***	yes
H7: PEOU -> INT	0.08	no	0.31***	yes
H8: PU -> INT	0.42***	yes	0.31***	yes
H9: PSR -> INT	-0.05	no	-0.19**	yes
H10: PFR -> INT	-0.15	no	-0.03	no
H11: PB -> INT	0.43***	yes	0.04	no
H12: PB -> ATT	0.20*	yes	0.15***	yes

Table 29: Results from hypotheses testing/ Source:[Or]

4.2 DISCUSSION

Cronbach's Alpha was applied to prove the internal consistency of the surveys. The reliability of the US survey results were better than the German survey. All values of

Cronbach's Alpha are greater than the minimum value of 0.5. For the US survey, the constructs PEOU and INT have good internal consistency. PU, PB, ATT, and BI have an acceptable internal consistency. PSR and PFR have weaker results and lies in the questionable area for internal consistency. The German survey results were worse than the US survey. PEOU has a good internal consistency. ATT and BI are acceptable. PU, PSR, PFR, and INT lie in the questionable area. PB has achieved a poor result with 0.52. According to the definitions from Table 3, each construct exhibits a value above 0.5 and therefore the overall reliability is assumed to be acceptable.

The correlation significance test (Table 19, Table 20) gave evidenced that all correlations between constructs for both surveys are statistically significant. This means that all constructs have a strong enough power with each other to model a relationship. The correlation and regression analysis shows the strength between the constructs and provides a view of the data distribution. For both countries, the data distribution is not normally distributed and can be described rather as left-skewed with outliers. The correlation plots serve as a good visualization for the power of correlations and show a higher correlation power for the US survey.

An EFA simplified the data set and provided an overview of a few factors in which the data is interpretable. Before an EFA was conducted, the data set of both surveys has been tested for Bartlett-test and KMO (Table 25, Table 26). Both the Bartlett-test and the Kaiser-Meyer-Olkin Measure of Sampling Adequacy indicate that the variables are suitable for factor analysis and suggest that a factor analysis is applicable for the dataset. Moreover, the inverse matrix (Table 21, Table 22) is presented as a diagonal matrix and confirms the suitability for an EFA. Through the EFA not meaningful questions e.g. with

low commonalities or low factor loadings were removed to represent a good fit model. A rotation 'promax' was used to determine the factors. Although the scree plot (Figure 23, Figure 25) indicates the presence of four factors for the US analysis and seven factors for the Germany analysis, a three-factor solution was chosen based on the eigenvalues (Figure 24, Figure 26) and test runs. To meet the minimum criteria in terms of factor loadings and commonalities (Table 7) of a suitable model, the item "PS3 with $h^2 < 0.2$ " was eliminated from the USA analysis. For the German survey more items, six in total must be dropped to meet the minimum criteria for a suitable model. The eliminated items are "PU2 with $h^2 < 0.2$ ", "PB1 with $h^2 < 0.2$ ", "PB3 with $h^2 < 0.2$ ", "PB4 with $h^2 < 0.2$ ", "PSR1 with $h^2 < 0.2$ ", "PSR2 with loading < 0.39 ". The higher amount of removed questions for the Germany analysis could be related to the worse data quality (MSA= 0.83, Table 26) for Germany when compared to the US (MAS=0.9, Table 26). Furthermore, another reason could be related to the reliability of the German survey which is more poor. The improved model is shown in a diagram (Figure 27, Figure 29) to see which items follow and load on which factor. The table of loadings (Figure 28, Figure 30) provides an overview of the factor loadings and their variances. The three factors could be interpreted as: 'Positive Attitude', 'Perceived Risks', and 'Ease of Use'.

Four ANOVA tests were conducted in order to prove whether there are significant differences between age groups, gender, commute time, and preferred SAE-level on behavioral intention to use vehicles with SAE-4. For the US, the ANOVA results revealed a significant difference between age groups ($F(4,126) = 5.002$; $p = 0.00914***$) and preferred SAE-level ($F(5,126) = 13.54$; $p = 1.8e-10***$) on behavioral intention. Boxplots show (as seen in Appendix E - R Studio Programs/ 7.5.3 and 7.5.4) that the highest

intention to use vehicles with SAE-4 is by age group 40-50 followed by 30-40, 20-30, and > 60. Age group 50-60 has the lowest intention to use the technology. Another finding is, the higher the preferred automation level, the higher the intention to use it. Except for people who prefer SAE-3 & SAE-4, they have the same behavioral intention to use such technology. A statistical difference between daily commute ($F(4,126) = 1.422$; $p = 0.231$) and gender ($F(1,126) = 3.11$; $p = 0.0803$) on behavioral intention was found to be statistically non-significant.

For Germany, gender ($F(1,117) = 11.02$; $p = 0.00121^{**}$) and preferred SAE-level ($F(5,117) = 8.168$; $p = 1.35e-06^{***}$) was revealed to be statistically significant on behavioral intention. In this case it needs to be considered that the gender distribution was 32% females and 68% males. Males have a higher intention to use such vehicles with SAE-4 than females. The preferred SAE-level is similar to the US, the higher the preferred SAE-level, the higher the intention to use such vehicles. However, the highest intention to use is for SAE-4 followed by SAE-5. Age groups ($F(4,117) = 0.774$; $p = 0.544$) and daily commute ($F(4,117) = 1.45$; $p = 0.222$) was found to be statistically non-significant on behavioral intention. In this case, the most participants from Germany were between 20 and 40 years old. The higher age groups are rather not comparable with each other in this data set. The highest intention was for the age group 30-40 followed by 20-30, 50-60, 40-50. The lowest intention was in the age group > 60.

A PLS-SEM (Appendix E - R Studio Programs/ 7.5.11 and 7.5.12) was conducted to prove the assumed hypotheses and relationships between the constructs. The finding from TAM (

Figure 31 and Figure 32) revealed that initial trust is not the most critical factor to shape a positive attitude towards technology for both countries. Especially for the US, initial trust turns out to be non-significant while in Germany initial trust is significant to a positive attitude toward technology. The result differs from the research of Zhang et al, 2019 [5], where initial trust has been found as the most critical factor to shape a positive attitude towards technology. But it needs to be considered that this published research has been done with the Chinese population in China and for vehicles with SAE-3. Moreover, there are differences in perceived safety risk and perceived financial risk. The results show that both risks are not significant on influencing positive initial trust, in turn in Germany, perceived safety risk was revealed to be significant on initial trust. Another interesting relationship is the perceived benefit. It shows a significant positive effect to shape a positive attitude towards technology for both countries, but is only significant for the initial trust for the US population. The construct perceived ease of use differs also between both countries. It has a positive effect on attitude towards technology and is non-significant to initial trust. In Germany, perceived ease of use has a positive effect on initial trust but is non-significant for attitude towards technology. The strongest relationship for the US is perceived ease of use on perceived usefulness followed by a positive attitude towards technology. For Germany, on the other hand, a positive attitude towards technology has the strongest effect on behavioral intention. Based on those findings, the assumed hypotheses H6, H7, H9, H10 for the US, and H5, H10, H11 for the Germans will not be supported (as seen in Table 29). It is also important to consider that these results are based

on the fact that the description for SAE-4 was only given in words for the participants. Pictures or videos of SAE-4 could have also been included.

5 CHAPTER 5 – CONCLUSION

The aim of this study was to investigate the acceptance for partially Automated Vehicles with SAE-4 in the US and Germany. For that purpose an online survey was conducted in both countries and the collected data were analyzed using the method EFA and PLS-SEM. The results of this study show the factors which are influencing the behavioral intention to use AVs. It contributes to a better understanding of public technology acceptance in terms of vehicles with a high automation stage. These findings show also that acceptance research is a broad area that needs to be consistently researched because the biggest roadblocks standing in the ways of mass adoption of AVs may be the psychological aspect and not the technological. The acceptance of the people and psychological aspects can change immediately in a positive or in a negative direction if an event has occurred. Therefore understanding which factors and how they influence users' acceptance and adoption of AVs is important. Acceptance is also dependent on many different factors like time, country, culture and regions, technology development, technology experience, trust in technology, marketing, etc.

By incorporating additional constructs e.g. initial trust, perceived safety risk, perceived financial risk, and perceived benefit in the original TAM, this study shows an empirically tested extended TAM to comprehend user's attitude to behavioral intention to use AVs with high automation in the countries USA and Germany which are both well-prepared for Autonomous Driving.

The findings show that many factors have a positive effect on user's behavioral intention to use AVs with SAE-4. A positive trend towards automated driving can be clearly identified in both countries. This study provides an important overview of the

preferable automation level of the people. When people asked which level of automation they would prefer for their vehicle in the future, SAE-2 got the most votes in both countries, followed by SAE-3 for the US and SAE-4 & SAE-5 for Germany. By adding up the votes for SAE-3, SAE-4, and SAE-5 and comparing them to SAE-2, these three votes combined reach a higher number than SAE-2. That shows that people want to use at least partial automation in their vehicles and tend to prefer higher levels of automation. Considering that vehicles with SAE-3, SAE-4, and SAE-5 are not penetrated completely in the market yet, these findings show that approximately half of the people would prefer to use it. But a slight difference between the USA and Germany is visible. In terms of the preferred higher level of automation, a downward trend from SAE-3 to SAE-5 is visible in the US. The trend in Germany from SAE-3 is more of an ease increase towards a higher automation level. The TAM of both countries shows that the path coefficient from attitude towards technology to behavioral intention is almost the same (US $\beta = 0.56^{***}$, Germany $\beta = 0.55^{***}$). The causal relationship between attitude towards technology and behavioral intention can be interpreted as a strong effect. Therefore based on this research it can be said that in the US as well as in Germany the intention to use vehicles with SAE-4 is relatively high and the people would rather accept the vehicles than reject them. In both countries, the daily commuting distance does not show a significant difference for behavioral intention to use vehicles with high automation. The most intention to use AVs with SAE-4 is for people between 30 and 50 in the US and for people between 20 and 40 in Germany. Males more want to use the technology more than females in the US as well as in Germany. Based on this result it can be stated that the people in the US and

Germany have the same positive attitude towards technology which influences their behavioral intention to use such vehicles.

Although the effect on behavioral intention is the same, the relationship between a few constructs differ from each other. Under the same model conditions, there is a difference between the constructs initial trust, perceived benefit, and attitude towards technology. The assumption was that perceived benefit and initial trust have a positive effect on attitude towards technology, and also perceived benefit has a positive effect on attitude towards technology. These assumptions could not be confirmed by 100% in both countries. While in the US, perceived benefit has a positive effect to initial trust and attitude towards technology, initial trust has no positive effect on attitude towards technology. In contrast, in Germany perceived benefit and initial trust influences positive attitude towards technology, but the perceived benefit does not influence positive initial trust. From this, it can be concluded that the US drivers needed to see an advantage in the technology to have a positive attitude towards the technology and build up trust for it. Initial trust is found as non-significant to shaping a positive attitude towards technology. In Germany, on the other hand, initial trust has a positive effect to attitude towards technology and there must be benefits perceived in technology to have a positive attitude towards technology. However, benefits do not influence positive initial trust.

A further difference between both countries lies in the perceived risks. Perceived safety risk and perceived financial risk were revealed as non-significant to build up initial trust for the US, while in Germany perceived safety risk does have a negative effect on initial trust. In terms of perceived financial risk, this finding and the finding from the study of Benleulmi and Blecker, 2017 [48] where financial risk were found as non-significant for

FAVs in the US and Germany show that financial risk has no negative effect on trust for higher automation levels (SAE-4 and SAE-5). Perceived safety risk was found to be significant in their study too, but only for Germany in this study. This finding also confirms the findings from the study of Ward et al., 2017 [46] in the US, where they found that safety risk has a non-significance, but it was for Automated Driving without any specific SAE-level. Furthermore, in comparison to the study from Zhang et al., 2019 [5], initial trust was found to be not the most critical factor to shape a positive attitude towards technology, on the contrary, in the US it was revealed as non-significant.

All in all, based on the results it can be stated that although the Germans tend to use more higher automation levels, they care more about the safety risks which could be a blockade for initial trust. Decreases in the perceived safety risk in Germany could help to build up initial trust to shape a positive attitude towards technology. The US people rather need to see the benefits in the technology to build up trust for it and shape a positive attitude towards technology, but trust has no positive effect on shaping a positive attitude towards technology. Financial risk does not negatively affect the trust of people in both countries.

Moreover, the three factors from the EFA could be interpreted to imply that there are three kinds of people who participated in this survey regarding the adoption for vehicles with SAE-4: people who find it easy to use such vehicles, people who see risks in the technology, and people who have a positive attitude towards the technology.

By consideration of the limitations in this study, these empirical findings could provide an important aid for car manufacturers, governments, insurance agencies, and marketing agencies to successfully adapt the technology on market to users' acceptance.

6 LIMITATIONS AND FUTURE WORK

This study needs to be interpreted in consideration with some limitations. First of all, the results are referring to 126 participants for the US and 117 for Germany. Future work can aim to gather a higher sample size in order to achieve more representative results. The higher the sample size of participants, the more precisely the results can be presented. Moreover, special care should be taken to ensure that the age groups are optimally distributed to represent population age groups and compare them with each other. Around 80% of the German participants were between 20 and 40 years old. The age group <20 could not reach any response for both countries. The percentage of the age groups from the collected data set should map the percentage of the actual percentage of age groups living in the respective country.

A further limitation is that about 50% of the participants were from Rhode Island and Lower Saxony. Therefore, the results represent a certain state for each country. Further studies can conduct more surveys in different states to see if there is a significant difference between them in terms of acceptance. Moreover, a nationwide survey including all states could be done to provide an overview of acceptance in the whole country. To represent the results as accurately as possible from the collected data, the percentage of each state should map the actual percentage of population in each state.

Another important point to shape a positive attitude towards technology is the driver experience, car ownership & utilization. Most participants own their own car, lease one, or use cars from others. Only 2% in the US and 10% in Germany do not use a vehicle. Also, about 90% in both countries own a driver's license for at least one year. 73% in the US and 87% in Germany reported that they have a driver's license for more than 6 years. Based on

these findings it can be stated that the participants in this experiment have driver's experience and own or use a vehicle. Future studies could focus more on people who use more public transport systems or bicycles in order to investigate the importance of psychological ownership and driver's experience in terms of promoting a positive attitude towards technology.

In the future, the level of trust and its influenced constructs would change because users get more familiar with the systems and its technology. The development of the technology is consistently growing and users get a deeper understanding of how the systems work. Therefore, longitudinal studies are recommended to investigate how trust and its role in user acceptance will evolve after users have gained more experience interacting with AVs [5]. It should also be noted that this study was conducted on the basis that SAE-2 vehicles have already conquered the market and SAE-3 is not far away. At a time when higher SAE-levels than SAE-2 have penetrated the market, the acceptance for such vehicles would probably be different.

This model provides a suitable theoretical framework to investigate and describe the user's acceptance in terms of FAVs and AVs. Further studies can take the survey and prove and use a Confirmatory Factor Analysis (CFA) to confirm the model validity. In addition, through the improvement of some questions, the model validity with the fit indices for the PLS-SEM can be improved and confirmed.

Moreover, further studies can explore the relationships of more factors such as driving pleasure after using such vehicles, perceived cyber-security risk, and perceived liability concerns on acceptance. In conclusion, this study was built upon an automation level of SAE-4 AVs with a dominant feature that human intervention is possible if needed. The

relationships between the constructs of the proposed model might change in the context of higher or lower levels.

It should be noted that the survey was carried out online. It can be assumed that the results might be different if the survey were carried out in different locations such as shopping centers, malls, DMVs, parking lots, or events, either in paper form or even by computer. In a nationwide survey with a higher sample size, these types of public locations should be included in order to reach a broad sample of participants. Due to the way the survey was distributed it is possible that many responses came from people associated with the university in those states. During the COVID-19 pandemic it was not possible to give paper-based surveys in public locations in this research. In addition, the survey should be designed in such a way that people from all age groups, from very young to very old can take part in it. Also, more attention should be paid to older people who cannot drive anymore or people with disabilities because the technology of Autonomous Driving promises to provide a new mobility option for them.

Future work could also design an experiment with the driving simulator to investigate the acceptance before and after driving an AV. For such an experiment the driving simulator at the University of Rhode Island could be used. Therefore, it is necessary to find out how far the driving simulator at the University of Rhode Island can be equipped with ADASs. Currently, no ADASs on the driving simulator are possible or available. Therefore exploring the associated hardware and software is necessary in order to find out which possibilities exist in terms of modeling ADASs on the driving simulator and scenario programming. After determining to what extent ADASs are possible to replicate in the driving simulator, surveys with pilot tests could be conducted. The proposed approach is to examine how quickly drivers of a partially or highly Automated Vehicle can intervene in operating a

simulated vehicle, from the moment that they detect a critical event or takeover condition on the road or its surroundings. The approach aims to determine whether the driver is ready to intervene and whether the potential intervention increases the safety of driving. Scenarios and instruments could be programmed to allow the driving simulator to mimic AVs. The experimental design allows a complete analysis of each subject's performance under different conditions with different forms of stimuli. It is envisioned that the AV will cruise through a virtual city with pedestrians and cars, where the test subject will be confronted with a dangerous and unexpected situation, such as a car that suddenly crosses the road, or a sudden stop of the preceding vehicle, etc. Such dangerous situations will require the test subject, who is in the simulator, to quickly and actively intervene in the driving process and take control of the driving until the situation is over. The results of this experiment will measure the readiness of drivers to take control of an AV. Additional surveys can provide an overview of differences in terms of acceptance before and after driving an AV. It will also help to identify the factors and their interactions with the greatest influence on driving behavior. Because human test subjects are involved in such an experiment the study must be approved by the URI IRB.

All in all, the results of this study investigating the user acceptance for the technology of autonomous driving shows a positive trend in which users favor the technology. The Technology Acceptance Model shows a strong correlation with the psychological aspect of acceptance. The identified relationships between the constructs can be used in the future as a basis for improvements to shape a positive attitude towards technology, as well as increase the behavioral intention to use FAVs and AVs. Based on these findings, it can be stated that the technology will succeed faster with a higher behavioral intention for a higher automation level and concludes that roads can be made safer.

7 APPENDICES

7.1 APPENDIX A – SURVEY USA

Default Question Block

You are being asked to participate in a research study. The purpose of this online survey is to assess public opinion about partially automated vehicles with a high automation stage. Please read the following before deciding to participate in the study.

If you agree to be in this study, the survey will take approximately 8-12 minutes to complete. In this survey you will be asked questions about demographic characteristics (e.g. gender, age, nationality) and partially Automated Vehicles. For participation in the experiment there are no known risks, benefits or compensation. Your responses will be strictly anonymous. The responses may be used for a thesis or research publications at the University of Rhode Island (URI) and Technische Universität Braunschweig (TU BS).

The decision to participate in this experiment is entirely up to you. You may refuse to take part in the study at any time without affecting your relationship with the investigators of this study or the research institutions of URI and TU BS. Your decision will not result in any loss of benefits to which you are otherwise entitled. You have the right to not answer any single question, as well as to withdraw completely from the experiment at any point during the process; additionally, you have the right to request that the researchers not use any of your responses.

You have the right to ask questions about this research study and to have those questions answered by the researcher Sergio Bujanov or the principal investigator Valerie Maier-Speredelozzi before, during or after the research. If you have questions about the study, at any time feel free to contact Valerie Maier-Speredelozzi from the

Department of Mechanical, Industrial and Systems Engineering, at 401.874.5187. Additionally, you may contact the URI Institutional Review Board (IRB) if you have questions regarding your rights as a research participant. Also contact the IRB if you have questions, complaints or concerns which you do not feel you can discuss with the investigator. The University of Rhode Island IRB may be reached by phone at (401) 874-4328 or by e-mail at researchintegrity@etal.uri.edu. You may also contact the URI Vice President for Research and Economic Development by phone at (401) 874-4576.

If you want to have a copy of this document for your record, please print or save this page now. You may also contact the researcher to request a copy.

By clicking "I understand" below to begin the survey, you indicate that you are at least 18 years old, have a valid driver's license, and have read and understood the above points and volunteer to participate in this study

☐ I understand

* If you want to participate in the Amazon gift card drawing, please type your email address here. If not, just click on Continue.

(Email addresses will only be used for selecting a winner. As soon as the survey ends and the winner has been selected, all email addresses will be deleted. Evaluating survey responses will take place after deleting all E-Mail addresses. E-Mail addresses are kept strictly confidential and secure on a password-protected computer and will also never be sold or distributed to third parties. Email addresses will not be associated with survey responses.)

☐ I want participate and leave my E-Mail dress here

☐ Continue

Please indicate your age:

- ☐ < 20
- ☐ 20 - 30
- ☐ 30 - 40
- ☐ 40 - 50
- ☐ 50 - 60
- ☐ > 60

Please indicate your gender:

- ☐ Male
- ☐ Female
- ☐ Unspecified

Please indicate your nationality:

- ☐ United States
- ☐ Other:

In which state is your current residence?

Do you own your own car?

- ☐ I own a car (Ownship)
- ☐ I am leasing a car (Leasing, Company Car)
- ☐ I do not own a car, but do borrow a car from others
- ☐ I am not using a car

How long have you had your driver's license?

- ☐ < 1 year
- ☐ 1 - 2 years
- ☐ 2 - 6 years
- ☐ > 6 years

How long is your daily commute? (back and forth)

- ☐ < 5 miles
- ☐ 5 - 20 miles
- ☐ 20 - 40 miles

- ☐ 40 – 60 miles
- ☐ > 60 miles

The follow questions refer to partially Automated Vehicles with a high automation stage. The definition is for such a vehicles is:

“A high automation vehicle is designed to perform all aspects of the driving task, even if the human driver does not respond appropriately to request to intervene. The operator of the high automation car can undertake non- driving activities (e.g., responding to emails, viewing scenery, reading a book) when the vehicle is in control of all driving tasks. Automation mode may not be suitable in poor weather conditions (e.g., heavy storms, snow) and may only be supported in specific geographic areas. A high Automation Vehicle will still include a steering wheel and pedals to allow a human driver to take over when required (e.g., in an emergency, or by choice)

- ☐ Continue

Learning to use partially Automated Vehicles will be easy for me

- ☐ Strongly agree
- ☐ Somewhat agree
- ☐ Neither agree nor disagree

- ☐ Somewhat disagree
- ☐ Strongly disagree

I will find it easy to get partially Automated Vehicles to do what I want to do

- ☐ Strongly agree
- ☐ Somewhat agree
- ☐ Neither agree nor disagree
- ☐ Somewhat disagree
- ☐ Strongly disagree

It will be easy for me to become skillful at using partially Automated Vehicles

- ☐ Strongly agree
- ☐ Somewhat agree
- ☐ Neither agree nor disagree
- ☐ Somewhat disagree
- ☐ Strongly disagree

I will find partially Automated Vehicles easy to use

- ☐ Strongly agree
- ☐ Somewhat agree
- ☐ Neither agree nor disagree
- ☐ Somewhat disagree

☐ Strongly disagree

Using partially Automated Vehicles will reduce my stress of driving

- ☐ Strongly agree
- ☐ Somewhat agree
- ☐ Neither agree nor disagree
- ☐ Somewhat disagree
- ☐ Strongly disagree

Using partially Automated Vehicles will let me do other tasks, such as eating, watching a movie, or making cell phone calls

- ☐ Strongly agree
- ☐ Somewhat agree
- ☐ Neither agree nor disagree
- ☐ Somewhat disagree
- ☐ Strongly disagree

Using partially Automated Vehicles will be useful in meeting my driving needs

- ☐ Strongly agree
- ☐ Somewhat agree
- ☐ Neither agree nor disagree
- ☐ Somewhat disagree

☐ Strongly disagree

Using partially Automated Vehicles will decrease my accident risk

- ☐ Strongly agree
- ☐ Somewhat agree
- ☐ Neither agree nor disagree
- ☐ Somewhat disagree
- ☐ Strongly disagree

I am concerned about the uncertainty of legal responsibility due to an unavoidable crash situation where decisions have been made by the vehicle

- ☐ Strongly agree
- ☐ Somewhat agree
- ☐ Neither agree nor disagree
- ☐ Somewhat disagree
- ☐ Strongly disagree

I am concerned about the liability if an accident occurs when a partially Automated Vehicle operates in self-driving mode

- ☐ Strongly agree
- ☐ Somewhat agree
- ☐ Neither agree nor disagree

- ☐ Somewhat disagree
- ☐ Strongly disagree

I am concerned about the difficulty in responding appropriately when avoidable or unexpected situation arise

- ☐ Strongly agree
- ☐ Somewhat agree
- ☐ Neither agree nor disagree
- ☐ Somewhat disagree
- ☐ Strongly disagree

I am concerned about the difficulty in interacting with conventional vehicles or bicycles on the road

- ☐ Strongly agree
- ☐ Somewhat agree
- ☐ Neither agree nor disagree
- ☐ Somewhat disagree
- ☐ Strongly disagree

I am concerned that partially Automated Vehicles will collect too much personal information about me

- ☐ Strongly agree
- ☐ Somewhat agree
- ☐ Neither agree nor disagree

- ☐ Somewhat disagree
- ☐ Strongly disagree

I am concerned about occurrences about system failures, errors, or problems from hacking

- ☐ Strongly agree
- ☐ Somewhat agree
- ☐ Neither agree nor disagree
- ☐ Somewhat disagree
- ☐ Strongly disagree

I am concerned that purchasing a new partially Automated Vehicle will have additional costs due to the installation of electronic equipment and intelligent systems

- ☐ Strongly agree
- ☐ Somewhat agree
- ☐ Neither agree nor disagree
- ☐ Somewhat disagree
- ☐ Strongly disagree

I am concerned about that increased costs of operating and maintaining a partially Automated Vehicle, such as system upgrades, map upgrades, network usage costs, higher insurance costs, etc.

- ☐ Strongly agree
- ☐ Somewhat agree
- ☐ Neither agree nor disagree
- ☐ Somewhat disagree
- ☐ Strongly disagree

Partially Automated Vehicles prevent collisions between vehicles and pedestrians, using environmental recognition, automatic control, etc.

- ☐ Strongly agree
- ☐ Somewhat agree
- ☐ Neither agree nor disagree
- ☐ Somewhat disagree
- ☐ Strongly disagree

Partially Automated Vehicles reduce fatigue and difficulties in driving due to self-driving and finding the optimal path

- ☐ Strongly agree
- ☐ Somewhat agree
- ☐ Neither agree nor disagree
- ☐ Somewhat disagree
- ☐ Strongly disagree

Partially Automated Vehicles reduce traffic congestion during commute times in certain areas

- ☐ Strongly agree
- ☐ Somewhat agree
- ☐ Neither agree nor disagree
- ☐ Somewhat disagree
- ☐ Strongly disagree

Partially Automated Vehicles reduce parking stress through automatic parking or parking assistance

- ☐ Strongly agree
- ☐ Somewhat agree
- ☐ Neither agree nor disagree
- ☐ Somewhat disagree
- ☐ Strongly disagree

Partially Automated Vehicles are reliable

- ☐ Strongly agree
- ☐ Somewhat agree
- ☐ Neither agree nor disagree
- ☐ Somewhat disagree
- ☐ Strongly disagree

Overall, I can trust partially Automated Vehicles and their technology

- ☐ Strongly agree

- ☐ Somewhat agree
- ☐ Neither agree nor disagree
- ☐ Somewhat disagree
- ☐ Strongly disagree

Using partially Automated Vehicles is a wise idea

- ☐ Strongly agree
- ☐ Somewhat agree
- ☐ Neither agree nor disagree
- ☐ Somewhat disagree
- ☐ Strongly disagree

Using partially Automated Vehicles is pleasant

- ☐ Strongly agree
- ☐ Somewhat agree
- ☐ Neither agree nor disagree
- ☐ Somewhat disagree
- ☐ Strongly disagree

I predict I would use partially Automated Vehicles in the future

- ☐ Strongly agree
- ☐ Somewhat agree
- ☐ Neither agree nor disagree
- ☐ Somewhat disagree

☐ Strongly disagree

I will purchase a partially Automated Vehicles with my next car

☐ Strongly agree

☐ Somewhat agree

☐ Neither agree nor disagree

☐ Somewhat disagree

☐ Strongly disagree

What do you think causes the most road accidents?

☐ Speeding

☐ Distracted driving

☐ Drowsy driving

☐ Driving under influence of drugs/ alcohol/ psychoactive substances

☐ Weather conditions

☐ Road/ infrastructure conditions

☐ Technical failure of vehicle

Please check the level of Automated Driving that you would prefer in the future for vehicles that you own or use

☐ Level 0: Zero Automation. The human performs all driving tasks (steering, acceleration, braking, etc.)

☐ Level 1: The vehicle is controlled by the driver, but some driving assist features may be included in the vehicle (e.g. it monitors speed through cruise control)

- ☐ Level 2: The vehicle has combined automatic functions, like acceleration and steering, but the driver must remain engaged with the driving task and monitor the environment at all times
- ☐ Level 3: The driver does not have to monitor the environment permanently, but only has to be ready to take control if this is necessary
- ☐ Level 4: The vehicle performs all driving tasks under specific circumstances. The driver may have the option to control the vehicle
- ☐ Level 5: Full Automation. The vehicle is capable of performing all driving tasks in all conditions. Zero human attention or interaction is required

Thank you for participation in this research study

7.2 APPENDIX B – SURVEY GERMANY

Default Question Block

Sie werden gebeten, an einer Forschungsstudie teilzunehmen. Der Zweck dieser Online-Umfrage ist die Beurteilung der öffentlichen Meinung zu teilautomatisierten Fahrzeugen mit einem hohen Automatisierungsgrad. Bitte lesen Sie die folgenden Informationen, bevor Sie sich für die Teilnahme an der Studie entscheiden.

Wenn Sie der Teilnahme an dieser Studie zustimmen, dauert das Ausfüllen der Umfrage ca. 8-12 Minuten. In dieser Umfrage werden Ihnen Fragen zu demographischen Merkmalen (z. B. Geschlecht, Alter, Nationalität), und teilautomatisierten Fahrzeugen gestellt. Für die Teilnahme am Experiment sind keine Risiken, Vorteile oder Entschädigungen bekannt. Ihre Antworten werden streng anonym behandelt. Die Antworten können für eine Abschlussarbeit oder Forschungspublikationen an der University of Rhode Island (URI) und der Technischen Universität Braunschweig (TU BS) verwendet werden.

Die Entscheidung, an dieser Umfrage teilzunehmen, liegt ganz bei Ihnen. Sie können sich jederzeit weigern, an der Studie teilzunehmen, ohne Ihre Beziehung zu den Ermittlern dieser Studie oder der Forschungseinrichtungen der URI und TU BS zu beeinträchtigen. Ihre Entscheidung führt nicht zum Verlust von Vorteilen, auf die Sie anderweitig Anspruch haben. Sie haben das Recht, eine einzelne Frage nicht zu beantworten und sich zu jedem Zeitpunkt des Prozesses vollständig vom Experiment zurückzuziehen. Darüber hinaus haben Sie das Recht, die Forscher aufzufordern, keine Ihrer Antworten zu verwenden.

Sie haben das Recht, Fragen zu dieser Forschungsstudie zu stellen und diese Fragen von dem Forscher Sergio Bujanov oder der Hauptforscherin Valerie Maier-Speredelozzi vor, während oder nach der Forschung beantworten zu lassen. Wenn Sie Fragen zur Studie haben, können Sie sich jederzeit an Valerie Maier-Speredelozzi vom Department of Mechanical, Industrial and Systems Engineering unter der Nummer 401.874.5187 wenden. Sie können sich auch an das URI Institutional Review Board (IRB) wenden wenn Sie Fragen zu Ihren Rechten als Forschungsteilnehmer haben. Wenden Sie sich auch an das IRB, wenn Sie Fragen, Beschwerden oder Bedenken haben, die Sie Ihrer Meinung nach nicht mit dem Ermittler besprechen können. Das IRB der University of Rhode Island kann telefonisch unter (401) 874-4328 oder per E-Mail unter researchintegrity@etal.uri.edu erreicht werden. Sie können sich auch telefonisch unter (401) 874-4576 an den URI-Vizepräsidenten für Forschung und wirtschaftliche Entwicklung wenden. Wenn Sie eine Kopie dieses Dokuments für Ihre Unterlagen haben möchten, drucken oder speichern Sie diese Seite jetzt. Sie können sich auch an den Forscher wenden, um eine Kopie anzufordern.

Wenn Sie auf die Schaltfläche "Verstanden" unten klicken, geben Sie an, dass Sie mindestens 18 Jahre alt sind, einen gültigen Führerschein besitzen und die oben genannten Informationen gelesen und verstanden haben, und melden sich freiwillig zur Teilnahme an dieser Studie an.

☐ Verstanden

* Wenn Sie an der Verlosung des Amazon Gutscheins teilnehmen möchten, dann hinterlassen Sie bitte hier Ihre E-Mail Adresse. Wenn nicht, klicken Sie einfach auf Weiter.

(E-Mail-Adressen werden nur zur Auswahl des Gewinners verwendet. Sobald die Umfrage endet und der Gewinner ausgewählt wurde, werden alle E-Mail-Adressen gelöscht. Die Auswertung der Umfrageantworten erfolgt nach dem Löschen aller E-Mail-Adressen. E-Mail-Adressen werden auf einem passwortgeschützten Computer streng vertraulich und sicher behandelt und auch niemals an Dritte

verkauft oder verteilt. E-Mail-Adressen werden nicht mit Umfrageantworten verknüpft.

- ☐ Ich möchte an der Verlosung teilnehmen und hinterlasse meine E-Mail Adresse

- ☐ Weiter

Bitte geben Sie Ihr Alter an:

- ☐ < 20
☐ 20 - 30
☐ 30 - 40
☐ 40 - 50
☐ 50 - 60
☐ > 60

Bitte geben Sie Ihr Geschlecht an:

- ☐ M
☐ W
☐ Anderes

Bitte geben Sie Ihre Nationalität an:

- ☐ Deutsch
☐ Andere:

In welchem Bundesland ist Ihr derzeitiger Wohnsitz?

A dropdown menu with a list of German federal states. The list is as follows:

- Baden-Württemberg
- Bayern
- Berlin
- Brandenburg
- Hansestadt Bremen
- Hamburg
- Hessen
- Mecklenburg- Vorpommern
- Niedersachsen
- Nordrhein-Westfalen

Besitzen Sie ein eigenes Autos?

- ☐ Ich besitze ein eigenes Auto (Eigentümer)
- ☐ Ich lease ein Auto (Leasing, Firmenauto)
- ☐ Ich besitze kein Auto, aber nutze/leihe ein Auto von anderen
- ☐ Ich nutze kein Auto

Wie lange haben Sie Ihren Führerschein?

- ☐ < 1 Jahr
- ☐ 1 - 2 Jahre
- ☐ 2 - 6 Jahre
- ☐ > 6 Jahre

Wie lang ist Ihre tägliche Pendelstrecke? (hin und zurück)

- ☐ < 5 km
- ☐ 5 – 20 km
- ☐ 20 – 40 km
- ☐ 40 – 60 km
- ☐ > 60 km

Die folgenden Fragen beziehen sich auf teilweise automatisierte Fahrzeuge mit einem hohen Automatisierungsgrad. Die Definition für solche Fahrzeuge lautet:

„Ein Fahrzeug mit hoher Automatisierung ist so konzipiert, dass es alle Aspekte der Fahraufgabe erfüllt, auch wenn der menschliche Fahrer nicht angemessen auf die Aufforderung zum Eingreifen reagiert. Der Fahrer des Autos mit hoher Automatisierung kann nicht fahrende Aktivitäten ausführen (z. B. Antworten auf E-Mails, Betrachten von Landschaften, Lesen eines Buches), wenn das Fahrzeug die Kontrolle über alle Fahraufgaben hat. Der Automatisierungsmodus ist möglicherweise bei schlechten Wetterbedingungen (z. B. schweren Stürmen, Schnee) nicht geeignet und wird möglicherweise nur in bestimmten geografischen Gebieten unterstützt. Ein Fahrzeug mit hoher Automatisierung enthält weiterhin eine Lenkung und Pedale, damit ein menschlicher Fahrer bei Bedarf (z. B. im Notfall oder nach Wahl) die Kontrolle übernehmen kann.

☐ Weiter

Das Erlernen, von teilweise automatisierten Fahrzeugen wird mir leicht fallen

- ☐ Stimme voll zu
- ☐ Stimme etwas zu
- ☐ Enthalte mich
- ☐ Stimme eher nicht zu
- ☐ Stimme nicht zu

Ich werde es leicht finden teilweise automatisierte Fahrzeuge dazu zu bringen, das zu tun, was ich tun möchte

- ☐ Stimme voll zu
- ☐ Stimme etwas zu
- ☐ Enthalte mich
- ☐ Stimme eher nicht zu
- ☐ Stimme nicht zu

Es wird mir leicht fallen, teilweise automatisierte Fahrzeuge zu beherrschen

- ☐ Stimme voll zu
- ☐ Stimme etwas zu
- ☐ Enthalte mich
- ☐ Stimme eher nicht zu
- ☐ Stimme nicht zu

Ich werde es einfach finden, teilweise automatisierte Fahrzeuge zu bedienen

- ☐ Stimme voll zu
- ☐ Stimme etwas zu
- ☐ Enthalte mich
- ☐ Stimme eher nicht zu
- ☐ Stimme nicht zu

Die Verwendung von teilweise automatisierten Fahrzeugen reduziert meinen Fahrstress

- ☐ Stimme voll zu
- ☐ Stimme etwas zu
- ☐ Enthalte mich
- ☐ Stimme eher nicht zu
- ☐ Stimme nicht zu

Wenn ich teilweise automatisierte Fahrzeuge benutze, kann ich andere Aufgaben erledigen, z. B. Essen, einen Film ansehen oder mit dem Handy beschäftigt sein

- ☐ Stimme voll zu
- ☐ Stimme etwas zu
- ☐ Enthalte mich
- ☐ Stimme eher nicht zu
- ☐ Stimme nicht zu

Die Verwendung von teilweise automatisierten Fahrzeugen ist hilfreich, um meine Fahranforderungen zu erfüllen

- ☐ Stimme voll zu
- ☐ Stimme etwas zu
- ☐ Enthalte mich
- ☐ Stimme eher nicht zu
- ☐ Stimme nicht zu

Die Verwendung von teilweise automatisierten Fahrzeugen verringert mein Unfallrisiko

- ☐ Stimme voll zu
- ☐ Stimme etwas zu
- ☐ Enthalte mich
- ☐ Stimme eher nicht zu
- ☐ Stimme nicht zu

Ich habe Bedenken über die Unsicherheit der rechtlichen Verantwortung, wo das Fahrzeug in einer unvermeidbaren Unfallsituation die Entscheidung getroffen hat

- ☐ Stimme voll zu
- ☐ Stimme etwas zu
- ☐ Enthalte mich
- ☐ Stimme eher nicht zu
- ☐ Stimme nicht zu

Ich habe Bedenken über die Haftung, wenn durch ein teilweise automatisiertes Fahrzeug welches im Selbst-Fahrmodus fährt ein Unfall ausgelöst wird

- ☐ Stimme voll zu
- ☐ Stimme etwas zu
- ☐ Enthalte mich
- ☐ Stimme eher nicht zu
- ☐ Stimme nicht zu

Ich habe Bedenken über die Schwierigkeit angemessen zu reagieren, wenn während des Fahrens vermeidbare oder unerwartete Situationen auftreten

- ☐ Stimme voll zu
- ☐ Stimme etwas zu
- ☐ Enthalte mich
- ☐ Stimme eher nicht zu
- ☐ Stimme nicht zu

Ich habe Bedenken über die Schwierigkeiten bei der Interaktion mit herkömmlichen Fahrzeugen oder Fahrrädern auf der Straße

- ☐ Stimme voll zu
- ☐ Stimme etwas zu
- ☐ Enthalte mich
- ☐ Stimme eher nicht zu

☐ Stimme nicht zu

Ich habe Bedenken das teilweise automatisierte Fahrzeuge zu viele persönliche Informationen von mir sammeln

- ☐ Stimme voll zu
- ☐ Stimme etwas zu
- ☐ Enthalte mich
- ☐ Stimme eher nicht zu
- ☐ Stimme nicht zu

Ich habe Bedenken über das Auftreten von Systemversagen, von Systemfehlern oder von Problemen durch das Hacking

- ☐ Stimme voll zu
- ☐ Stimme etwas zu
- ☐ Enthalte mich
- ☐ Stimme eher nicht zu
- ☐ Stimme nicht zu

Ich habe Bedenken das teilweise automatisierte Fahrzeuge aufgrund der Installation elektronischer Features und intelligenter Systeme zusätzliche Kosten für den Neukauf eines Fahrzeugs verursachen

- ☐ Stimme voll zu
- ☐ Stimme etwas zu

- ☐ Enthalte mich
- ☐ Stimme eher nicht zu
- ☐ Stimme nicht zu

Ich bin besorgt über die erhöhten Kosten für den Betrieb und die Wartung eines teilweise automatisierten Fahrzeugs, wie z. B. System-Upgrades, Karten-Upgrades, Netzwerknutzungskosten, höhere Versicherungskosten usw.

- ☐ Stimme voll zu
- ☐ Stimme etwas zu
- ☐ Enthalte mich
- ☐ Stimme eher nicht zu
- ☐ Stimme nicht zu

Teilweise automatisierte Fahrzeuge verhindern Kollisionen zwischen Fahrzeugen und Fußgängern mithilfe von Umgebungserkennung, automatischer Steuerung usw.

- ☐ Stimme voll zu
- ☐ Stimme etwas zu
- ☐ Enthalte mich
- ☐ Stimme eher nicht zu
- ☐ Stimme nicht zu

Teilweise automatisierte Fahrzeuge reduzieren Ermüdung und Fahrschwierigkeiten aufgrund des Selbstfahrens und des Findens

des optimalen Weges

- ☐ Stimme voll zu
- ☐ Stimme etwas zu
- ☐ Enthalte mich
- ☐ Stimme eher nicht zu
- ☐ Stimme nicht zu

Teilweise automatisierte Fahrzeuge reduzieren Verkehrsstaus während der Pendelzeiten in bestimmten Bereichen

- ☐ Stimme voll zu
- ☐ Stimme etwas zu
- ☐ Enthalte mich
- ☐ Stimme eher nicht zu
- ☐ Stimme nicht zu

Teilweise automatisierte Fahrzeuge reduzieren Parkstress und -schwierigkeiten durch automatisches Einparken oder Einparkhilfe

- ☐ Stimme voll zu
- ☐ Stimme etwas zu
- ☐ Enthalte mich
- ☐ Stimme eher nicht zu
- ☐ Stimme nicht zu

Teilweise automatisierte Fahrzeuge sind zuverlässig

- ☐ Stimme voll zu
- ☐ Stimme etwas zu
- ☐ Enthalte mich
- ☐ Stimme eher nicht zu
- ☐ Stimme nicht zu

Insgesamt kann ich teilweise automatisierten Fahrzeugen und deren Technologie vertrauen

- ☐ Stimme voll zu
- ☐ Stimme etwas zu
- ☐ Enthalte mich
- ☐ Stimme eher nicht zu
- ☐ Stimme nicht zu

Die Verwendung von teilweise automatisierten Fahrzeugen ist eine kluge Idee

- ☐ Stimme voll zu
- ☐ Stimme etwas zu
- ☐ Enthalte mich
- ☐ Stimme eher nicht zu
- ☐ Stimme nicht zu

Die Verwendung von teilweise automatisierten Fahrzeugen ist angenehm

- ☐ Stimme voll zu
- ☐ Stimme etwas zu
- ☐ Enthalte mich
- ☐ Stimme eher nicht zu
- ☐ Stimme nicht zu

Ich gehe davon aus, dass ich in Zukunft teilweise automatisierte Fahrzeuge nutzen werde

- ☐ Stimme voll zu
- ☐ Stimme etwas zu
- ☐ Enthalte mich
- ☐ Stimme eher nicht zu
- ☐ Stimme nicht zu

Beim nächsten Autokauf, werde ich mir ein teilweise automatisiertes Fahrzeug kaufen

- ☐ Stimme voll zu
- ☐ Stimme etwas zu
- ☐ Enthalte mich
- ☐ Stimme eher nicht zu
- ☐ Stimme nicht zu

Was verursacht Ihrer Meinung nach die meisten Verkehrsunfälle?

- ☐ Geschwindigkeitsüberschreitung

- ☐ Abgelenktes Fahren
- ☐ Müdigkeit und Tagesschläfrigkeit
- ☐ Fahren unter Einfluss von Drogen/ Alkohol/ Psychoaktive Substanzen
- ☐ Wetterbedingungen
- ☐ Straßen-/ Infrastrukturbedingungen
- ☐ Technisches Versagen des Fahrzeugs

Bitte kreuzen Sie den Grad des automatisierten Fahrens an, den Sie zukünftig für Fahrzeuge bevorzugen würden, die Sie besitzen oder nutzen

- ☐ Level 0: Null Automatisierung. Ausführen aller Fahraufgaben durch den Fahrer (lenken, beschleunigen, bremsen usw.)
- ☐ Level 1: Das Fahrzeug wird vom Fahrer gesteuert, aber einige Fahrerassistenzsysteme können im Fahrzeug enthalten sein (z. B. Geschwindigkeitsüberwachung durch Tempomat).
- ☐ Level 2: Das Fahrzeug wird mit automatisierten Funktionen wie Beschleunigen, Lenken, Parken kombiniert, aber die dauerhafte Überwachung und Steuerung des Fahrzeugs verbleibt beim Fahrer
- ☐ Level 3: Der Fahrer muss die Umgebung nicht dauerhaft überwachen sondern muss nur bereit sein die Kontrolle zu übernehmen wenn dies erforderlich ist
- ☐ Stufe 4: Das Fahrzeug kann unter bestimmten Bedingungen alle Fahraufgaben selbst ausführen, der Fahrer hat aber die option einzugreifen
- ☐ Level 5: Vollautomatisierung. Das Fahrzeug ist in der Lage alle Fahraufgaben unter allen Bedingungen ohne menschliche Aufmerksamkeit auszuführen. Fahrerlos

Vielen Dank für die Teilnahme and dieser Forschungs Studie.

7.3 APPENDIX C – RECRUITMENT

Recruitment for the first run.

Win a \$20 Amazon Gift Card by

At the University of Rhode Island, we investigate driver acceptance of Partially Automated Vehicles with a high automation stage. Please help us to gather input about human understanding in order to gauge public opinion about the technology of Autonomous Driving.

This short survey is anonymous and will be treated confidentially. The survey will take 8 - 12 minutes. The winner will be contacted via email. The deadline for completion is April 25th, 2020 at 11:59 p.m.

Link for participation: [Qualtrics link](#)

Gewinnen Sie einen Amazon Gutschein im Wert 20€

An der University of Rhode Island untersuchen wir die Fahrerakzeptanz von teilweise automatisierten Fahrzeugen mit einem hohen Automatisierungsgrad. Bitte helfen Sie uns Informationen über das menschliche Verständnis zu sammeln, um die öffentliche Meinung über die Technologie des autonomen Fahrens einzuschätzen.

Diese kurze Umfrage ist anonym und wird vertraulich behandelt. Die Umfrage dauert 8 - 12 Minuten. Der Gewinner wird per E-Mail kontaktiert. Die Frist für die Fertigstellung endet am 25. April 2020 um 23:59 Uhr.

Link zur Teilnahme: [Qualtrics link](#)

Recruitment for the second run.

An der University of Rhode Island untersuchen wir die Fahrerakzeptanz von teilweise automatisierten Fahrzeugen mit einem hohen Automatisierungsgrad. Bitte helfen Sie uns Informationen über das menschliche Verständnis zu sammeln, um die öffentliche Meinung über die Technologie des autonomen Fahrens einzuschätzen.

Diese kurze Umfrage ist anonym und wird vertraulich behandelt. Die Umfrage dauert 8 - 12 Minuten. **Diese Umfrage ist nur für Personen ab einer Altersklasse von 40 Jahren.** Die Frist für die Fertigstellung endet am 05. Mai 2020 um 23:59 Uhr. Diese Studie wurde vom Institutional Review Board der University of Rhode Island genehmigt.

Link zur Teilnahme: [Qualtrics Link](#)

Translation

At the University of Rhode Island, we investigate driver acceptance of Partially Automated Vehicles with a high automation stage. Please help us to gather input about human understanding in order to gauge public opinion about the technology of Autonomous Driving.

This short survey is anonymous and will be treated confidentially. The survey will take 8 - 12 minutes. **This survey is only for people over 40 years of age.** The deadline for completion is May 5th, 2020 at 11:59 p.m. This Research has been approved by the University of Rhode Island Institutional Review Board

Link for participation: [Qualtrics Link](#)

Recruitment for the third run is similar to second run, only the time and the date have been changed.

7.4 APPENDIX D - IRB DOCUMENTS

7.4.1 IRB APPLICATION FORM

THE
UNIVERSITY
OF RHODE ISLAND
DIVISION OF RESEARCH
AND ECONOMIC
DEVELOPMENT

IRB
Application
Rev. March 2019

OFFICE OF
RESEARCH INTEGRITY

The University of Rhode Island (URI) Institutional Review Board (IRB) is under the governance of the Office of Human Subject Research Protection. The Office of Human Subject Research Protection (OHRP) is the federal agency under the Department of Health and Human Services (DHHS) responsible for implementing regulations (45 CFR 45) governing Biomedical, Behavioral and Social Sciences research involving human subjects. DHHS requires federally funded research to be monitored for compliance with its regulations by an Institutional Human Subject Research Protection Program. URI fosters a culture of compliance and requires all research involving humans, regardless of sponsorship, to comply with the regulations governing human subject research.

The protective oversight for human research activities are delegated to the IRB to assure compliance with the governing federal regulations for human subject research set forth by OHRP.

The IRB is charged with assuring that all human subject research, regardless of sponsorship, conducted at the URI complies with the federal regulations (45 CFR 46) of the Department of Health and Human Services (DHHS), Food and Drug Administration (FDA), the Belmont Report, State and Local Laws, and IRB policies and procedures.

All human subject research must be reviewed, prospectively approved and subject to continuing oversight (at least annually) by the IRB to assure the safety and welfare of research participants remains in compliance with governing federal regulations and guidance.

Research requiring Registration

Use this form to register research involving human subjects.
Human subject use may not proceed until authorization from the IRB is received.

Form Submittal

Submit via IRBNet the following:

- This IRB Application. Please try to limit your answers to the space provided. Upload separate document if you believe additional information is valuable to the committee (refer to specific questions you are addressing).
- Any attachments (e.g., appendices, consent form(s), assent form(s), flyers, etc.)
- CITI certification (Human Subjects Group 1 (Social Behavior)) for all key personnel (no more than 3 years old)
- Relevant thesis, dissertation, or grant proposals
- Signed Proposal Approval Signature Sheet, if part of a thesis/dissertations MA/PhD
- Student Assurance form. If graduate student will be using project data to complete a thesis/dissertation

Training

All faculty, staff, and students listed on the Protocol must complete the on-line training course at www.CITIprogram.org. Register as a new user and choose URI as your institution. Complete the Human Subjects Group 1 (Social Behavioral) course. The IRB Administrator will alert you if other training modules are also required.

Questions?

- Contact the Office of Research Integrity at 401-874-4328 or email: researchintegrity@etal.uri.edu
- For training materials on IRBNet or the Human Subject Research, refer to the Office of Research Integrity Website.

1

Add all documents checked in this list to IRBNet Package

Application Contents

Indicate the documents being submitted for this research project. Check all appropriate boxes.

- ☒ IRB Application of Human Subjects Research – REQUIRED FOR ALL NEW PROTOCOLS.
- ☒ CITI certification for all personnel – REQUIRED
- ☒ Consent form(s), Assent Form(s), Permission Form(s), and Verbal Scripts (including translated documents for all documents participants will see).
- ☐ Data Collection Form(s) for Investigator-Initiated Studies (Section 11)
- ☐ Data Collection Form(s) involving protected health information (Appendix N)
- ☐ Recruitment Materials (e.g., ads, flyers, telephone or other oral script, radio/TV scripts, internet solicitations)
- ☐ Script(s) or Information Sheets, including Debriefing Materials
- ☒ Instruments (e.g., questionnaires or surveys to be completed by participants) (Section 11)
- ☐ Other Committee Approvals/Letters of Support
- ☐ HIPAA Research Authorizer Form(s)
- ☒ Research Protocol of Proposal – Required for MA/PhD Students
- ☒ MA/PhD Proposal Approval Form – Required for MA/PhD Students
- ☐ Complete Grant Application or Funding Proposal, as applicable
- ☐ Drug Manufacturer's Approved Labeling/Investigator's Drug Brochure (Appendix F)
- ☐ Device Manufacturer's Approved Labeling (Appendix E)
- ☐ All other supporting documentation and/or materials

Appendices

If box is checked, appendix must be included in IRBNet Submission, package for processing.

☒ Appendix B: Expedited Review (See section 1)	☐ Appendix L: Prisoners (See section 14, pg. 12)
☐ Appendix C: Data Repositories (See section 11, Definition – Retain for future research)	☒ Appendix M1: Waiver or Alteration of Consent Process (See section 11 and section 18)
☐ Appendix D: Deception (See section 11)	☐ Appendix M2: Waiver of Signed Consent (See section 18)
☐ Appendix E: Devices (See section 11)	☐ Appendix N: Waiver of Alteration of HIPAA Research Authorization (See section 21)
☐ Appendix F: Drugs or Biologics (See section 11)	☐ Appendix O: Research in International Settings (See section 7)
☐ Appendix G: Genetic Testing (See section 11)	☐ Appendix P: Radiation (See section 11)
☐ Appendix H: Storage of Biological Materials (See section 14)	☐ Appendix Q: Adults with Decisional Impairment (See section 14)
☐ Appendix I: Minors (See section 14, 12)	☐ Appendix R: Change in Personnel (See section 2)
☒ Appendix J: Non-English Speaking Participants (See 14, pg. 12 and section 18, pg. 14)	☐ Appendix V: Unaffiliated Investigator Agreement
☐ Appendix K: Pregnant Woman/Fetuses/Neonates (See section 14, pg. 12)	☐ Appendix X: Conflict of Interest in HSR

Section 1 – Administration

Project Title

Create Project Short Title

Research Start Date: **Upon IRB Approval**

I would like to defer the start date of my research to:
(May be no more than 1 year)

Anticipated Research End Date (should be ≥ 1 year):

Select level of review that applies to this project: ☐ Full ☒ Expedited $\rightarrow$ Complete Appendix B

Exempt Review: To qualify, research must fall into six (6) federally-defined exempt categories. If proposing Exempt research, complete the **Exempt Research Form**. Do not complete this form.

Section 2 – Personnel – List all personnel associated with the project

Principal Investigator (PI)

Principal Investigator must be URI Faculty or Staff

Name

College

Email

Department

Position
Number

Phone

If Non-URI check box ☐

If Non-URI: Name of
Institution

If Non-URI and Investigator's Institution does not have an FWA #, submit Appendix V - Unaffiliated Investigator Agreement in IRBNet Package

Co-Investigator

Students may not be Co-Investigators

Name

College

Email

Department

Position
Number

Phone

If Non-URI check box ☐

If Non-URI: Name of
Institution

If Non-URI and Investigator's Institution does not have and FWA #, submit Appendix V - Unaffiliated Investigator Agreement in IRBNet Package.

Co-Investigator

Students may not be Co-Investigators

Name	<input type="text"/>	College	<input type="text" value="Choose from list:"/>
Email	<input type="text"/>	Department	<input type="text"/>
Position Number	<input type="text" value="Choose from list:"/>	Phone	<input type="text"/>

If Non-URI check box ☐ If Non-URI: Name of Institution

If Non-URI and Investigator's Institution does not have and FWA #, submit Appendix V - Unaffiliated Investigator Agreement in IRBNet Package.

MA/PhD Researcher

Name	<input type="text" value="Sergio Bujanov"/>	College	<input type="text" value="Engineering"/>
Email	<input type="text" value="s.bujanov@tu-bs.de"/>	Department	<input type="text" value="Mechanical, Industrial and Systems Engineering"/>
Position Number	<input type="text" value="Graduate Student"/>	Phone	<input type="text" value="401.212.1569"/>

If Non-URI check box ☐ If Non-URI: Name of Institution

If Non-URI and Investigator's Institution does not have and FWA #, submit Appendix V - Unaffiliated Investigator Agreement in IRBNet Package

Will this project be used as a thesis or dissertation proposal ☒ Yes
☐ No

If Yes, Please submit

- Signed MA or PhD Proposal Approval Form
- Proposal Document

Other Key Personnel

Responsibilities

Name	Position	Non-URI	Consent Subject	Recruit	Protocol Design	Data Analysis	Intervention
<input type="text"/>	<input type="text" value="Choose from list:"/>	☐	☐	☐	☐	☐	☐
<input type="text"/>	<input type="text" value="Choose from list:"/>	☐	☐	☐	☐	☐	☐
<input type="text"/>	<input type="text" value="Choose from list:"/>	☐	☐	☐	☐	☐	☐
<input type="text"/>	<input type="text" value="Choose from list:"/>	☐	☐	☐	☐	☐	☐

<input type="text"/>	Choose from list:	☐	☐	☐	☐	☐	☐
----------------------	-------------------	--------------------------	--------------------------	--------------------------	--------------------------	--------------------------	--------------------------

Key personnel are defined as individuals who participate in the design, conduct or reporting of human subjects research. At a minimum, include individuals who recruit participants, obtain consent or who collect study data.

Section 3 – Education

Educational requirements (initial and continuing) must be satisfied prior to submitting the application for IRB review. See [Human Subjects Protection Training](#) or contact ORI for more information.

Have all University of Rhode Island investigators and key personnel completed the required web-based course (CITI) for Human Subject Research, Group 1 (Social Behavioral). ☒ Yes ☐ No Attach PDF of CITI Training Certificate for all personnel listed.

If this research meets the definition of a clinical trial, "A research study in where one or more human subjects are prospectively assigned to one or more research interventions", one of the following must be completed by all investigators: GCP – Social and Behavioral Research Best Practices for Clinical Research, GCP for Clinical Investigations of Devices, or GCP for Clinical Trials with Investigational Drugs or Biologics (ICH Focus).

☐ Yes ☒ No Attach PDF of CITI Training Certificate for all personnel listed.

Section 4 – Financial Conflict of Interest (FCOI)

A financial conflict of interest may exist whenever financial considerations or publication rights have the potential to compromise or have the appearance of compromising one's professional judgement and independence in the design, conduct or publication of research.

The IRB considers the investigator's financial interests when evaluating the protection of human subjects. If a financial interest is reported, the IRB will assess the investigator's objectivity in:

- Communicating Risks
- Selecting Subjects
- Promoting informed consent
- Gathering, analyzing, and reporting data

Does any University of Rhode Island investigator (including principal or co-investigator), key personnel, or their immediate family members have a financial interest (including salary or other payments for services, equity interests, or intellectual property rights) that would reasonable appear to be affected by the research, or a financial interest in any entity whose financial interest would reasonable appear to be affected by the research?

☐ Yes → Complete Appendix X – Conflict of Interests in Human Subjects Research

☒ No

Section 5 – Funding or Other Support

If the research is federally funded and involves a subcontract to or from another entity, an IRB Authorization Agreement may be required. Contact ORI for more information.

- a. Is the research funded or has funding been requested? ☐ Yes ☒ No

If Yes → Specify funding agency and support:

☐ By checking this box, you have provided a copy of the grant application or funding proposal in your IRBNet submission package. The university is required to verify that all funding proposals and grants (new or renewals) have been reviewed by the IRB before funds are awarded.

- b. Is any support other than monetary (e.g., drugs, equipment, etc.) being provided for the study?

☐ Yes ☒ No

If Yes → Specify provider or agency and support:

Section 6 – Other Institutional Approvals

Check all that apply and provide applicable documentation. **IRB review cannot be conducted until required institutional approvals or exemptions are obtained, except as noted.**

☐ [Institutional Biosafety Committee \(IBC\)](#) – Approval required for research activity involving:

- Recombinant DNA (rDNA)
- Biological agents (e.g., viable infectious microorganisms (including prions) regardless of their pathogenicity to humans)
- Human or nonhuman primate materials (e.g., blood, unfixed tissue, cell lines, finger sticks and blood draws)
- Biological toxins subject to the National Select Agents Registry Program managed by the U.S. Departments of Health and Human Services (HHS) and Agriculture (USDA).

☐ [Conflict of Interest Management Committee \(CIMC\)](#) – CIMC is responsible for the review and assessment of all financial disclosures related to research projects at URI and for determining any actions required to ensure that real or perceived financial conflicts of interest are managed or eliminated.

☒ None

Section 7 – Location of Research

- a. List the **URI specific site(s)** at which the research will be conducted

Location Name (or description)	Address
College of Engineering	45 Upper College Rd, Kingston, RI 02881, United States

Research to be conducted outside of URI's facilities will minimally require a **LETTER OF AUTHORIZATION** (on institutional letterhead) and may require another IRB's approval if personnel are engaged. See OHRP Engagement Guidance or contact ORI for more information.

- b. Location of Non-URI Research? ☐ Domestic Sites - Upload a letter of authorization, on institution letterhead, as applicable
☐ International Sites – Upload a letter of authorization, on institution letterhead and :
Complete Appendix O – Research in International Setting
- c. List the **non-URI specific site(s)**.

Location Name (or description)	Address

Has a letter of authorization for each non-URI site been uploaded to IRBNet? ☐ Yes ☐ No

d. Are there multiple PIs at different sites? ☐ Yes ☒ No

A multi-site project involves additional principal investigator(s) overseeing sites external to URI.

If Yes, complete the following:

- Is an institutional IRB agreement (IAA) requested or in process for this protocol? ☐ Yes ☒ No

If Yes, please elaborate.

- Describe the communication between sites that might be relevant to the protection of participants, such as unanticipated

blems, interim results, and protocol modifications.

- Describe IRB oversight arrangements for each collaborative site (i.e., who will provide IRB review and approval). Upload copies of the non-URI approvals, as applicable. Contact ORI if requesting that University of Rhode Island serves as the IRB

ecord.

Have IRB approvals included? ☐ Yes ☐ No

Section 8 – Summary of Research

Summarize the proposed research using non-technical language that can be readily understood by someone outside the discipline. Explain briefly (no more than 2 or 3 paragraphs) the:

- Research design (e.g., cross-sectional, case-control, cohort, randomized controlled trial, crossover, etc.)
- Procedures to be used with a focus on human subject interactions

- Risks and anticipated benefits for the subjects
- The importance of the knowledge that may reasonably be expected to result.

Use complete sentences.

The study is divided in two parts, part A and part B. Part A consists of conducting an online questionnaire survey created with the online software Qualtrics, to which URI subscribes. The questions of the survey are based on a current literature review and should contribute to understand societal acceptance in terms of partially automated vehicles. The survey will be provided in English for the US citizens and in German for the German citizens. The online survey will be spread out via link in different places e.g. university and will be provided to the participants. Because human test subjects are involved in this experiment the study must be approved by the URI IRB. Participation in this study is completely voluntary and answers will be collected anonymously. Names of the respondents will not be requested. Information and answers will be kept strictly confidential.

At the end of the survey, the collected data is evaluated, analyzed and stored on password protected computers in secured offices of the University of Rhode Island. Third parties are not involved and the collected data will not be passed to third parties. Participants who decide to participate in this survey may cancel it at any time without giving a reason. The online survey will compare demographic characteristics of gender, age, and nationality. It is planned to collect data from 100 persons from each country in order to achieve an accurate sample and analyze how people accept the technology. The sample is limited to citizens from New England, a region that is not specifically associated with car manufacturing and citizens from lower Saxony where car manufacturing is prevalent.

The IRB application form for the driving simulator pilot tests in Part B of this research will be submitted in March as soon as the capabilities of the driving simulator are better known. An exact experiment design will be explained in an amendment to the IRB application.

Section 9 – Scientific Background & Literature Review

Summarize existing published knowledge and previous work that support the expectation of obtaining useful results without undue risk to human subjects. Explain briefly (no more than 2 or 3 paragraphs). *Use complete sentences.*

Through the advanced development of automotive technology, autonomous driving is becoming more and more popular and has already affected the political, economic, industrial and social spheres despite the remaining obstacles preventing its complete spread. (Montoro et al., 2019). Fully autonomous vehicles (AVs) are still not allowed to operate in most locations, but some vehicles are already equipped with hardware that would theoretically allow them to operate autonomously. (Richter, 2019). The National Highway Traffic Safety Administration predicts that the years 2016 to 2025 and beyond will see a progression through various levels of partially automated safety features that move the technology towards fully automated vehicles (NHTSA, 2019). The levels, as defined by the Society of Automotive Engineers (SAE) are:

SAE Level 0 – no automation – the driver performs all driving tasks

SAE Level 1- driver assistance – the driver controls the vehicle, with some assist features

SAE Level 2 – partial automation – driver must remain engaged in driving task at all times

SAE Level 3 – conditional automation – drivers are necessary to take control if needed

SAE Level 4 – high automation – the vehicle performs all driving tasks in certain conditions

SAE Level 5 – full automation – the vehicle is capable of performing all driver tasks

While fully AVs with a SAE-Level 4 and 5 are not yet available for purchase, except for particular trials in closed environments with a trained driver behind the wheel, automated vehicles with Advanced Driver Assistance Systems (ADASs) e.g. Adaptive Cruise Control (ACC), Lane Keeping Assistance (LKA) or Automated-Parking Assist (APA) are already available for consumers. Several original equipment manufacturers (OEMs) including Tesla, Audi, BMW, Kia, Nissan and Mercedes Benz already have vehicles with SAE- Level 2 for sale (Hardman, Lee, & Tal, 2019). Vehicles with SAE- Level 3 are not far from penetrating the market and are expected soon (Zhang et al., 2019). It is also estimated that by 2030 in Europe, cars with SAE-Level 5 may represent more than 30% of the automotive fleet on road. A survey with 7,755 respondents from 116 countries about the acceptance of AVs has shown that the participants would enjoy taking a ride in a driverless vehicle. In the year 2022, in the European Union and the US all new vehicles will be assisted by automated features, such as ACC, LKA, APA or Autonomous Emergency Braking (AEB). (Nordhoff, Winter, & Kyriakidis, 2018).

On the one hand, the technology is still in development in order to complete its tasks 100% reliable. On the other hand, if an accident occurs with an AV on road the incident cannot be eliminated, then there may be human skepticism and low trust in technology. There are several examples e.g. in 2018 a Tesla Model S in "Autopilot" mode crashed into the back of a fire truck; several months later in Arizona a pedestrian was killed by an Uber car operating in self-driving mode. Such accidents increased the public's concern and reduced trust in AVs (Rhim, Lee, & Lee, 2020).

(Zhang et al., 2019) has shown that initial trust is the most critical factor in order to promote a positive attitude towards AVs. The results also show by improving perceived usefulness (PU) and reducing perceived safety risks (PSR) the initial trust could be enhanced.

Different studies have already agreed that autonomous vehicles will transform transportation. Recent studies have also identified that the technology will be associated with several benefits which will be profitable for humans worldwide. Potential benefits of AVs consist of crash prevention, enhanced mobility for people who cannot drive due to age or disabilities, emission reduction and increased safety for cyclists and pedestrians. Nowadays, ADAS technology in motor vehicles already helps to save lives and prevent injuries (NHTSA, 2019). The constant evolution of vehicle safety systems contributes to significant decreases of accidents, deaths and injuries on the road (Montoro et al., 2019).

AVs will also offer sustainable profits to the community, we can include better transport dynamization. AVs increase the driver's safety and extensively decrease injuries and deaths caused by human-factor-related accidents (Pettigrew, Dana, & Norman, 2019).

Section 10 – Research Objectives

List the specific scientific or scholarly aims of the research study. Explain briefly (no more than 2 or 3 paragraphs). Use complete sentences.

This study will focus on vehicles where some automation features are present, but the system still relies on a driver who may need to takeover in response to a critical event, namely SAE- Levels 1-4. The goal of this Takeover Readiness for Partially Automated Vehicles project is to provide a

comprehensive approach to understand, assess and evaluate driver interaction with ADASs. This study will survey the public from the United States and Germany to gauge their readiness and acceptance for the technology, as well as baseline knowledge of and usage of existing ADAS technology.

The specific objective of this study is to gauge driver acceptance for partially automated vehicles and takeover readiness when using ADASs in a driving simulator.

- To what extent are individuals ready to accept partially-automated vehicles from two different countries?

- What are barriers for acceptance and what do people consider as benefits of the technology of automated vehicles ?

- Is there a significant difference in acceptance and trust between people who are familiar with the technology and people who are not familiar with the technology ?

- What are the baseline conditions of driver knowledge of and usage of ADASs ?

- How do drivers perform in controlled studies that simulate ADASs, and how ready are they to take control of a (simulated) vehicle if conditions change ?

- What kind of ADASs can be programmed and simulated in the driving simulator at URI?

- What measurements can be used to assess driver performance with ADASs, including driving simulator performance reports, and pre- and post- perceptions of test subjects who use ADASs, possibly for the first time ?

Section 11 – Research Methods & Activities

- a. Identify and describe all interactions and interventions (if applicable) that are to be performed solely for the research study. Distinguish research (e.g., observational, experimental) activities from non-research activities. *Provide descriptions (e.g., spreadsheet, forms, or flow charts) of data being collected if appropriate. Do not include case report forms for multi-site industry-sponsored or cooperative group studies.*

The study is divided in two parts, part A and part B. Part A consists of conducting an online questionnaire survey created with the online software Qualtrics, to which URI subscribes. The questions of the survey are based on a current literature review and should contribute to understand societal acceptance in terms of partially automated vehicles. The survey will be provided in English for the US citizens and in German for the German citizens. The online survey will be spread out via link in different places e.g. university and will be provided to the participants. Because human test subjects are involved in this experiment the study must be approved by the URI IRB. Participation in this study is completely voluntary and answers will be collected anonymously. Names of the respondents will not be requested. Information and answers will be kept strictly confidential.

At the end of the survey, the collected data is evaluated, analyzed and stored on password protected computers in secured offices of the University of Rhode Island. Third parties are not involved and the collected data will not be passed to third parties. Participants who decide to participate in this survey may cancel it at any time without giving a reason. The online survey will compare demographic characteristics of gender, age, and nationality. It is planned to collect data from 100 persons from each country in order to achieve an accurate sample and analyze how people accept the technology. The sample is limited to

citizens from New England, a region that is not specifically associated with car manufacturing and citizens from lower Saxony where car manufacturing is prevalent. Part B is to determine how far the driving simulator can be equipped with ADASs. Currently, no ADASs on the driving simulator are possible or available. Therefore exploring the associated hardware and software is necessary in order to find out which possibilities exist in terms of modeling ADASs on the driving simulator and scenario programming. After determining to what extent ADASs are possible to replicate in the driving simulator, a second survey with pilot tests will take place. The proposed approach is to examine how quickly drivers of a partially automated vehicle can intervene in operating a simulated vehicle, from the moment that they detect a critical event or takeover condition on the road or its surroundings. The approach aims to determine whether the driver is ready to intervene and whether the potential intervention increases the safety of driving. To check driver readiness, a blocked factorial experiment will be implemented with test subjects sitting on the driver's seat of a driving simulator. Scenarios and instruments will be programmed to allow the driving simulator to mimic a partially automated vehicle. The experimental design allows a complete analysis of each subject's performance under different conditions with different forms of stimuli. It is envisioned that the partially-automated vehicle will cruise through a virtual city with pedestrians and cars, where the test subject will be confronted with a dangerous and unexpected situations, such as a car that suddenly crosses the road, a sudden stop of the preceding vehicle, etc. Such dangerous situations require the test subject, who is in the simulator, to quickly and actively intervene in the driving process and take control of the driving until the situation is over.

The proposed experiments will employ an L3 Communications MPRI driving simulator, as seen in Figure 3. All experiments are carried out in the Driving Simulation Lab of the University of Rhode Island (URI). The TranSim VS IV driving simulator offers a highly precise real driving environment that can be adapted to different applications and hazardous situations in the form of scenarios and environments. In this way, the simulator exhibits the look and feel of a real vehicle within a laboratory. This structure is intended to convey the feeling of real driving to the subjects. The driving simulator will be retro-fitted to mimic a partially automated vehicle with ADAS devices. It is planned to place the test subject in the driving simulator with different levels of vehicle automation while exposing the subject to a set of challenging situations in a controlled environment, presented in a randomized manner. Adaptable scenarios also make it possible to simulate different situations on the road under relatively realistic conditions. It is possible to expose all test subjects to the same scenarios and circumstances and thus establish comparability. The users of the simulator interact with it via an integrated steering wheel, accelerator pedal, and brake pedal of a real vehicle. The test subjects' driving decisions are transmitted in real time to the control computers.

The results of this experiment will measure the readiness of drivers to take control of a partially automated vehicle. It will also help identify the factors and their interactions with the greatest influence on driving behavior. Because human test subjects are involved in this experiment the study must be approved by the URI IRB. The IRB application form for the driving simulator pilot tests in Part B of this research will be submitted in March as soon as the capabilities of the driving simulator are better known. An exact experiment design will be explained in an amendment to the IRB application.

b. Check all research activities that apply:

General Research	
☐ Data repositories → Complete Appendix C – Data Repositories (future unspecified use, including research databases)	☐ Program Protocol (Umbrella Protocol)
☐ Randomization	☐ Clinical Trial

Social / Behavioral Research	
☐ Audio, video, digital, or image recordings	☐ Data, publicly available (Provide source below)
☐ Deception → Complete Appendix D - Deception & M1 – Waiver or Alteration of Consent Process	Provide source: <input type="text"/>
☐ Diet, exercise, sleep modifications or assessment	☐ Data, not publicly available (Provide source below)
☐ Focus Groups	Provide source: <input type="text"/>
☐ Health related intervention prospectively assigned	☒ Surveys, questionnaires, or interviews (one-on-one)
☒ Internet or e-mail collection	☐ Surveys, questionnaires, or interviews (group)
☐ Materials that may be considered sensitive, offensive threatening or degrading	☒ Observation of participants (including field notes)
	☐ Other → Specify: <input type="text"/>

Bio/Medical Research	
☐ Biohazards (e.g., rDNA, infectious agents, select agents, toxins) – IBC Approval Required	☐ Non-invasive medical procedures (e.g., EKG, Doppler)
☐ Biological sampling (other than blood) – IBC Approval Required	☐ Pregnancy Testing
☐ Blood drawing – IBC Approval Required	☐ Radiation (e.g., CT or DEXA scans, X-rays, nuclear medicine procedures) → Complete Appendix P - Radiation

☐ Clinical Trial	☐ Record Review – If HIPAA, include Appendix N – Waiver or Alteration of HIPAA Research Authorization
☐ Devices → Complete Appendix E – Devices	☐ Specimen Research
☐ Drugs or biologics → Complete Appendix F – Drugs or Biologics	☐ Stem Cell Research – IBC Approval Required
☐ Food Supplements	☐ Storage of Biologic Materials → Complete Appendix H – Storage of Biologic Materials & Appendix C – Data Repositories
☐ Genetic Testing → Complete Appendix G – Genetic Testing	☐ Surgical Procedures (including biopsies or other invasive medical procedures)
☐ Magnetic Resonance Imaging (MRI)	☐ Other → Specify

Section 12 – Duration

Estimate the time (i.e., minutes, hours) required from each participant, including individual interactions, total time commitment, and long-term follow-up, if any. (If complicated design, please attach a flowchart).

The online survey will take 5 - 10 minutes

Section 13 – Number of Participants

The number of participants is defined as the number of individuals who agree to participate (i.e., those who provide consent or whose records are accessed, etc.) even if all do not prove eligible or complete the study. The total number of research participants may be increased only with prior IRB approval.

- a. Provide the number of participants (or number of participant records, specimens, etc.) for whom you are seeking URI IRB approval.

200

- b. Explain how this number was derived and provide details, such as sample size calculation, convenience sample, pilot study, saturation estimation or other. **This must be consistent across all documents.**

Section 14 – Participation Population

- a. Specify the age range(s) of the individuals who may participate in the research: **This must be consistent across all documents.**

18 and older

b. Specify the participant population(s). Check all that apply:

☒ Adults	☐ Pregnant women/fetus → Complete Appendix K – Pregnant Women, Fetuses, Neonates
☐ Children (< 18 years) → Complete Appendix I – Minors	☐ Neonates (uncertain viability/nonviable → Complete Appendix K – Pregnant Women, Fetuses, Neonates
☐ Adults with decisional impairment → Complete Appendix Q – Adults with Decisional Impairment	☐ Prisoners → Complete Appendix L – Prisoners
☒ Non-English speaking → Complete Appendix J – Non-English Speaking Participants	☐ Unknown (e.g., secondary use of data/specimens, non-targeted surveys, program protocols)
☐ URI students (e.g., psychology, linguistics, non-targeted surveys, program protocols) →	Specify: <input type="text"/>

c. Describe the characteristics of the proposal participants, and explain how the nature of the research requires/justifies their inclusion.

d. Will any participants be excluded based on age, gender, race/ethnicity, pregnancy status, language, education or financial status? ☒ Yes ☐ No

only English or German speaking adults should respond to the online survey

If Yes → Explain the criteria and reason(s) for each exclusion. *Consider the study's scientific or scholarly aims and risks.*

e. Are any of the participants likely to be vulnerable to coercion or undue influence? ☐ Yes ☒ No. *This includes students, employees, terminally ill persons, or others who may have limited autonomy?*

If Yes → Describe additional safeguards to protect participants' rights and welfare. *Consider strategies to ensure voluntary*

participation.

Section 15 – Participation Identification, Recruitment, and Selection

- a. Provide evidence that you will be able to recruit the necessary number of participants to complete the study.

Investigator will provide the online survey via link.

Please consider completing a survey that graduate student Sergio Bujanov is conducting as part of a research study at the University of Rhode Island. (link to Qualtrics survey here)

Win an Amazon \$20 Voucher

by completing the survey about Partially Autonomous Vehicles and Advanced Driver Assistance Systems by Mar. 15th

Win an Amazon 20\$ Voucher! Complete this short URI survey about Autonomous Vehicles and Advanced Driver Assistance Systems for a chance to win \$20 from Amazon.

At the University of Rhode Island, we investigate the driver acceptance of partially automated vehicles in order to assess public opinion about the technology of autonomous transportation. Please help us gather input about human understanding of advanced automated features in vehicles.

The short survey is anonymous. The survey will take less than 10 minutes. After the survey closes, if you choose to provide an email address, one respondent will be drawn at random to win a \$20 Voucher from Amazon. We will contact the winner via email.

Click here to open the survey. The deadline for completion is Mar. 15th, 2020 at 11:59 p.m.

On behalf of the University of Rhode Island; Department of Mechanical, Industrial and Systems Engineering, thank you for your time.

- b. Describe how potential participants will be identified (e.g., advertising, individuals known to investigator, record review, etc.).

survey will be distributed through email and social media to individuals known to the investigator and to networks of those individuals

Explain how investigator(s) will gain access to this population, as applicable.

Participants only need to have a valid drivers license and must be at least 18 year old.

- c. Describe the process that will be used to determine participant eligibility. Upload recruitment scripts to IRBNet.

Investigator will provide the Link in different places e.g. University, Friends, Whatsapp Groups.

- d. Describe the recruitment process; including the setting in which recruitment will take place.

Are copies of proposed recruitment materials and guidelines (e.g., ads, flyers, website postings, recruitment letters, and oral/written scripts) uploaded onto IRBNet? ☒ Yes ☐ No

Participation in this study is completely voluntary. Participants can stop any time. All information and collected data subjects will be kept confidential in a protected computer stored in a locked URI office. No other personnel will be allowed to see the data.

e. Explain how the process respects potential participants' privacy.

Section 16 – Incentives to Participate

Will participants receive compensation or other incentives (e.g., free services, cash payments, gift certificates, parking, classroom credit, travel reimbursement) to participate in the research study? Compensation plans should be pro-rated (not contingent upon study completion) and should consider participant withdrawals, as applicable. ☒ Yes ☐ No

Among all participating individuals who finish the survey and choose to provide an email address, one \$20 Amazon Gift Voucher will be raffled off.

If Yes
→
Describe
the

incentive, including the amount and timing of all payments.

Section 17 – Alternatives to Study Participation

Other than choosing not to participate, list any specific alternatives, including available procedures or treatments that may be advantageous to the subject. If giving student credit for participation, there needs to be a time equivalent alternative.

N/A

Or
☐

Section 18 – Informed Consent Process

Indicate the consent process(es) and document(s) to be used in the study. Check all that apply. Upload copies of consent forms, documents and/or complete relevant appendices, as needed, to IRBNet.

☐ Assent – Form	☐ Parental Permission - Form
☐ Assent – Oral Script	☐ Parental Permission – Oral Script → Complete Appendix

☐ Written Consent – Form	☐ Translated Consent/Assent – Form(s) → Complete Appendix J – Non-English Speaking Participants
☐ Oral Script → Complete Appendix M2 – Waiver of Signed Consent	☒ Waiver or Alteration of Consent Process → Complete Appendix M1 – Waiver or Alteration of Consent Process
☒ Consent – Online	☐ Waiver of Signed Consent → Complete Appendix M2 – Waiver of Signed Consent

- a. Describe the consent process. Explain when and where consent will be obtained and how subjects and/or their legally authorized representatives will be provided sufficient opportunity (e.g., waiting period, if any) to consider participation. **Will a teach-back method be utilized? A teach-back method is a confirmation procedure to check to see if a participant understands what they are consenting.** ☒ Yes ☐ No or ☐ N/A

Consent form will be provided before starting the survey. Participants who choose to continue with the survey will indicate their consent by clicking a button on the screen.

Participation in this study is completely voluntary, and participants can choose not to participate or to stop the survey at any time.

- b. Explain how the possibility of coercion or undue influence will be minimized in the consent process.

Or ☐ N/A

- c. Will any other tools (e.g., quizzes, visual aids, information sheets) be used during the consent process to assist participant comprehension? ☐ Yes ☒ No
If Yes → Upload copies of these forms to IRBNet.

- d. Will any other consent forms be used (e.g., for clinical procedures such as MRI, surgery, etc. and/or consent forms from other institutions)? ☐ Yes ☒ No
If Yes → Upload copies of these forms to IRBNet.
Also If Yes → Indicate if another IRB has approved them and which one(s). Indicate that approval is pending if that is the case.

Section 19 – Privacy of Participants

Survey results will be treated with care to maintain the confidentiality of the subjects. The data pertaining to subjects and their answers will be stored on password protected computers and kept in secured offices located in College of Engineering, 45 Upper College Rd, Kingston, RI

02881, Research Laboratory 367.

- a. Describe the provisions to protect the privacy interests of the participants. *Consider the circumstances and nature of information to be obtained, taking into account factors (e.g., age, gender, ethnicity, education level, etc.) that may influence participants' expectations of privacy.*
- b. Does the research require access to personally identifiable private information? ☐ Yes ☒ No
If Yes → Describe the personally identifiable private information involved in the research. List the information source(s) (e.g.,

educational records, surveys, medical records, etc.)

Section 20 – Confidentiality of Data

- a. Explain how information is handled, including storage security measures (as necessary), and who will have access to the information. Include both electronic and hard copy records. **Methods for handling and storing data (including the use of personal computers and portable storage devices) must comply with university policies. Please include URI Building & Room Location. Note: paper copies of informed consent forms must be stored ON CAMPUS.**
Explain here:

ASurvey results will be treated with care to maintain the confidentiality of the subjects. The data pertaining to subjects and their answers will be stored on password protected computers and kept in secured offices located in Colledge of Engineering, 45 Upper Colledge Rd, Kingston, RI 02881, Research Laboratory 367.

N/A

Or ☐

- b. Explain if any personal or sensitive information that could be potentially damaging to participants (e.g., relating to illegal behaviors, alcohol or drug use, sexual attitudes, mental health, etc.) will be collected. Indicate when data will be destroyed and how.
Explain here:

Or ☒ N/A

- c. Will you be obtaining an NIH Certificate of Confidentiality?
☐ Yes ☒ No If Yes → Upload a copy to IRBNet when Certificate of Confidentiality is issued

- d. Explain any circumstances (ethical or legal) where it would be necessary to break confidentiality. Explain here:

Or ☐ N/A

- e. Indicate what will happen to identifiable data at the end of the study. Research data should be retained for a minimum of **three years** after final project closeout, **five years** if **FDA Study**. Usually only one of these apply unless necessary based on research design.

- ☐ Identifiable data will not be collected
- ☒ Identifiers will be permanently removed from the data and destroyed (resulting in de-identified data)
- ☐ Identifiable or coded/linked data will be retained and stored securely (as appropriate)
- ☐ Identifiable data will be retained and may be made public with participant consent (e.g., ethnographic research)

Section 21 – HIPAA Research Authorization

Will individually identifiable Protected Health Information (PHI) subject to the [HIPAA Privacy Rule](#) requirements be accessed, used or disclosed in the research study? ☐ Yes ☒ No

If Yes → Check all that apply:

- ☐ Written Authorization → Provide a copy of the Authorization Form
- ☐ Partial Waiver (recruitment purposes only) → **Complete Appendix N – Waiver or Alteration of HIPAA Research Authorization**
- ☐ Full Waiver (entire research study) → **Complete Appendix N – Waiver or Alteration of HIPAA Research Authorization**
- ☐ Alteration (written documentation) → **Complete Appendix N – Waiver or Alteration of HIPAA Research Authorization**

Section 22 – Reasonably Anticipated Benefits

- a. List the potential benefits that participants may expect as a result of this research study. State if there are no

The participants have the chance to win one \$20 voucher from Amazon.

direct benefits to individual participants. **Compensation is not to be considered a benefit.**

- b. List the potential benefits that society and/or others may expect as a result of this research study.

The results can be important for stakeholders or car manufacturers in order to provide the automotive technology in the way the society want. Furthermore, through the results it can be identified how comfortable society is with the technology and how the society accepts the technology.

Section 23 – Risks, Harm & Discomforts

- a. Describe all reasonable expected risks, harms and/or discomforts that may apply to the research. Discuss severity and likelihood of occurrence. As applicable, include potential risks to an embryo or fetus if a woman is or may become pregnant. *Consider the range of risks, including physical, psychological, social, legal and economic. All research involves at least minimal risk.*

There are no expected risks, harms, and discomforts that may apply to the survey

- b. Describe how risks, harms and/or discomforts will be minimized. *If testing will be performed to identify individuals who may be at increased risk (e.g., pregnant women, individuals with HIV/AIDS, depressive disorders, etc.), address timing and*

Since there are no expected risks, harms, and discomfort that may apply to the survey, there are no processes needed to minimize them.

method of testing; include how positive test results will be handled.

Section 24 – Monitoring

Does the research involve greater than minimal risk (i.e., are the harms or discomforts described in Section 22 beyond what is ordinarily encountered in daily life or during the performance of routine physical or psychological tests)? ☐ Yes ☒ No

If Yes → Describe the plan to oversee and monitor data collected to ensure participant safety and data integrity. Include the following:

- The information that will be evaluated (e.g., incidence and severity or actual harm compared to that expected)
- Who will perform the monitoring (e.g., investigator, sponsor, or independent monitoring committee)
- Timing of monitoring (e.g., at specific points in time, after a specific number of participants have been enrolled)
- Decisions to be made as a result of the monitoring process (e.g., provisions to stop the study early for unanticipated problems).

Section 25 – Assessment of Risks vs. Benefits

Discuss how risks to participants are reasonable when compared to the anticipated benefits to participants (if any) and the importance of the knowledge that may reasonably be expected to result.

* Must be answered by all researchers

There are no risks.

Section 26- Participant Costs/Reimbursements

- a. List any potential costs participants (or their insurers) will incur as a result of study participation (e.g., parking, study drugs, diagnostic test, etc.)

For participants no costs occur.

- b. List any costs to participants that will be covered by the research study.

Among all participated individuals who completed the survey and choose to provide an email address, one \$20 Amazon Gift Voucher will be raffled off.

Assurance – Certifications and Endorsements by Principal Investigator

I agree to follow all applicable federal regulations, guidance, state and local laws, and university policies related to the protection of human subjects in research, as well as professional practice standards and generally accepted good research practices for investigators, including, but not limited to, the responsibilities described in the [URI IRB Policy](#).

☒ I verify that the information provided in this IRB Application for Human Subjects Research is accurate and complete.

☒ I verify that this IRB Application has been sheared (on IRBNet) with the PI, all Co-Investigators, and the Department Chair.

7.4.2 IRB AMENDMENT FORM/ CHANGES TO RESEARCH

Amendment form for the second run.

Protocol Number: 1561278-2
Project HU#: IRB1920-148
Project Short Title: Driver Acceptance and Takeover Readiness

1. Principal Investigator

Principal Investigator: Valerie Maier-Sperdelozzi

If any contact information has changed since last IRB review - provide below:

PI Name
University Academic Title Phone Number
College/Department Email

Highlight and bold ALL information
in application that has changed

2. Proposed Change(s)

a. Indicate each change for which you are seeking IRB review and approval (check all that apply):

- ☐ Change in study personnel (including change in PI) --> Complete **Appendix R - "Change in Personnel"**
☒ Change in the number of participants --> Complete **Appendix T - "Change in the Number of Participants"**
☒ All other research changes

3. Description of Change(s)

Highlight and bold ALL information in
application form that has changed

Briefly describe the changes you are requesting:

Number of Participants. add 100 more:

1. Currently I have more participants then expected, 223 total. I am asking for permission to add 100 more. So 300 in total.
2. I want conduct a second-run survey in Germany in order to get a representative samle size focusing only to three age groups (40-50, 50-60, >60) (see document changes)

Changes in survey:

Age groups - instead of 6 age groups, now only 3 age groups. (see document changes)

Q2 was deleted because no gift card will be raffled. (see document changes)

Upload into IRBNet submission package for all Revised Documents:

- The most recently used version of the document, where all new revisions have been highlighted and bolded.
- A new, clean version of the proposed document, without track changes

4. Revised Documents

a. This request requires the revision(s), addition(s), and/or deletion(s) to the following (check all that apply):

☐ Research Protocol

☒ Consent Form(s), Assent Form(s), Permission Form(s), and Verbal Script(s) including translated documents

Upload into the IRBNet submission package:

- The most recently used consent document where all new revisions have been highlighted and bolded.
- A new, clean copy, without tracked changes, of the revised consent document with the bottom right corner BLANK.

☐ HIPAA Research Authorization Form(s)

☒ Recruitment Materials (e.g. ads, flyers, telephone or other oral script, radio/TV scripts, internet solicitations)

☐ Script(s) or Information Sheet(s), including debriefing materials

☒ Instruments (e.g., questionnaires or surveys completed by participants)

☒ Other, Specify:

Age in the survey. instead of 6 age groups, now only 3 age groups. (see changes)
Number of Participants. add 100 more. (Appendix T is included)
Q2 was deleted.

5. Principal Investigator's Assurance

I agree to follow all applicable federal regulations, guidance, state and local laws, and university policies related to the protection of human subjects in research, as well as professional practice standards and generally accepted good research practices for investigators, including, but not limited to, the responsibilities described in the [URI IRB policy](#).

☒ By checking this box, I verify that the information provided in this Amendment Form/Changes to Research Form application is accurate and complete.

Date

Amendment form for the third run.

Protocol Number: 1561278-2
Project HU#: IRB1920-148
Project Short Title: Driver Acceptance and Takeover Readiness

1. Principal Investigator

Principal Investigator: Valerie Maier-Speredelozzi

If any contact information has changed since last IRB review - provide below:

PI Name
University Academic Title Phone Number
College/Department Email

Highlight and bold ALL information
in application that has changed

2. Proposed Change(s)

a. Indicate each change for which you are seeking IRB review and approval (check all that apply):

- ☐ Change in study personnel (including change in PI) --> Complete **Appendix R - "Change in Personnel"**
☐ Change in the number of participants --> Complete **Appendix T - "Change in the Number of Participants"**
☒ All other research changes

3. Description of Change(s)

Highlight and bold ALL information in
application form that has changed

Briefly describe the changes you are requesting:

I am asking for an extension for a third run for the survey in Germany.
I included multiple (3) recruitment documents in case I have to extend the survey again.
No changes in the survey.

Upload into IRBNet submission package for all Revised Documents:
– The most recently used version of the document, where all new revisions have been highlighted and bolded.
– A new, clean version of the proposed document, without track changes

4. Revised Documents

a. This request requires the revision(s), addition(s), and/or deletion(s) to the following (check all that apply):

☐ Research Protocol

☐ Consent Form(s), Assent Form(s), Permission Form(s), and Verbal Script(s) including translated documents

Upload into the IRBNet submission package:

– The most recently used consent document where all new revisions have been highlighted and bolded.

– A new, clean copy, without tracked changes, of the revised consent document with the bottom right corner BLANK.

☐ HIPAA Research Authorization Form(s)

☒ Recruitment Materials (e.g. ads, flyers, telephone or other oral script, radio/TV scripts, internet solicitations)

☐ Script(s) or Information Sheet(s), including debriefing materials

☐ Instruments (e.g., questionnaires or surveys completed by participants)

☐ Other, Specify:

5. Principal Investigator's Assurance

I agree to follow all applicable federal regulations, guidance, state and local laws, and university policies related to the protection of human subjects in research, as well as professional practice standards and generally accepted good research practices for investigators, including, but not limited to, the responsibilities described in the [URI IRB policy](#).

☒ By checking this box, I verify that the information provided in this Amendment Form/Changes to Research Form application is accurate and complete.

Date

7.4.3 IRB APPENDIX B – EXPEDITED REVIEW

Complete this form to request expedited review of the proposed research. If the research meets the conditions for expedited review, the review of the protocol will be carried out by the IRB chairperson or by one or more experienced reviewers designated by the chairperson from among members of the URI IRB according to [45 CFR 46.102](#) and the [URI IRB Policy](#).

Principal Investigator: Professor Valerie Maier-Sperdelozzi

Project Short Title: Driver Acceptance and Takeover Readiness

Conditions required for expedited IRB review:

- 1) The Federal Regulations establish two main criteria for an expedited review:
 - (a) The research may not involve more than "minimal risk." "Minimal risk" means that "the probability and magnitude of harm or discomfort anticipated in the research are not greater in and of themselves than those ordinarily encountered in daily life or during the performance of routine physical or psychological examinations or tests" ([45 CFR 46.102\(i\)](#) and [21 CFR 56.102\(ii\)](#)).
 - (b) The entire research project must be consistent with one or more of the federally defined categories.
- 2) The categories in this list apply regardless of the age of the participants, except as noted.
- 3) The expedited review procedure may not be used where identification of the participants and/or their responses would reasonably place them at risk of criminal or civil liability or be damaging to the participant's financial standing, employability, insurability, reputation, or be stigmatizing, unless reasonable and appropriate protections will be implemented so that risks related to invasion of privacy and breach of confidentiality are no greater than minimal.
- 4) The expedited review procedure may not be used for classified research involving human subjects.
- 5) Investigators are reminded that the standard requirements for informed consent (or its waiver, alteration, or exception) apply regardless of the type of review (i.e., expedited or convened) utilized by the IRB.

Indicate all categories that describe the research project.

(1) Clinical studies of drugs and medical devices only when condition (a) or (b) is met.

- ☐ (a) Research on drugs for which an investigational new drug application ([21 CFR 312](#)) is not required. (Note: Research on marketed drugs that significantly increases the risks or decreases the acceptability of the risks associated with the use of the product is not eligible for expedited review.)
- ☐ (b) Research on medical devices for which (i) an investigational device exemption application ([21 CFR 812](#)) is not required; or (ii) the medical device is cleared/approved for marketing and the medical device is being used in accordance with its cleared/approved labeling.

(2) Collection of blood samples by finger stick, heel stick, ear stick, or venipuncture as follows:

- ☐ (a) from healthy, nonpregnant adults who weigh at least 110 pounds. For these participants, the amounts drawn may not exceed 550 ml in an 8 week period and collection may not occur more than 2 times per week.
- ☐ (b) from other adults and children (defined as "persons who have not attained the legal age for consent to treatments or procedures involved in the research, under the applicable law of the jurisdiction in which the research will be conducted." [45 CFR 46.402\(a\)](#)), considering the age, weight, and health of the participants, the collection procedure, the amount of blood to be collected, and the frequency with which it will be collected. The amount drawn may not exceed the lesser of 50 ml or 3 ml per kg in an 8 week period and collection may not occur more than 2 times per week.

(3) Prospective collection of biological specimens for research purposes by non-invasive means.

Examples:

- ☐ ● hair and nail clippings in a non-disfiguring manner;
- deciduous teeth at time of exfoliation or if routine patient care indicates a need for extraction;
- permanent teeth if routine patient care indicates a need for extraction;
- excreta and external secretions (including sweat);
- uncannulated saliva collected either in an unstimulated fashion or stimulated by chewing gumbase or wax or by applying a dilute citric solution to the tongue;
- placenta removed at delivery;
- amniotic fluid obtained at the time of rupture of the membrane prior to or during labor;
- supra- and subgingival dental plaque and calculus, provided the collection procedure is not more invasive than routine prophylactic scaling of the teeth and the process is accomplished in accordance with accepted prophylactic techniques;
- mucosal and skin cells collected by buccal scraping or swab, skin swab, or mouth washings;
- sputum collected after saline mist nebulization.

(4) Collection of data through noninvasive procedures (not involving general anesthesia or sedation) routinely employed in clinical practice, excluding procedures involving x-rays or microwaves. Where medical devices are employed, they must be cleared/approved for marketing. (Studies intended to evaluate the safety and effectiveness of the medical device are not generally eligible for expedited review, including studies of cleared medical devices for new indications.)

Examples:

- ☐ ● physical sensors that are applied either to the surface of the body or at a distance and do not involve input of significant amounts of energy into the participant or an invasion of the participant's privacy;
- weighing or testing sensory acuity;
- magnetic resonance imaging;
- electrocardiography, electroencephalography, thermography, detection of naturally occurring radioactivity, electroretinography, ultrasound, diagnostic infrared imaging, doppler blood flow, and echocardiography;
- moderate exercise, muscular strength testing, body composition assessment, and flexibility testing where appropriate given the age, weight, and health of the individual.

(5) Research involving materials (data, documents, records, or specimens) that have been collected or will be collected solely for nonresearch purposes (such as medical treatment or diagnosis). (NOTE: Some research in this category may be exempt from the HHS regulations for the protection of human subjects [45 CFR 46.101\(b\)\(4\)](#). This listing refers only to research that is not exempt.)

☒ **(6) Collection of data from voice, video, digital or image recordings made for research purposes.**

(7) Research made on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies. (NOTE: Some research in this category may be exempt from the HHS regulations for the protection of human subjects [45 CFR 46.101](#) (b)(2) and (b)(3). This listing refers only to research that is not exempt.)

7.4.4 IRB APPENDIX J – NON-ENGLISH PARTICIPANTS

Complete this form to request inclusion of non-English speaking participants in the proposed research. The IRB requires consent forms (unless waived) and all documents seen by participants to be written in a language understandable to the participant. Translation into a language other than English must be performed by a qualified translator (e.g., native speaker in the language, professional translation services, etc.). The IRB may request verification by an independent expert in that language, as necessary.

Procedures:

1. The IRB must approve the English version of the consent form, as well as any other documents seen by participants (e.g., recruitment materials, information sheets, surveys, etc.).
2. The translated documents, as well as documentation of the qualifications of the translator, must be submitted to the IRB for final approval.

For guidance (including use of the short form consent documentation), see [21 CFR 50.27 \(b\)\(2\)](#).

Principal Investigator:

Protocol Short Title:

1. List the language(s) the participants will speak.

English
German

2. List any investigator(s) and/or key personnel who are fluent in the language(s) of the participants.

Sergio Bujanov

3. Describe the provisions in place to provide translation services during the participant recruitment and consent processes.

The survey will take place in English for US citizens and in German for the German citizens.

4. Describe the provisions in place to provide translation services throughout the participants' duration in the study.

The translation from English in German will be done by the Investigator Sergio Bujanov.

5. Describe the provisions in place to handle emergency contacts (i.e., questions, problems) from non-English speaking participants.

The survey has no known risks or harms. Since that is an online survey the participants may cancel the survey at any time. An e-mail address will be provided for the participants for questions.

7.4.5 IRB APPENDIX M1 – WAIVER OR ALTERATION OF C.P.

Complete this form to request a waiver or alteration of the consent process. DHHS regulations permit waivers (or alterations) of the consent process if the research meets certain conditions; however, FDA has no provision for waiver or alteration of consent.

Do not complete this form to request a waiver of documentation of consent, use Appendix M2.

Principal Investigator: Professor Valerie Maier-Sperdelozzi

Protocol Short Title: Driver Acceptance and Takeover Readiness

1. Indicate the type of waiver/alteration requested: ☒ Waiver of Consent Process
☐ Alteration of Consent Process

2. Is the research subject to FDA regulations (i.e., involves use of a food, drug, biologic, device)? ☐ Yes
If the research involves a product regulated by FDA or the results of the research may be submitted to FDA as part of a marketing application, consent cannot be waived. ☒ No

3. Is the research (or demonstration project) subject to the approval of state or local government officials and designed to study public benefit or service programs or procedures for obtaining benefits under those programs, changes in or alternatives to those programs or procedures, or changes in methods or levels of payment for benefits or services under those programs? ☐ Yes
☒ No

If **Yes** --> explain why the research could not 'practicably' be carried out without the waiver or alteration. Inconvenience or expense is not an adequate response as it does not satisfy the criterion for waiver or alteration.

If the answer to questions 2 and 3 above is **No** --> complete the following to request waiver or alteration.

4. Explain how the research involves no more than minimal risk.

Since that is an online survey no risks and harms are known.

5. Explain why the waiver or alteration will not adversely affect the rights and welfare of the participants.

The survey is completely voluntary and collected data will be kept confidential. Participants may cancel the survey at any time without giving a reason.

6. Explain why the research could not 'practicably' be carried out without the waiver or alteration.

Inconvenience or expense is not an adequate response as it does not satisfy the criterion for waiver or alteration.

The Consent Form provides the information about the survey and educated the participants about their rights. The waiver provides the participants the option to agree the survey without reading the consent form. The waiver is entirely up to the participant.

7. Will the participants be provided with additional pertinent information after participation?

☐ Yes

☒ No

Explain why or why not:

The collected data is for the research study. After the finishing the survey, the participants will not be provided with further information.

7.4.6 IRB APPENDIX M2 – WAIVER SIGNED CONSENT

This form should be used for waiver of signed consent for anonymous research

Complete this form to request a waiver of signed consent for the proposed research. DHHS regulations permit waivers of signed consent if the research meets certain conditions. DHHS and FDA regulations differ regarding when an IRB may waive the requirement to document the informed consent process.

Do not complete this form to request a waiver or alteration of the entire consent process, use Appendix M1.

Principal Investigator:

Protocol Short Title:

1. Is the research subject to FDA regulations (e.g., involves use of a food, drug, biologic, device)? ☐ Yes
- If Yes**, only section (2) may be used to request waiver of signed consent. ☒ No
- If No**, either section (2) or (3) may be used to request waiver of signed consent.

Signed consent cannot be waived under the conditions of the last section below if the research involves a product regulated by FDA or the results of the research may be submitted to FDA as part of a marketing application.

2. Both answers below (2a and 2b) must be **No** for a waiver of signed consent:
- a. Does the research present greater than minimal risk? ☐ Yes
- ☒ No
- b. Does the research involve procedures for which written consent is normally required outside the research context? ☐ Yes
- ☒ No

If **No** --> explain how the research meets both (2a and 2b) of the conditions above.

We are seeking approval to survey respondents will answer questions about Autonomous Vehicles and Advanced Driver Assistance Systems. Since respondents will only be asked to answer opinion questions, we believe the research does not present greater than minimal risk and does not involve procedures for which written consent is normally required outside the research context.

3. Both answers below (3a and 3b) must be **Yes** for a waiver of signed consent:
- a. Would the only record linking the participant and the research be the consent document? ☐ Yes
- ☐ No
- b. Would the principal risk to the participant be potential harm resulting from a breach in confidentiality? ☐ Yes
- ☐ No

NOTE: The participant should be asked whether he/she wants documentation linking the participant with the research; the participant's wishes will govern.

If **Yes** --> explain how the research meets both (3a and 3b) of the conditions above.

7.4.7 IRB APPENDIX O – RESEARCH IN INT. SETTINGS

Complete this form when conducting research in locations outside the United States. Provide information about the local context in which the research will be conducted.

Procedures:

- Determine if local research and/or ethics reviews are also required. If so, attach a copy of the approval/review.
- Provide local letters of support from host or participating organizations, if applicable.

For a list of regulations, laws, and guidelines pertaining to international human subjects research for selected countries, see [International Compilation of Human Research Protections](#).

Principal Investigator:

Protocol Short Title:

1. Describe the international site(s). Provide location, name of local contact or investigator, and local contact information, as applicable.

2. Describe any cultural, political, religious, or other local influences that may affect conduct of the proposed research and how these will be addressed (e.g., issues posing potential threats, requiring changes in recruitment methods, etc.).

☒ N/A

3. Describe any local exceptions to the required consent process and how these will be addressed (e.g., a request from outsiders to sign documents would be treated with suspicion based on customs, previous history, etc.).

☒ N/A

4. List the language(s) in which the research will be conducted. Indicate whether a member of the research team is fluent in the language of the potential participants. If not, describe the provisions in place to provide translation services throughout the duration of the study.

Survey in English and German, English for US Citizens and German for German Citizens.

Sergio Bujanov is a German native.

5. Will children be enrolled in the study?

☐ Yes

☒ No

If Yes --> Describe any local exceptions regarding the requirements for adult permission and child assent and how these will be addressed.

6. If compensation is being offered, describe its appropriateness for the setting.

☐ N/A

There are no known compensations!

7. Explain any benefits to the local community that will remain with the community once the research is complete.

The results can be important for stakeholders or car manufacturers in order to provide the automotive technology in the way the society want. Furthermore, through the results it can be identified how comfortable society is with the technology and how the society accepts the technology.

8. Describe the researchers' training/experience with conducting research (or studying or residing) in the research setting, including any relationship(s) with the community from which participants will be recruited

Online Survey will be provided via link at Universities, Social Media and E-Mails.

9. Provide the name, title, and contact information (including email addresses) for two individuals who are **not affiliated** with the research (or researchers) who are knowledgeable about the location and population who could serve as a consultant(s) regarding the proposed research. **Note: It is not required that these individuals reside or work in the research location.**

N/A

10. Describe communication and oversight plans between the IRB and the researchers(s) who will be on-site. **Note: Consider how issues will be handled that might be relevant to the protection of participants (e.g., unanticipated problems, complaints, noncompliance, etc.).**

There are no known risks and harms. It is just a online survey which can be any time canceled from the participants.

11. Describe procedures for data storage in the local setting and for transfer of data to URI.

A Survey results will be treated with care to maintain the confidentiality of the subjects. The data pertaining to subjects and their answers will be stored on password protected computers and kept in secured offices located in Colledge of Engineering, 45 Upper Colledge Rd, Kingston, RI 02881, Research Laboratory 367.

12. Will the research involve medical procedures and/or treatment?

☐ Yes

☒ No

If **Yes** --> Indicate if any planned research procedures are considered to be standard of care in the country or location.

If **Yes** --> Describe provisions for emergency treatment that are available in the location.

7.4.8 IRB APPENDIX T – CHANGED PARTICIPANTS NUMBER

Complete this form to increase the total number of participants to be involved in the research approved by the University of Rhode Island IRB.

The number of participants is defined as the number of individuals who agree to participate (i.e., those who provide consent or whose records are accessed, etc.) even if all do not complete the study. The proposed maximum should include the number of participants who are required (considering participation criteria, withdrawals, etc.) to obtain the desired outcome of the study.

As applicable, provide the currently approved materials (marked as "current"), and the revised materials, one copy with change(s) tracked (or underlined) and one copy with change(s) incorporated (clean). All materials should be submitted single sided.

To request changes in participant numbers before the next continuing review, upload the **Amendment Form/Changes to Research**.

Principal Investigator:

Professor Valerie Maier- Speredelozzi

Protocol Short Title:

Driver Acceptance for Partially Automated Vehicles

1. Current University of Rhode Island IRB approved maximum number of participants (or records, specimens, etc.):

200

2. Requested number of participants (or records, specimens, etc.) to be added:

100

3. Total requested maximum number of participants (1 + 2):

300

4. Rationale for adding participants:

I am asking for increasing the number of participants because I have more participants then expected (Currently 223) and I want collect a small sample size 30 - 60 in Germany again in order to get representative results.

7.5 APPENDIX E - R STUDIO PROGRAMS

7.5.1 DEMOGRAPHICS USA

Data set for the US named `model2`. Source: [90], [91], [92]

```
> str(model2)
'data.frame': 163 obs. of 39 variables:
 $ Conf      : int  1 1 1 1 1 1 1 1 1 1 ...
 $ GiftC     : int  1 1 1 1 1 2 1 1 1 1 ...
 $ Age       : int  2 2 2 2 2 2 2 3 6 2 ...
 $ Gender    : int  1 2 2 2 1 1 2 1 2 1 ...
 $ Nat       : int  1 1 1 1 1 1 2 2 1 2 ...
 $ Other.Nat: Factor w/ 11 levels "", "Cameroon",...: 1 1 1 1 1 1 2 10 1 4 ...
 $ State     : int  39 39 39 7 39 39 39 23 39 39 ...
 $ Ownership: int  1 3 1 3 1 2 3 1 1 1 ...
 $ License   : int  3 4 3 3 4 4 3 3 4 4 ...
 $ Commute   : int  2 2 2 1 5 1 2 5 1 2 ...
 $ Def       : int  1 1 1 1 1 1 1 1 1 1 ...
 $ PEOU1     : int  1 2 2 1 2 3 4 1 2 1 ...
 $ PEOU2     : int  3 3 3 2 2 3 5 2 2 3 ...
 $ PEOU3     : int  1 2 2 1 1 3 4 1 3 2 ...
 $ PEOU4     : int  1 2 2 1 2 3 4 2 2 2 ...
 $ PU1       : int  5 2 5 2 1 3 5 2 2 3 ...
 $ PU2       : int  5 4 2 1 4 3 5 1 2 4 ...
 $ PU3       : int  5 2 5 1 2 3 5 1 2 3 ...
 $ PU4       : int  3 2 2 2 1 3 4 2 2 3 ...
 $ PSR1      : int  2 2 5 1 2 3 2 1 2 3 ...
 $ PSR2      : int  5 2 1 2 5 3 3 1 3 2 ...
 $ PSR3      : int  5 3 1 5 5 3 4 3 5 2 ...
 $ PSR4      : int  5 2 1 2 1 3 1 1 2 2 ...
 $ PFR1      : int  5 2 1 1 4 3 2 1 2 3 ...
 $ PFR2      : int  1 2 1 1 3 3 2 1 3 5 ...
 $ PFR3      : int  2 2 1 1 2 3 1 1 2 2 ...
 $ PFR4      : int  1 2 2 1 2 3 2 1 2 2 ...
 $ PB1       : int  2 2 3 2 2 3 3 1 2 2 ...
 $ PB2       : int  3 2 3 2 1 3 3 1 2 4 ...
 $ PB3       : int  4 3 5 1 4 3 4 1 3 3 ...
 $ PB4       : int  2 3 1 1 3 3 2 1 1 4 ...
 $ INT1      : int  3 2 4 2 2 3 5 2 2 3 ...
 $ INT2      : int  4 3 5 2 2 3 5 2 2 4 ...
 $ ATT1      : int  3 2 4 2 1 3 5 1 2 2 ...
 $ ATT2      : int  3 3 3 1 3 3 3 1 2 2 ...
 $ BI1       : int  1 2 3 3 1 3 4 3 1 3 ...
 $ BI2       : int  3 3 4 3 2 3 5 2 2 5 ...
 $ Accidents: int  2 2 2 4 2 2 2 1 2 2 ...
 $ SAE       : int  2 4 3 6 5 5 3 5 6 3 ...
```



```

24
25 # Analysis Demographics
26 # Data Filter to Demographics
27 # Remove unnecessary columns
28 demo <- select(model2, -ConF, -GiftC, -Other.Nat, -Def)
29 # ----Considering only completed cases USA
30 demo_c <- demo[complete.cases(demo), ]      # = 126
31 # ----Male & Female; 126 in total USA
32 demo_male <- subset(demo_c, Gender == 1)    # = 52/126
33 demo_female <- subset(demo_c, Gender == 2)  # = 74/126
34 # ----Age groups; 126 USA
35 demo_20mi <- subset(demo_c, Age == 1)      # = 0/126
36 demo_20t30 <- subset(demo_c, Age == 2)     # = 38/126
37 demo_30t40 <- subset(demo_c, Age == 3)     # = 20/126
38 demo_40t50 <- subset(demo_c, Age == 4)     # = 10/126
39 demo_50t60 <- subset(demo_c, Age == 5)     # = 35/126
40 demo_60pl <- subset(demo_c, Age == 6)      # = 23/126
41
42 # ---- Males & Age groups USA
43 demo_m20mi <- subset(demo_male, Age == 1)   # = 0/52
44 demo_m20t30 <- subset(demo_male, Age == 2)  # = 21/52
45 demo_m30t40 <- subset(demo_male, Age == 3)  # = 12/52
46 demo_m40t50 <- subset(demo_male, Age == 4)  # = 4/52
47 demo_m50t60 <- subset(demo_male, Age == 5)  # = 9/52
48 demo_m60pl <- subset(demo_male, Age == 6)   # = 6/52
49
50 # ---- Females & Age groups USA
51 demo_f20mi <- subset(demo_female, Age == 1) # = 0/74
52 demo_f20t30 <- subset(demo_female, Age == 2) # = 17/74
53 demo_f30t40 <- subset(demo_female, Age == 3) # = 8/74
54 demo_f40t50 <- subset(demo_female, Age == 4) # = 6/74
55 demo_f50t60 <- subset(demo_female, Age == 5) # = 26/74
56 demo_f60pl <- subset(demo_female, Age == 6) # = 17/74
57

```

```

57
58 # ----Nationality USA
59 demo_nat <- subset(demo_c, Nat == 1)    #= 117/126
60 # ----Residence
61 demo_res <- subset(demo_c, State == 39) #= 73/126
62 # ----Ownership for own car USA
63 demo_own1 <- subset(demo_c, Ownership == 1) #= 106/126 owe own car
64 demo_own2 <- subset(demo_c, Ownership == 2) #= 8/126 Leasing
65 demo_own3 <- subset(demo_c, Ownership == 3) #= 10/126 from others
66 demo_own4 <- subset(demo_c, Ownership == 4) #= 2/126 no usage
67 # ----Driver's License USA
68 demo_DL1mi <- subset(demo_c, License == 1) #= 0/126
69 demo_DL1t2 <- subset(demo_c, License == 2) #= 10/126
70 demo_DL2t6 <- subset(demo_c, License == 3) #= 24/126
71 demo_DL6pl <- subset(demo_c, License == 4) #= 92/126
72 # ----Daily Commute USA
73 demo_Commute5 <- subset(demo_c, Commute == 1)    #= 32/126
74 demo_Commute5t20 <- subset(demo_c, Commute == 2) #= 53/126
75 demo_Commute20t40 <- subset(demo_c, Commute == 3) #= 30/126
76 demo_Commute40t60 <- subset(demo_c, Commute == 4) #= 8/126
77 demo_Commute60pl <- subset(demo_c, Commute == 5) #= 3/126
78
79 # ----Question: What people think causes the most road accidents USA
80 demo_Accidents1 <- subset(demo_c, Accidents == 1)    #= 17/126
81 demo_Accidents2 <- subset(demo_c, Accidents == 2)    #= 91/126
82 demo_Accidents3 <- subset(demo_c, Accidents == 3)    #= 4/126
83 demo_Accidents4 <- subset(demo_c, Accidents == 4)    #= 10/126
84 demo_Accidents5 <- subset(demo_c, Accidents == 5)    #= 4/126
85 demo_Accidents6 <- subset(demo_c, Accidents == 6)    #= 0/126
86 demo_Accidents7 <- subset(demo_c, Accidents == 7)    #= 0/126
87
88 # ----Question: What automation level would people prefer USA
89 demo_SAE0 <- subset(demo_c, SAE == 1)    #= 9/126
90 demo_SAE1 <- subset(demo_c, SAE == 2)    #= 17/126
91 demo_SAE2 <- subset(demo_c, SAE == 3)    #= 40/126
92 demo_SAE3 <- subset(demo_c, SAE == 4)    #= 26/126
93 demo_SAE4 <- subset(demo_c, SAE == 5)    #= 22/126
94 demo_SAE5 <- subset(demo_c, SAE == 6)    #= 12/126
95

```

7.5.2 DEMOGRAPHICS GERMANY

Data set for Germany named `model2G`. Source: [90], [91], [92]

```
> str(model2G)
'data.frame': 135 obs. of 39 variables:
 $ ConF      : int  1 1 1 1 1 1 1 1 1 1 ...
 $ GiftC     : int  2 1 2 2 2 2 1 1 1 1 ...
 $ Age       : int  3 2 3 3 2 3 2 2 3 2 ...
 $ Gender    : int  1 1 1 1 1 1 1 1 1 1 ...
 $ Nat       : int  1 2 1 1 1 1 1 1 1 1 ...
 $ Other.Nat : Factor w/ 6 levels "", "Aegypten",...: 1 2 1 1 1 1 1 1 1 1 ...
 $ State     : int  9 1 9 7 9 9 3 3 6 9 ...
 $ Ownership : int  1 3 1 1 1 2 4 3 1 1 ...
 $ License   : int  4 3 4 4 4 4 1 4 4 4 ...
 $ Commute   : int  3 2 5 3 3 2 1 2 3 2 ...
 $ Def       : int  1 1 1 1 1 1 1 1 1 1 ...
 $ PEOU1     : int  2 1 2 2 2 2 1 2 2 1 ...
 $ PEOU2     : int  2 2 2 2 1 2 2 2 3 2 ...
 $ PEOU3     : int  4 1 2 4 1 2 1 2 3 2 ...
 $ PEOU4     : int  2 1 4 1 1 1 1 4 3 2 ...
 $ PU1       : int  3 2 5 1 1 1 1 1 2 5 ...
 $ PU2       : int  1 4 1 2 1 2 2 3 2 1 ...
 $ PU3       : int  5 1 5 2 1 2 4 2 3 2 ...
 $ PU4       : int  1 1 5 1 1 2 1 2 3 3 ...
 $ PSR1      : int  1 2 1 1 2 2 2 2 2 4 ...
 $ PSR2      : int  2 2 2 1 3 2 4 2 4 1 ...
 $ PSR3      : int  5 5 1 1 3 1 1 2 1 1 ...
 $ PSR4      : int  1 4 1 1 1 1 2 2 1 1 ...
 $ PFR1      : int  1 4 1 2 2 1 1 4 1 2 ...
 $ PFR2      : int  2 5 4 1 1 2 1 2 1 2 ...
 $ PFR3      : int  1 2 1 2 1 2 5 2 1 2 ...
 $ PFR4      : int  2 1 1 1 1 1 2 1 4 1 ...
 $ PB1       : int  2 2 2 2 2 2 2 2 1 4 ...
 $ PB2       : int  2 1 2 2 1 2 1 1 2 2 ...
 $ PB3       : int  3 3 5 1 1 4 1 1 2 2 ...
 $ PB4       : int  4 2 4 2 1 2 2 2 1 3 ...
 $ INT1      : int  2 1 4 3 1 2 3 2 4 2 ...
 $ INT2      : int  2 1 2 2 1 2 4 3 2 4 ...
 $ ATT1      : int  5 1 5 2 1 2 1 2 2 2 ...
 $ ATT2      : int  2 2 2 2 1 2 1 1 2 2 ...
 $ BI1       : int  3 1 5 5 2 2 1 1 2 1 ...
 $ BI2       : int  3 1 5 1 2 2 4 2 5 2 ...
 $ Accidents : int  2 1 2 2 3 3 2 2 1 7 ...
 $ SAE       : int  4 5 1 6 5 5 3 5 6 6 ...
```

```

106
107 # Analysis Demographics
108 # Data Filter to Demographics
109 # Remove unnecessary columns
110 demoG <- select(model2G, -ConF, -GiftC, -Other.Nat, -Def)
111 # ----Considering only completed cases GE
112 demoG_c <- demoG[complete.cases(demoG), ]      # = 117
113 # ----Male & Female; 125 in total GE
114 demoG_male <- subset(demoG_c, Gender == 1)      # = 80/117
115 demoG_female <- subset(demoG_c, Gender == 2)    # = 37/117
116 # ----Age groups; 117 GE
117 demoG_20mi <- subset(demoG_c, Age == 1) # = 0/117
118 demoG_20t30 <- subset(demoG_c, Age == 2) # = 64/117
119 demoG_30t40 <- subset(demoG_c, Age == 3) # = 34/117
120 demoG_40t50 <- subset(demoG_c, Age == 4) # = 9/117
121 demoG_50t60 <- subset(demoG_c, Age == 5) # = 8/117
122 demoG_60pl <- subset(demoG_c, Age == 6) # = 2/117
123
124 # ---- Males & Age groups GE
125 demoG_m20mi <- subset(demoG_male, Age == 1) # = 0/80
126 demoG_m20t30 <- subset(demoG_male, Age == 2) # = 43/80
127 demoG_m30t40 <- subset(demoG_male, Age == 3) # = 24/80
128 demoG_m40t50 <- subset(demoG_male, Age == 4) # = 6/80
129 demoG_m50t60 <- subset(demoG_male, Age == 5) # = 5/80
130 demoG_m60pl <- subset(demoG_male, Age == 6) # = 2/80
131
132 # ---- Females & Age groups GE
133 demoG_f20mi <- subset(demoG_female, Age == 1) # = 0/37
134 demoG_f20t30 <- subset(demoG_female, Age == 2) # = 21/37
135 demoG_f30t40 <- subset(demoG_female, Age == 3) # = 10/37
136 demoG_f40t50 <- subset(demoG_female, Age == 4) # = 3/37
137 demoG_f50t60 <- subset(demoG_female, Age == 5) # = 3/37
138 demoG_f60pl <- subset(demoG_female, Age == 6) # = 0/37
139

```

```

57
58 # ----Nationality USA
59 demo_nat <- subset(demo_c, Nat == 1)   #= 117/126
60 # ----Residence
61 demo_res <- subset(demo_c, State == 39) #= 73/126
62 # ---- Ownership for own car USA
63 demo_own1 <- subset(demo_c, Ownership == 1) #= 106/126   owe own car
64 demo_own2 <- subset(demo_c, Ownership == 2) #= 8/126    Leasing
65 demo_own3 <- subset(demo_c, Ownership == 3) #= 10/126   using from others
66 demo_own4 <- subset(demo_c, Ownership == 4) #= 2/126    no usage
67 # ---- Driver's License USA
68 demo_DL1mi <- subset(demo_c, License == 1) #= 0/126
69 demo_DL1t2 <- subset(demo_c, License == 2) #= 10/126
70 demo_DL2t6 <- subset(demo_c, License == 3) #= 24/126
71 demo_DL6pl <- subset(demo_c, License == 4) #= 92/126
72 # ---- Dayli Commute USA
73 demo_Commute5 <- subset(demo_c, Commute == 1)   #= 32/126
74 demo_Commute5t20 <- subset(demo_c, Commute == 2) #= 53/126
75 demo_Commute20t40 <- subset(demo_c, Commute == 3) #= 30/126
76 demo_Commute40t60 <- subset(demo_c, Commute == 4) #= 8/126
77 demo_Commute60pl <- subset(demo_c, Commute == 5) #= 3/126
78
79 # ---- Qustion: What the people think causes the most road accidents USA
80 demo_Accidents1 <- subset(demo_c, Accidents == 1)   #= 17/126
81 demo_Accidents2 <- subset(demo_c, Accidents == 2)   #= 91/126
82 demo_Accidents3 <- subset(demo_c, Accidents == 3)   #= 4/126
83 demo_Accidents4 <- subset(demo_c, Accidents == 4)   #= 10/126
84 demo_Accidents5 <- subset(demo_c, Accidents == 5)   #= 4/126
85 demo_Accidents6 <- subset(demo_c, Accidents == 6)   #= 0/126
86 demo_Accidents7 <- subset(demo_c, Accidents == 7)   #= 0/126
87
88 # ---- Qustion: What automation level would people prefer USA
89 demo_SAE0 <- subset(demo_c, SAE == 1)   #= 9/126
90 demo_SAE1 <- subset(demo_c, SAE == 2)   #= 17/126
91 demo_SAE2 <- subset(demo_c, SAE == 3)   #= 40/126
92 demo_SAE3 <- subset(demo_c, SAE == 4)   #= 26/126
93 demo_SAE4 <- subset(demo_c, SAE == 5)   #= 22/126
94 demo_SAE5 <- subset(demo_c, SAE == 6)   #= 12/126
95

```

```

139
140 # ----Nationality GE;
141 demoG_nat <- subset(demoG_c, Nat == 1)    #= 112/117
142 # ----Residence GE
143 demoG_res <- subset(demoG_c, State == 9) #= 82/117
144 # ----Ownership for own car GE
145 demoG_own1 <- subset(demoG_c, Ownership == 1) #= 72/117 owe own car
146 demoG_own2 <- subset(demoG_c, Ownership == 2) #= 11/117 Leasing
147 demoG_own3 <- subset(demoG_c, Ownership == 3) #= 22/117 from others
148 demoG_own4 <- subset(demoG_c, Ownership == 4) #= 12/117 no usage
149 # ----Driver's License GE
150 demoG_DL1mi <- subset(demoG_c, License == 1) #= 1/117
151 demoG_DL1t2 <- subset(demoG_c, License == 2) #= 1/117
152 demoG_DL2t6 <- subset(demoG_c, License == 3) #= 13/117
153 demoG_DL6pl <- subset(demoG_c, License == 4) #= 102/117
154 # ---- Daily Commute GE
155 demoG_Commute5 <- subset(demoG_c, Commute == 1)    #= 27/117
156 demoG_Commute5t20 <- subset(demoG_c, Commute == 2) #= 39/117
157 demoG_Commute20t40 <- subset(demoG_c, Commute == 3) #= 22/117
158 demoG_Commute40t60 <- subset(demoG_c, Commute == 4) #= 14/117
159 demoG_Commute60pl <- subset(demoG_c, Commute == 5) #= 15/117
160
161 # ---- Question: What people think causes the most road accidents GE
162 demoG_Accidents1 <- subset(demoG_c, Accidents == 1)    #= 15/117
163 demoG_Accidents2 <- subset(demoG_c, Accidents == 2)    #= 84/117
164 demoG_Accidents3 <- subset(demoG_c, Accidents == 3)    #= 8/117
165 demoG_Accidents4 <- subset(demoG_c, Accidents == 4)    #= 6/117
166 demoG_Accidents5 <- subset(demoG_c, Accidents == 5)    #= 2/117
167 demoG_Accidents6 <- subset(demoG_c, Accidents == 6)    #= 1/117
168 demoG_Accidents7 <- subset(demoG_c, Accidents == 7)    #= 1/117
169
170 # ---- Question: What automation level would people prefer GE
171 demoG_SAE0 <- subset(demoG_c, SAE == 1)    #= 5/117
172 demoG_SAE1 <- subset(demoG_c, SAE == 2)    #= 17/117
173 demoG_SAE2 <- subset(demoG_c, SAE == 3)    #= 39/117
174 demoG_SAE3 <- subset(demoG_c, SAE == 4)    #= 18/117
175 demoG_SAE4 <- subset(demoG_c, SAE == 5)    #= 19/117
176 demoG_SAE5 <- subset(demoG_c, SAE == 6)    #= 19/117
177

```


7.5.3 ANOVA USA

Data set for the US named `model2comparison22`. Source: [91], [93], [94], [95]

```
> str(model2comparison22)
'data.frame': 126 obs. of 5 variables:
 $ Age   : Factor w/ 5 levels "B","C","D","E",...: 1 1 1 1 1 1 1 2 5 1 ...
 $ Gender: Factor w/ 2 levels "F","M": 2 1 1 1 2 2 1 2 1 2 ...
 $ Commute: Factor w/ 5 levels "A","B","C","D",...: 2 2 2 1 5 1 2 5 1 2 ...
 $ BI    : num 2 2.5 3.5 3 1.5 3 4.5 2.5 1.5 4 ...
 $ SAE   : Factor w/ 6 levels "SAE0","SAE1",...: 2 4 3 6 5 5 3 5 6 3 ...
```

```
17 #Age on BI
18 class(BI)
19 class(Age)
20 levels(Age)
21 boxplot((BI~Age), las=1)
22 #H0: Mean Behavioral Intention is the same for all Age groups
23 Anova1 <- aov(BI~Age)
24 Anova1
25 summary(Anova1)
26 # p-value less than alpha -> reject H0, not all means are equal!
27 TukeyHSD(Anova1)
28 plot(TukeyHSD(Anova1), las=1) # rotate y-axis
29 kruskal.test(BI~Age)
30
```

```

30
31 #SAE on BI
32 class(BI)
33 class(SAE)
34 levels(SAE)
35 boxplot((BI~SAE),las=1)
36 #H0: Mean Behavioral Intention is the same for all SAE Levels
37 Anova2 <- aov(BI~SAE)
38 Anova2
39 summary(Anova2)
40 # p-value less then alpha -> reject H0, not all means are equal!
41 TukeyHSD(Anova2)
42 plot(TukeyHSD(Anova2), las=1) # rotate y-axis
43 kruskal.test(BI~SAE)
44

```

```

44
45 #Commute on BI
46 class(BI)
47 class(Commute)
48 levels(Commute)
49 boxplot((BI~Commute),las=1)
50 #H0: Mean Behavioral Intention is the same for all Commute
51 Anova3 <- aov(BI~Commute)
52 Anova3
53 summary(Anova3)
54 # p-value less then alpha -> reject H0, not all means are equal!
55 TukeyHSD(Anova3)
56 plot(TukeyHSD(Anova3), las=1) # rotate y-axis
57 kruskal.test(BI~Commute)
58

```

```

58
59 #Gender on BI
60 class(BI)
61 class(Gender)
62 levels(Gender)
63 boxplot((BI~Gender),las=1)
64 #H0: Mean Behavioral Intention is the same for all Gender
65 Anova4 <- aov(BI~Gender)
66 Anova4
67 summary(Anova4)
68 # p-value less then alpha -> reject H0, not all means are equal!
69 TukeyHSD(Anova4)
70 plot(TukeyHSD(Anova4), las=1) # rotate y-axis
71 kruskal.test(BI~Gender)
72

```

7.5.4 ANOVA GERMANY

Date set for Germany named `model2Gcompared22`. Source: [91], [93], [94], [95]

```
> str(model2Gcompared22)
'data.frame': 117 obs. of 5 variables:
 $ AgeG : Factor w/ 5 levels "B","C","D","E",...: 2 1 2 2 1 2 1 1 2 1 ...
 $ GenderG : Factor w/ 2 levels "F","M": 2 2 2 2 2 2 2 2 2 2 ...
 $ CommuteG : Factor w/ 5 levels "A","B","C","D",...: 3 2 5 3 3 2 1 2 3 2 ...
 $ BIG : num 3 1 5 3 2 2 2.5 1.5 3.5 1.5 ...
 $ SAEG : Factor w/ 6 levels "SAE0","SAE1",...: 4 5 1 6 5 5 3 5 6 6 ...
```

```
89
90 #AgeG on BIG
91 class(BIG)
92 class(AgeG)
93 levels(AgeG)
94 boxplot((BIG~AgeG), las=1)
95 #H0: Mean Behavioral Intention is the same for all Age groups
96 Anova1G <- aov(BIG~AgeG)
97 Anova1G
98 summary(Anova1G)
99 # p-value less then alpha -> reject H0, not all means are equal!
100 TukeyHSD(Anova1G)
101 plot(TukeyHSD(Anova1G), las=1) # rotate y-axis
102 kruskal.test(BIG~AgeG)
103
```

```

103
104 #SAEG on BIG
105 class(BIG)
106 class(SAEG)
107 levels(SAEG)
108 boxplot(BIG~SAEG, las=1)
109 #H0: Mean Behavioral Intention is the same for all SAE Levels
110 Anova2G <- aov(BIG~SAEG)
111 Anova2G
112 summary(Anova2G)
113 # p-value less then alpha -> reject H0, not all means are equal!
114 TukeyHSD(Anova2G)
115 plot(TukeyHSD(Anova2G), las=1) # rotate y-axis
116 kruskal.test(BIG~SAEG)
117

```

```

117
118 #CommuteG on BIG
119 class(BIG)
120 class(CommuteG)
121 levels(CommuteG)
122 boxplot((BIG~CommuteG),las=1)
123 #H0: Mean Behavioral Intention is the same for all Commute
124 Anova3G <- aov(BIG~CommuteG)
125 Anova3G
126 summary(Anova3G)
127 # p-value less then alpha -> reject H0, not all means are equal!
128 TukeyHSD(Anova3G)
129 plot(TukeyHSD(Anova3G), las=1) # rotate y-axis
130 kruskal.test(BIG~CommuteG)
131
132 #GenderG on BIG
133 class(BIG)

```

```

131
132 #GenderG on BIG
133 class(BIG)
134 class(GenderG)
135 levels(GenderG)
136 boxplot((BIG~GenderG), las=1)
137 #H0: Mean Behavioral Intention is the same for all Gender
138 Anova4G <- aov(BIG~GenderG)
139 Anova4G
140 summary(Anova4G)
141 # p-value less then alpha -> reject H0, not all means are equal!
142 TukeyHSD(Anova4G)
143 plot(TukeyHSD(Anova4G), las=1) # rotate y-axis
144 kruskal.test(BIG~GenderG)
145

```

7.5.5 CORRELATION AND REGRESSION ANALYSIS USA

Data set for the US named `itemsonlymodel2\_c`. Source: [96], [97]

```
> str(itemsonlymodel2_c)
'data.frame': 126 obs. of 8 variables:
 $ PEOU: num 1.5 2.25 2.25 1.25 1.75 3 4.25 1.5 2.25 2 ...
 $ PU : num 4.5 2.5 3.5 1.5 2 3 4.75 1.5 2 3.25 ...
 $ PSR : num 4.25 2.25 2 2.5 3.25 3 2.5 1.5 3 2.25 ...
 $ PFR : num 2.25 2 1.25 1 2.75 3 1.75 1 2.25 3 ...
 $ PB : num 2.75 2.5 3 1.5 2.5 3 3 1 2 3.25 ...
 $ INT : num 3.5 2.5 4.5 2 2 3 5 2 2 3.5 ...
 $ ATT : num 3 2.5 3.5 1.5 2 3 4 1 2 2 ...
 $ BI : num 2 2.5 3.5 3 1.5 3 4.5 2.5 1.5 4 ...
```

```

49
50 #import data set for the US
51 data(itemsonlymodel2)
52 #consider only completed cases
53 itemsonlymodel2_c <- itemsonlymodel2[complete.cases
54                                     (itemsonlymodel2), ]
55 str(itemsonlymodel2_c)
56
57 summary(itemsonlymodel2_c)
58 itemsonlymodel2_c$PEOU <- as.numeric
59 (impute(itemsonlymodel2_c$PEOU,mean))
60
61 itemsonlymodel2_c$PU <- as.numeric
62 (impute(itemsonlymodel2_c$PU,mean))
63
64 itemsonlymodel2_c$PSR <- as.numeric
65 (impute(itemsonlymodel2_c$PSR,mean))
66
67 itemsonlymodel2_c$PFR <- as.numeric
68 (impute(itemsonlymodel2_c$PFR,mean))
69
70 itemsonlymodel2_c$PB <- as.numeric
71 (impute(itemsonlymodel2_c$PB,mean))
72
73 itemsonlymodel2_c$INT <- as.numeric
74 (impute(itemsonlymodel2_c$INT,mean))
75
76 itemsonlymodel2_c$ATT <- as.numeric
77 (impute(itemsonlymodel2_c$ATT,mean))
78
79 itemsonlymodel2_c$BI <- as.numeric
80 (impute(itemsonlymodel2_c$BI,mean))
81
82 summary(itemsonlymodel2_c)
83
84 #Select a Subset of numeric items for regression modelling
85 itemsonlymodel2_c.sel <- subset(itemsonlymodel2_c, select =
86                               c(PEOU, PU, PSR, PFR, PB, INT,
87                               ATT, BI))
88
89 pairs.panels(itemsonlymodel2_c.sel, col="red")
90

```


7.5.6 CORRELATION AND REGRESSION ANALYSIS

Data set for Germany named `itemsonlymodel2G\_c`. [96], [97]

```
> str(itemsonlymodel2G_c)
'data.frame': 117 obs. of 8 variables:
 $ PEOU: num 2.5 1.25 2.5 2.25 1.25 1.75 1.25 2.5 2.75 1.75 ...
 $ PU : num 2.5 2 4 1.5 1 1.75 2 2 2.5 2.75 ...
 $ PSR : num 2.25 3.25 1.25 1 2.25 1.5 2.25 2 2 1.75 ...
 $ PFR : num 1.5 3 1.75 1.5 1.25 1.5 2.25 2.25 1.75 1.75 ...
 $ PB : num 2.75 2 3.25 1.75 1.25 2.5 1.5 1.5 1.5 2.75 ...
 $ INT : num 2 1 3 2.5 1 2 3.5 2.5 3 3 ...
 $ ATT : num 3.5 1.5 3.5 2 1 2 1 1.5 2 2 ...
 $ BI : num 3 1 5 3 2 2 2.5 1.5 3.5 1.5 ...
```

```

7  #import data set
8  data(itemsonlymodel2G)
9  #consider only completed cases
10 itemsonlymodel2G_c <- itemsonlymodel2G[complete.cases
11                                     (itemsonlymodel2G), ]
12 str(itemsonlymodel2G_c)
13
14 summary(itemsonlymodel2G_c)
15 itemsonlymodel2G_c$PEOU <- as.numeric
16 (impute(itemsonlymodel2G_c$PEOU,mean))
17
18 itemsonlymodel2G_c$PU <- as.numeric
19 (impute(itemsonlymodel2G_c$PU,mean))
20
21 itemsonlymodel2G_c$PSR <- as.numeric
22 (impute(itemsonlymodel2G_c$PSR,mean))
23
24 itemsonlymodel2G_c$PFR <- as.numeric
25 (impute(itemsonlymodel2G_c$PFR,mean))
26
27 itemsonlymodel2G_c$PB <- as.numeric
28 (impute(itemsonlymodel2G_c$PB,mean))
29
30 itemsonlymodel2G_c$INT <- as.numeric
31 (impute(itemsonlymodel2G_c$INT,mean))
32
33 itemsonlymodel2G_c$ATT <- as.numeric
34 (impute(itemsonlymodel2G_c$ATT,mean))
35
36 itemsonlymodel2G_c$BI <- as.numeric
37 (impute(itemsonlymodel2G_c$BI,mean))
38
39 summary(itemsonlymodel2G_c)
40
41 #Select a Subset of numeric items for regression modelling
42 itemsonlymodel2G_c.sel <- subset(itemsonlymodel2G_c, select =
43                                c(PEOU, PU, PSR, PFR, PB, INT,
44                                ATT, BI))
45 pairs.panels(itemsonlymodel2G_c.sel, col="red")
46

```

7.5.7 EXPLANATORY FACTOR ANALYSIS USA

Data set for the US named `model2\_c`. Source: [78], [98], [99]

```
> str(model2_c)
'data.frame': 126 obs. of 26 variables:
 $ PEOU1: int 1 2 2 1 2 3 4 1 2 1 ...
 $ PEOU2: int 3 3 3 2 2 3 5 2 2 3 ...
 $ PEOU3: int 1 2 2 1 1 3 4 1 3 2 ...
 $ PEOU4: int 1 2 2 1 2 3 4 2 2 2 ...
 $ PU1 : int 5 2 5 2 1 3 5 2 2 3 ...
 $ PU2 : int 5 4 2 1 4 3 5 1 2 4 ...
 $ PU3 : int 5 2 5 1 2 3 5 1 2 3 ...
 $ PU4 : int 3 2 2 2 1 3 4 2 2 3 ...
 $ PSR1: int 2 2 5 1 2 3 2 1 2 3 ...
 $ PSR2: int 5 2 1 2 5 3 3 1 3 2 ...
 $ PSR3: int 5 3 1 5 5 3 4 3 5 2 ...
 $ PSR4: int 5 2 1 2 1 3 1 1 2 2 ...
 $ PFR1: int 5 2 1 1 4 3 2 1 2 3 ...
 $ PFR2: int 1 2 1 1 3 3 2 1 3 5 ...
 $ PFR3: int 2 2 1 1 2 3 1 1 2 2 ...
 $ PFR4: int 1 2 2 1 2 3 2 1 2 2 ...
 $ PB1 : int 2 2 3 2 2 3 3 1 2 2 ...
 $ PB2 : int 3 2 3 2 1 3 3 1 2 4 ...
 $ PB3 : int 4 3 5 1 4 3 4 1 3 3 ...
 $ PB4 : int 2 3 1 1 3 3 2 1 1 4 ...
 $ INT1: int 3 2 4 2 2 3 5 2 2 3 ...
 $ INT2: int 4 3 5 2 2 3 5 2 2 4 ...
 $ ATT1: int 3 2 4 2 1 3 5 1 2 2 ...
 $ ATT2: int 3 3 3 1 3 3 3 1 2 2 ...
 $ BI1 : int 1 2 3 3 1 3 4 3 1 3 ...
 $ BI2 : int 3 3 4 3 2 3 5 2 2 5 ...
```

```

260
261 str(model2_c)
262 #Barlett test of homogeneity of variances
263 bartlett.test(model2_c)
264 #KMO factor adequacy - Kaiser-Meyer-Olki&
265 #MSA- Measure of Adequacy values
266 KMO(model2_c)
267
268
269 J <-cor(model2_c, use="pairwise.complete.obs")
270 eigenvals <- eigen(J)
271 #eigenvalues
272 eigenvals$values
273 #Scree plot: Plots eigenvalues
274 scree(J, factors=FALSE)
275 EFA <- fa(model2_c, nfactors=3, rotate = 'promax', fm='pa')
276 print(EFA, digits=3, cutoff=0.3)
277 #TLI>0.9, RMSEA<0.05, BIC lower is better,
278 #SS loading >0.7 or greater than 1
279 #h^2<0.2,Diagram, At least 3 variables Yong and Pearce (2013)
280 fa.diagram(EFA)
281 print(EFA)
282
283
284 #factor realibility check before removing questions
285 factor1 <- select(model2_c,ATT1,PU1,PB2,ATT2,PU4,PU3,BI1,
286                   BI2,INT1,PB1,PB3,INT2,PB4,PU2,PEOU2)
287 alpha(factor1) #alpha= 0.94
288 factor2 <- select(model2_c,PSR4,PFR2,PFR3,PFR4,PFR1,PSR1,PSR3,PSR2)
289 alpha(factor2) #alpha= 0.75
290 factor3 <- select(model2_c,PEOU1,PEOU3,PEOU4)
291 alpha(factor3) #alpha= 0.86
292
293
294 #remove question according minimum criteria for h^2 & L
295 nopsr3 <- select(model2_c,-PSR3) # h^2 at PS3 = 0.17
296 EFAnew <- fa(nopsr3,nfactors=3, rotate = 'promax', fm='pa')
297 print(EFAnew)
298 fa.diagram(EFAnew)
299
300
301 #factor reliability check after removing questions
302 factor1.1.1 <- select(model2_c,ATT1,PU1,PB2,ATT2,PU4,
303                      PU3,BI1,BI2,INT1,PB1,PB3,INT2,PB4,PU2,PEOU2)
304 alpha(factor1.1.1) #alpha= 0.94
305 factor2.2.2 <- select(model2_c,PSR4,PFR2,PFR3,PFR4,PFR1,PSR1,PSR2)
306 alpha(factor2.2.2) #alpha= 0.75
307 factor3.3.3 <- select(model2_c,PEOU1,PEOU3,PEOU4)
308 alpha(factor3.3.3) #alpha= 0.86
309

```

7.5.8 EXPLANATORY FACTOR ANALYSIS GERMANY

Data set for the Germany named `model2G\_c`. Source: [78], [98], [99]

```
> str(model2G_c)
'data.frame':  117 obs. of  26 variables:
 $ PEOU1: int  2 1 2 2 2 2 1 2 2 1 ...
 $ PEOU2: int  2 2 2 2 1 2 2 2 3 2 ...
 $ PEOU3: int  4 1 2 4 1 2 1 2 3 2 ...
 $ PEOU4: int  2 1 4 1 1 1 1 4 3 2 ...
 $ PU1   : int  3 2 5 1 1 1 1 1 2 5 ...
 $ PU2   : int  1 4 1 2 1 2 2 3 2 1 ...
 $ PU3   : int  5 1 5 2 1 2 4 2 3 2 ...
 $ PU4   : int  1 1 5 1 1 2 1 2 3 3 ...
 $ PSR1  : int  1 2 1 1 2 2 2 2 2 4 ...
 $ PSR2  : int  2 2 2 1 3 2 4 2 4 1 ...
 $ PSR3  : int  5 5 1 1 3 1 1 2 1 1 ...
 $ PSR4  : int  1 4 1 1 1 1 2 2 1 1 ...
 $ PFR1  : int  1 4 1 2 2 1 1 4 1 2 ...
 $ PFR2  : int  2 5 4 1 1 2 1 2 1 2 ...
 $ PFR3  : int  1 2 1 2 1 2 5 2 1 2 ...
 $ PFR4  : int  2 1 1 1 1 1 2 1 4 1 ...
 $ PB1   : int  2 2 2 2 2 2 2 2 1 4 ...
 $ PB2   : int  2 1 2 2 1 2 1 1 2 2 ...
 $ PB3   : int  3 3 5 1 1 4 1 1 2 2 ...
 $ PB4   : int  4 2 4 2 1 2 2 2 1 3 ...
 $ INT1  : int  2 1 4 3 1 2 3 2 4 2 ...
 $ INT2  : int  2 1 2 2 1 2 4 3 2 4 ...
 $ ATT1  : int  5 1 5 2 1 2 1 2 2 2 ...
 $ ATT2  : int  2 2 2 2 1 2 1 1 2 2 ...
 $ BI1   : int  3 1 5 5 2 2 1 1 2 1 ...
 $ BI2   : int  3 1 5 1 2 2 4 2 5 2 ...
```

```

198
199 str(model2G_c)
200 #Barlett test of homogeneity of variances
201 bartlett.test(model2G_c)
202 #KMO factor adequacy - Kaiser-Meyer-Olki&
203 #MSA- Measure of Adequacy values
204 KMO(model2G_c)
205
206
207 JG <-cor(model2G_c, use="pairwise.complete.obs")
208 eigenvalsG <- eigen(JG)
209 #eigenvalues
210 eigenvalsG$values
211 scree(JG, factors=FALSE)
212 EFAG <- fa(model2G_c, nfactors=3, rotate = 'promax', fm='pa')
213 print(EFAG, digits=3, cutoff=0.3)
214 #TLI>0.9, RMSEA<0.05, BIC lower is better,
215 #SS loading >0.7 or greater than 1
216 #h^2<0.2,Diagram, At least 3 variables Yong and Pearce (2013)
217 fa.diagram(EFAG)
218 print(EFAG)
219
220
221 #factor realibility check before removing questions
222 factor1G <- select(model2G_c,ATT1,PU1,PB2,ATT2,
223                    PU4,PU3,BI1,BI2,INT1,PB1,PB3,INT2,PB4,)
224 alpha(factor1G) #alpha= 0.86
225 factor2G <- select(model2G_c,PSR4,PFR2,PFR3,PFR4,
226                    PFR1,PSR1,PSR3,PSR2)
227 alpha(factor2G) #alpha= 0.76
228 factor3G <- select(model2G_c,PEOU1,PEOU2,PEOU3,PEOU4)
229 alpha(factor3G) #alpha= 0.83
230

```

```

231
232 #remove questions according minimum criteria for h^2 & L
233 nopu2G <- select(model2G_c, -PU2) #PU2 = h2<0.2
234 fa(nopu2G,nfactors=3, rotate = 'promax', fm='pa')
235 nopb1G <- select(model2G_c, -PU2,-PB1) #PB1 = h2<0.2
236 fa(nopb1G,nfactors=3, rotate = 'promax', fm='pa')
237 nopb3G <- select(model2G_c, -PU2,-PB1,-PB3) #PB3 = h2<0.2
238 fa(nopb3G,nfactors=3, rotate = 'promax', fm='pa')
239 nopb4G <- select(model2G_c, -PU2,-PB1,-PB3,-PB4) #PB4 = h2<0.2
240 fa(nopb4G,nfactors=3, rotate = 'promax', fm='pa')
241 nopsr1G <- select(model2G_c, -PU2,-PB1,-PB3,
242                 -PB4,-PSR1) #PSR1 = h2<0.2
243 fa(nopsr1G,nfactors=3, rotate = 'promax', fm='pa')
244 nopsr2G <- select(model2G_c, -PU2,-PB1,-PB3,-PB4,
245                 -PSR1,-PSR2) #PSR2 = L<0.35
246
247
248 #suitable model after removing six questions
249 EFAnewG <- fa(nopsr2G,nfactors=3, rotate = 'promax', fm='pa')
250 print(EFAnewG)
251 fa.diagram(EFAnewG)
252
253
254 #factor reliability check after removing questions
255 factor1.1.1G <- select(model2G_c,ATT1,PU1,ATT2,PB2,BI1,PU4,
256                     BI2,PU3,INT1,INT2)
257 alpha(factor1.1.1G) #alpha= 0.87
258 factor2.2.2G <- select(model2G_c,PEOU3,PEOU1,PEOU2,PEOU4)
259 alpha(factor2.2.2G) #alpha= 0.83
260 factor3.3.3G <- select(model2G_c,PFR2,PFR1,PSR4,PFR3,PSR3,PFR4)
261 alpha(factor3.3.3G) #alpha= 0.74
262

```

7.5.9 RELIABILITY AND CORRELATIONS USA

Data set for the US named `model2\_c`. Source: [99], [100], [101]

```
> str(model2_c)
'data.frame': 126 obs. of 26 variables:
 $ PEOU1: int 1 2 2 1 2 3 4 1 2 1 ...
 $ PEOU2: int 3 3 3 2 2 3 5 2 2 3 ...
 $ PEOU3: int 1 2 2 1 1 3 4 1 3 2 ...
 $ PEOU4: int 1 2 2 1 2 3 4 2 2 2 ...
 $ PU1 : int 5 2 5 2 1 3 5 2 2 3 ...
 $ PU2 : int 5 4 2 1 4 3 5 1 2 4 ...
 $ PU3 : int 5 2 5 1 2 3 5 1 2 3 ...
 $ PU4 : int 3 2 2 2 1 3 4 2 2 3 ...
 $ PSR1 : int 2 2 5 1 2 3 2 1 2 3 ...
 $ PSR2 : int 5 2 1 2 5 3 3 1 3 2 ...
 $ PSR3 : int 5 3 1 5 5 3 4 3 5 2 ...
 $ PSR4 : int 5 2 1 2 1 3 1 1 2 2 ...
 $ PFR1 : int 5 2 1 1 4 3 2 1 2 3 ...
 $ PFR2 : int 1 2 1 1 3 3 2 1 3 5 ...
 $ PFR3 : int 2 2 1 1 2 3 1 1 2 2 ...
 $ PFR4 : int 1 2 2 1 2 3 2 1 2 2 ...
 $ PB1 : int 2 2 3 2 2 3 3 1 2 2 ...
 $ PB2 : int 3 2 3 2 1 3 3 1 2 4 ...
 $ PB3 : int 4 3 5 1 4 3 4 1 3 3 ...
 $ PB4 : int 2 3 1 1 3 3 2 1 1 4 ...
 $ INT1 : int 3 2 4 2 2 3 5 2 2 3 ...
 $ INT2 : int 4 3 5 2 2 3 5 2 2 4 ...
 $ ATT1 : int 3 2 4 2 1 3 5 1 2 2 ...
 $ ATT2 : int 3 3 3 1 3 3 3 1 2 2 ...
 $ BI1 : int 1 2 3 3 1 3 4 3 1 3 ...
 $ BI2 : int 3 3 4 3 2 3 5 2 2 5 ...
```



```

32 str(model2_c)
33 #Univariate normality (Shapiro test)
34 apply(model2_c, 2, shapiro.test)
35 #Multivariate normality (Kolmogorov-Smirnov Tests)
36 ks.test(model2_c,"pnorm")
37 #Score Scaling ####
38 my.key.list <- list(PEOU = c("PEOU1","PEOU2","PEOU3","PEOU4"),
39                    PU = c("PU1","PU2","PU3","PU4"),
40                    PSR = c("PSR1","PSR2","PSR3","PSR4"),
41                    PFR = c("PFR1","PFR2","PFR3","PFR4"),
42                    PB = c("PB1","PB2","PB3","PB4"),
43                    INT = c("INT1","INT2"),
44                    ATT = c("ATT1","ATT2"),
45                    BI = c("BI1","BI2"))
46
47 my.scales <- scoreItems(my.key.list,model2_c)
48 my.scales #show the output
49 print(my.scales,short=FALSE)
50 my.scores <- my.scales$scores
51 print(my.scores)
52 summary(my.scores)
53 describe(my.scores)
54
55 #Significance Test of Correlations
56 #items
57 sti <- corr.test(model2_c, use = "pairwise.complete.obs")$p
58 sti
59 write.csv2(sti, file = "export.csv")
60 #constructs
61 stc <- corr.test(my.scores, use = "pairwise.complete.obs")$p
62 stc
63 write.csv2(stc, file = "export.csv")
64
65 #Lower Correlation Matrix
66 #items
67 lowcoi <- lowerCor(model2_c)
68 lowcoi
69 write.csv2(lowcoi, file = "export.csv")
70 # constructs
71 lowcoc <- lowerCor(my.scores)
72 lowcoc
73 write.csv2(lowcoc, file = "export.csv")
74
75 #correlations
76 cor(model2_c)
77 cor(my.scores)
78
79 #inverse correlation matrix
80 cormyscor <- cor(my.scores)
81 inv <- solve(cormyscor) # Inverse Correlation matrix
82 inv
83 write.csv2(inv, file="export.csv")
84
85 #correlation plot
86 cor.plot(my.scores) #the same like lowcoc
87 cor.plot(model2_c)

```

Correlation plot

7.5.10 RELIABILITY AND CORRELATIONS GERMANY

Date set for Germany named `model2G\_c`. Source: [99], [100], [101]

```
> str(model2G_c)
'data.frame':  117 obs. of  26 variables:
 $ PEOU1: int  2 1 2 2 2 2 1 2 2 1 ...
 $ PEOU2: int  2 2 2 2 1 2 2 2 3 2 ...
 $ PEOU3: int  4 1 2 4 1 2 1 2 3 2 ...
 $ PEOU4: int  2 1 4 1 1 1 1 4 3 2 ...
 $ PU1  : int  3 2 5 1 1 1 1 1 2 5 ...
 $ PU2  : int  1 4 1 2 1 2 2 3 2 1 ...
 $ PU3  : int  5 1 5 2 1 2 4 2 3 2 ...
 $ PU4  : int  1 1 5 1 1 2 1 2 3 3 ...
 $ PSR1 : int  1 2 1 1 2 2 2 2 2 4 ...
 $ PSR2 : int  2 2 2 1 3 2 4 2 4 1 ...
 $ PSR3 : int  5 5 1 1 3 1 1 2 1 1 ...
 $ PSR4 : int  1 4 1 1 1 1 2 2 1 1 ...
 $ PFR1 : int  1 4 1 2 2 1 1 4 1 2 ...
 $ PFR2 : int  2 5 4 1 1 2 1 2 1 2 ...
 $ PFR3 : int  1 2 1 2 1 2 5 2 1 2 ...
 $ PFR4 : int  2 1 1 1 1 1 2 1 4 1 ...
 $ PB1  : int  2 2 2 2 2 2 2 2 1 4 ...
 $ PB2  : int  2 1 2 2 1 2 1 1 2 2 ...
 $ PB3  : int  3 3 5 1 1 4 1 1 2 2 ...
 $ PB4  : int  4 2 4 2 1 2 2 2 1 3 ...
 $ INT1 : int  2 1 4 3 1 2 3 2 4 2 ...
 $ INT2 : int  2 1 2 2 1 2 4 3 2 4 ...
 $ ATT1 : int  5 1 5 2 1 2 1 2 2 2 ...
 $ ATT2 : int  2 2 2 2 1 2 1 1 2 2 ...
 $ BI1  : int  3 1 5 5 2 2 1 1 2 1 ...
 $ BI2  : int  3 1 5 1 2 2 4 2 5 2 ...
```

```

115 str(model2G_c)
116 #Univariate normality (Shapiro test)
117 apply(model2G_c, 2, shapiro.test)
118 #Multivariate normality (Kolmogorov-Smirnov Tests)
119 ks.test(model2G_c,"pnorm")
120 #Score Scaling ####
121 my.key.listG <- list(PEOU = c("PEOU1","PEOU2","PEOU3","PEOU4"),
122                     PU = c("PU1","PU2","PU3","PU4"),
123                     PSR = c("PSR1","PSR2","PSR3","PSR4"),
124                     PFR = c("PFR1","PFR2","PFR3","PFR4"),
125                     PB = c("PB1","PB2","PB3","PB4"),
126                     INT = c("INT1","INT2"),
127                     ATT = c("ATT1","ATT2"),
128                     BI = c("BI1","BI2"))
129
130 my.scalesG <- scoreItems(my.key.listG,model2G_c)
131 my.scalesG #show the output
132 print(my.scalesG,short=FALSE)
133 my.scoresG <- my.scalesG$scores
134 print(my.scoresG)
135 summary(my.scoresG)
136 describe(my.scoresG)
137
138 #Significance Test of Correlations
139 #items
140 stiG <- corr.test(model2G_c, use = "pairwise.complete.obs")$p
141 stiG
142 write.csv2(stiG, file = "export.csv", dec=".",sep="\t")
143 #constructs
144 stcG <- corr.test(my.scoresG, use = "pairwise.complete.obs")$p
145 stcG
146 write.csv2(stcG, file = "export.csv")
147
148 #Lower Correlation Matrix
149 #items
150 lowcoiG <- lowerCor(model2G_c)
151 lowcoiG
152 write.csv2(lowcoG, file = "export.csv")
153 # constructs
154 lowcocG <- lowerCor(my.scoresG)
155 lowcocG
156 write.csv2(lowcocG, file = "export.csv")
157
158 #correlations
159 cor(model2G_c)
160 cormyscorG <- cor(my.scoresG)
161
162 #inverse correlation matrix
163 cormyscorG <- cor(my.scoresG)
164 invG <- solve(cormyscorG) # Inverse Correlation matrix
165 invG
166 write.csv2(inv, file="export.csv")
167
168 #correlation plot
169 cor.plot(my.scoresG)
170 cor.plot(model2G_c)

```

Correlation plot

7.5.11 STRUCTURAL EQUATION MODELLING USA

Data set for the US named `itemonlymodel2remQ\_c`. Source: [102], [103]

```
> str(itemonlymodel2rem1Q_c)
'data.frame': 126 obs. of 8 variables:
 $ PEOU: num 1.5 2.25 2.25 1.25 1.75 3 4.25 1.5 2.25 2 ...
 $ PU : num 4.5 2.5 3.5 1.5 2 3 4.75 1.5 2 3.25 ...
 $ PSR : num 4 2 2.33 1.67 2.67 3 2 1 2.33 2.33 ...
 $ PFR : num 2.25 2 1.25 1 2.75 3 1.75 1 2.25 3 ...
 $ PB : num 2.75 2.5 3 1.5 2.5 3 3 1 2 3.25 ...
 $ INT : num 3.5 2.5 4.5 2 2 3 5 2 2 3.5 ...
 $ ATT : num 3 2.5 3.5 1.5 2 3 4 1 2 2 ...
 $ BI : num 2 2.5 3.5 3 1.5 3 4.5 2.5 1.5 4 ...
```

Model fit indices:

```
> fitmeasures(fit33rem)
      npar      fmin      chisq      df      pvalue
      16.000      0.351      88.366     10.000      0.000
baseline.chisq baseline.df baseline.pvalue      cfi      tli
      579.283      22.000      0.000      0.859      0.691
      nnfi      rfi      nfi      pnfi      ifi
      0.691      0.664      0.847      0.385      0.862
      rni      logl unrestricted.logl      aic      bic
      0.859     -473.712     -429.529      979.424     1024.804
      ntotal      bic2      rmsea      rmsea.ci.lower      rmsea.ci.upper
      126.000      974.207      0.249      0.203      0.298
      rmsea.pvalue      rmr      rmr_nomean      srmr      srmr_bentler
      0.000      0.094      0.094      0.111      0.111
srmr_bentler_nomean      crmr      crmr_nomean      srmr_mplus      srmr_mplus_nomean
      0.111      0.113      0.113      0.102      0.102
      cn_05      cn_01      gfi      agfi      pgfi
      27.104      34.094      0.857      0.486      0.238
      mfi      ecvi
      0.733      0.955
```

```

138
139 #import data
140 data(itemsonlymodel2rem1Q)
141 #consider only complete cases
142 itemsonlymodel2rem1Q_c<-
143   itemsonlymodel2rem1Q[complete.cases(itemsonlymodel2rem1Q), ]
144
145 str(itemsonlymodel2rem1Q_c)
146
147 #Model structure
148 SEMMrem <- '
149 BI~ATT+PU
150 ATT~PEOU+INT+PU+PB
151 INT~+PSR+PFR+PU+PB+PEOU
152 PU~PEOU'
153
154 #fitting SEM model2 with removed question
155 fit33rem <- sem(SEMMrem,data=itemsonlymodel2rem1Q_c)
156 fit33rem
157 summary(fit33rem, standardized=TRUE)
158 modindices(fit33rem, sort. = TRUE)
159 inspect(fit33rem,what = "std")
160
161 ## R Square and model fit indices ##
162 view(fit33rem, 'r2')
163 fitmeasures(fit33rem)
164 fitmeasures(fit33rem, c("chisq","df","pvalue","cfi"
165   , "rmsea", "srmr", "tli"))
166
167 ## Visual representation ##
168 semPaths(fit33rem,what = "paths",whatLabels = "par",
169   style="lisrel",layout="tree",rotation = 2)
170
171 lavaanPlot(model = fit33rem, node_options =
172   list(shape = "box", fontname = "Helvetica"),
173   edge_options = list(color="grey"),
174   coefs = TRUE, covs = TRUE,stars=c("regress"))
175

```

```
> summary(fit33rem, standardized=TRUE)
lavaan 0.6-6 ended normally after 21 iterations
```

Estimator	ML
Optimization method	NLMINB
Number of free parameters	16
Number of observations	126

Model Test User Model:

Test statistic	88.366
Degrees of freedom	10
P-value (Chi-square)	0.000

Parameter Estimates:

Standard errors	Standard
Information	Expected
Information saturated (h1) model	Structured

Regressions:

	Estimate	Std.Err	z-value	P(> z)	Std.lv	Std.all
BI ~						
ATT	0.560	0.102	5.497	0.000	0.560	0.468
PU	0.401	0.094	4.265	0.000	0.401	0.363
ATT ~						
PEOU	0.294	0.078	3.761	0.000	0.294	0.272
INT	0.139	0.073	1.911	0.056	0.139	0.142
PU	0.390	0.064	6.127	0.000	0.390	0.422
PB	0.200	0.079	2.534	0.011	0.200	0.170
INT ~						
PSR	-0.046	0.083	-0.556	0.578	-0.046	-0.039
PFR	-0.148	0.096	-1.536	0.124	-0.148	-0.105
PU	0.423	0.067	6.308	0.000	0.423	0.447
PB	0.430	0.087	4.961	0.000	0.430	0.359
PEOU	0.077	0.097	0.791	0.429	0.077	0.070
PU ~						
PEOU	0.729	0.081	8.948	0.000	0.729	0.623

Variances:

	Estimate	Std.Err	z-value	P(> z)	Std.lv	Std.all
.BI	0.467	0.059	7.937	0.000	0.467	0.394
.ATT	0.233	0.029	7.937	0.000	0.233	0.281
.INT	0.336	0.042	7.937	0.000	0.336	0.387
.PU	0.593	0.075	7.937	0.000	0.593	0.611

7.5.12 STRUCTURAL EQUATION MODELLING GERMANY

Data set for Germany named `itemsonlymodel2Grem6Q\_c`. Source: [102], [103]

```
> str(itemsonlymodel2Grem6Q_c)
'data.frame': 117 obs. of 8 variables:
 $ PEOU: num 2.5 1.25 2.5 2.25 1.25 1.75 1.25 2.5 2.75 1.75 ...
 $ PU : num 3 1.33 5 1.33 1 1.67 2 1.67 2.67 3.33 ...
 $ PSR : num 3 4.5 1 1 2 1 1.5 2 1 1 ...
 $ PFR : num 1.5 3 1.75 1.5 1.25 1.5 2.25 2.25 1.75 1.75 ...
 $ PB : num 2 1 2 2 1 2 1 1 2 2 ...
 $ INT : num 2 1 3 2.5 1 2 3.5 2.5 3 3 ...
 $ ATT : num 3.5 1.5 3.5 2 1 2 1 1.5 2 2 ...
 $ BI : num 3 1 5 3 2 2 2.5 1.5 3.5 1.5 ...
```

Model fit indices:

```
> fitmeasures(fit33Grem)
      npar      fmin      chisq      df      pvalue
      16.000      0.187      43.829     10.000      0.000
baseline.chisq baseline.df baseline.pvalue      cfi      tli
      301.406      22.000      0.000      0.879      0.734
      nnfi      rfi      nfi      pnfi      ifi
      0.734      0.680      0.855      0.388      0.884
      rni      logl unrestricted.logl      aic      bic
      0.879     -502.235     -480.320     1036.470     1080.664
      ntotal      bic2      rmsea      rmsea.ci.lower      rmsea.ci.upper
      117.000     1030.087      0.170      0.120      0.223
      rmsea.pvalue      rmr      rmr_nomean      srmr      srmr_bentler
      0.000      0.121      0.121      0.115      0.115
srmr_bentler_nomean      crmr      crmr_nomean      srmr_mplus      srmr_mplus_nomean
      0.115      0.123      0.123      0.110      0.110
      cn_05      cn_01      gfi      agfi      pgfi
      49.870      62.957      0.873      0.542      0.242
      mfi      ecvi
      0.865      0.648
```

```

100
101 #import data
102 data(itemsonlymodel2Grem6Q)
103 #consider only complete cases
104 itemsonlymodel2Grem6Q_c<-
105   itemsonlymodel2Grem6Q[complete.cases(itemsonlymodel2Grem6Q), ]
106
107 str(itemsonlymodel2Grem6Q_c)
108
109 #Model structure
110 SEMMGrem <- '
111 BI~ATT+PU
112 ATT~PEOU+INT+PU+PB
113 INT~+PSR+PFR+PU+PB+PEOU
114 PU~PEOU'
115
116 #fitting SEM model2 with removed questions
117 fit33Grem <- sem(SEMMGrem,data=itemsonlymodel2Grem6Q_c)
118 fit33Grem
119 summary(fit33Grem, standardized=TRUE)
120 modindices(fit33Grem, sort. = TRUE)
121 inspect(fit33Grem, what = "std")
122
123 ## R Square and model fit indices ##
124 view(fit33Grem, 'r2')
125 fitmeasures(fit33Grem)
126 fitmeasures(fit33Grem, c("chisq","df","pvalue","cfi"
127   , "rmsea","srmr","tli"))
128
129 ## Visual representation ##
130 semPaths(fit33Grem,what = "paths",whatLabels = "par",
131   style="lisrel",layout="tree",rotation = 2)
132
133 lavaanPlot(model = fit33Grem, node_options =
134   list(shape = "box", fontname = "Helvetica"),
135   edge_options = list(color="grey"),
136   coefs = TRUE, covs = TRUE,stars=c("regress"))
137

```

```

> summary(fit33Grem, standardized=TRUE)
lavaan 0.6-6 ended normally after 20 iterations

Estimator ML
Optimization method NLMINB
Number of free parameters 16

Number of observations 117

Model Test User Model:

Test statistic 43.829
Degrees of freedom 10
P-value (Chi-square) 0.000

Parameter Estimates:

Standard errors Standard
Information Expected
Information saturated (h1) model Structured

Regressions:

```

	Estimate	Std.Err	z-value	P(> z)	Std.lv	Std.all
BI ~						
ATT	0.550	0.122	4.515	0.000	0.550	0.439
PU	0.240	0.119	2.024	0.043	0.240	0.197
ATT ~						
PEOU	0.074	0.079	0.933	0.351	0.074	0.075
INT	0.227	0.082	2.775	0.006	0.227	0.230
PU	0.453	0.073	6.170	0.000	0.453	0.465
PB	0.148	0.044	3.342	0.001	0.148	0.219
INT ~						
PSR	-0.191	0.061	-3.112	0.002	-0.191	-0.250
PFR	-0.026	0.083	-0.316	0.752	-0.026	-0.024
PU	0.311	0.074	4.214	0.000	0.311	0.316
PB	0.045	0.048	0.936	0.349	0.045	0.065
PEOU	0.313	0.082	3.809	0.000	0.313	0.312
PU ~						
PEOU	0.447	0.085	5.264	0.000	0.447	0.438

```

Variances:

```

	Estimate	Std.Err	z-value	P(> z)	Std.lv	Std.all
.BI	0.752	0.098	7.649	0.000	0.752	0.659
.ATT	0.343	0.045	7.649	0.000	0.343	0.473
.INT	0.394	0.052	7.649	0.000	0.394	0.532
.PU	0.618	0.081	7.649	0.000	0.618	0.809

8 BIBLIOGRAPHY

- [1] NHTSA, “The Evolution of Automated Safety Technologies,” 2019. [Online]. Available: <https://www.nhtsa.gov/technology-innovation/automated-vehicles-safety>.
- [2] I. Panagiotopoulos and G. Dimitrakopoulos, “An empirical investigation on consumers’ intentions towards autonomous driving,” *Transport Research Part C Emerg. Technol.*, vol. 95, no. August, pp. 773–784, 2018.
- [3] L. Montoro, S. A. Useche, F. Alonso, I. Lijarcio, P. Bosó-Seguí, and A. Martí-Belda, “Perceived safety and attributed value as predictors of the intention to use autonomous vehicles: A national study with Spanish drivers,” *Saf. Science*, vol. 120, no. June, pp. 865–876, 2019.
- [4] F. Richter, “Vehicles Are Ready for Autonomy - But We Are ?,” 2019. [Online]. Available: <https://www.statista.com/chart/20091/annual-increase-in-number-of-vehicles-equipped-with-hardware-for-fully-autonomous-driving/>.
- [5] T. Zhang, D. Tao, X. Qu, X. Zhang, R. Lin, and W. Zhang, “The roles of initial trust and perceived risk in public’s acceptance of automated vehicles,” *Transportation Research Part C Emerg. Technol.*, vol. 98, no. December 2018, pp. 207–220, 2019.
- [6] M. L. Cunningham, M. A. Regan, T. Horberry, K. Weeratunga, and V. Dixit, “Public opinion about automated vehicles in Australia: Results from a large-scale national survey,” *Transp. Res. Part A Policy Pract.*, vol. 129, no. July, pp. 1–18, 2019.
- [7] S. Nordhoff, J. De Winter, and M. Kyriakidis, “Acceptance of Driverless Vehicles : Results from a Large Cross-National Acceptance of Driverless Vehicles : Results

- from a Large Cross-National Questionnaire Study,” no. April, 2018.
- [8] S. Hardman, J. H. Lee, and G. Tal, “How do drivers use automation? Insights from a survey of partially automated vehicle owners in the United States,” *Transp. Res. Part A Policy Pract.*, vol. 129, no. June, pp. 246–256, 2019.
 - [9] N. Adnan, S. Md Nordin, M. A. bin Bahrudin, and M. Ali, “How trust can drive forward the user acceptance to the technology? In-vehicle technology for autonomous vehicle,” *Transp. Res. Part A Policy Pract.*, vol. 118, no. November, pp. 819–836, 2018.
 - [10] M. A. Nees, “Safer than the average human driver (who is less safe than me)? Examining a popular safety benchmark for self-driving cars,” *J. Safety Res.*, 2019.
 - [11] S. Pettigrew, L. M. Dana, and R. Norman, “Clusters of potential autonomous vehicles users according to propensity to use individual versus shared vehicles,” *Transp. Policy*, vol. 76, no. December 2018, pp. 13–20, 2019.
 - [12] World Health Organization, “Road Traffic Injuries,” 2018, 2019. [Online]. Available: <https://www.who.int/news-room/fact-sheets/detail/road-traffic-injuries>. [Accessed: 14-Jan-2020].
 - [13] L. Buckley, S. A. Kaye, and A. K. Pradhan, “A qualitative examination of drivers’ responses to partially automated vehicles,” *Transp. Res. Part F Traffic Psychol. Behav.*, vol. 56, pp. 167–175, 2018.
 - [14] McKinsey & Company, “Ten ways autonomous driving could redefine the automotive world,” 2015. [Online]. Available: <https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/ten-ways-autonomous-driving-could-redefine-the-automotive-world>.

- [15] H. Claypool, A. Bin-nun, and J. Gerlach, "Self-Driving Cars: The Impact On People With Disabilities," *Ruderman White Pap.*, no. January, pp. 30–31, 2017.
- [16] P. Jing, G. Xu, Y. Chen, Y. Shi, and F. Zhan, "The Determinants behind the Acceptance of Autonomous Vehicles: A Systematic Review," *Sustainability*, vol. 12, no. 5, p. 1719, 2020.
- [17] S. A. Kaye, I. Lewis, S. Forward, and P. Delhomme, "A priori acceptance of highly automated cars in Australia, France, and Sweden: A theoretically-informed investigation guided by the TPB and UTAUT," *Accid. Anal. Prev.*, vol. 137, no. May 2019, p. 105441, 2020.
- [18] M. Kyriakidis, R. Happee, and J. C. F. De Winter, "Public opinion on automated driving: Results of an international questionnaire among 5000 respondents," *Transp. Res. Part F Traffic Psychol. Behav.*, vol. 32, pp. 127–140, 2015.
- [19] Z. Xu, K. Zhang, H. Min, Z. Wang, X. Zhao, and P. Liu, "What drives people to accept automated vehicles? Findings from a field experiment," *Transp. Res. Part C Emerg. Technol.*, vol. 95, no. July, pp. 320–334, 2018.
- [20] J. Wu, H. Liao, J. W. Wang, and T. Chen, "The role of environmental concern in the public acceptance of autonomous electric vehicles: A survey from China," *Transp. Res. Part F Traffic Psychol. Behav.*, vol. 60, pp. 37–46, 2019.
- [21] J. Rhim, G. bbeum Lee, and J. H. Lee, "Human moral reasoning types in autonomous vehicle moral dilemma: A cross-cultural comparison of Korea and Canada," *Comput. Human Behav.*, vol. 102, no. April 2019, pp. 39–56, 2020.
- [22] F. D. Davis, R. P. Bagozzi, and P. R. Warshaw, "User Acceptance of Computer Technology: A Comparison of Two Theoretical Models," *Manage. Sci.*, vol. 35, no.

8, pp. 982–1003, 1989.

- [23] SAE, “SAE International,” 2020. [Online]. Available: <https://www.sae.org/news/press-room/2018/12/sae-international-releases-updated-visual-chart-for-its-“levels-of-driving-automation”-standard-for-self-driving-vehicles>.
- [24] medium.com, “Against The Odds: Why The AV Industry Should Just Stick ToThe Even-Numbered SAE Levels,” 2018. [Online]. Available: <https://medium.com/field-of-view/against-the-odds-why-the-av-industry-should-probably-focus-on-just-the-even-numbered-sae-autonomy-ed4510633dcf>. [Accessed: 03-Mar-2020].
- [25] Teo.T, *Technology Acceptance Research in Education*. 2011.
- [26] Martina Schäfer & Dorothee Keppler, “Modelle der technikorientierten Akzeptanzforschung,” Berlin, 2013.
- [27] C. Bernhard, D. Oberfeld, C. Hoffmann, D. Weismüller, and H. Hecht, “User acceptance of automated public transport: Valence of an autonomous minibus experience,” *Transp. Res. Part F Traffic Psychol. Behav.*, vol. 70, pp. 109–123, 2020.
- [28] I. Ajzen, “Theory of Planned Behavior Diagram,” *Theory Plan. Behav.*, 1991.
- [29] F. Venkatesh, Viswanath and Morris, Michael and Davis, Gordon and Davis, “User Acceptance of Information Technology: Toward a Unified View,” *MIS Q.*, vol. 27, pp. 425–478, 2003.
- [30] Xu, Venkatesh, Viswanath, James Y. L. Thong, “Extending the Unified Theory of Acceptance and Use of Technology.,” *MIS Q.*, vol. 36, pp. 157–178, 2012.

- [31] F. D. D. Venkatesh, Viswanath, “A Theoretical Extension of the Technology Acceptance Model: Four Longitudinal Field Studies.,” *Manage. Sci.*, vol. 46, pp. 186–204, 2000.
- [32] “TAM_2017_May et al_SAE1&2 .pdf.” .
- [33] R. Madigan, Louw, Dziennus, Graindorge, Ortega, Merat “Acceptance of Automated Road Transport Systems (ARTS): An Adaptation of the UTAUT Model,” *Transp. Res. Procedia*, vol. 14, no. 0, pp. 2217–2226, 2016.
- [34] J. Lee, D. Lee, Y. Park, S. Lee, and T. Ha, “Autonomous vehicles can be shared, but a feeling of ownership is important: Examination of the influential factors for intention to use autonomous vehicles,” *Transp. Res. Part C Emerg. Technol.*, vol. 107, no. February, pp. 411–422, 2019.
- [35] Y. Cho, J. Park, S. Park, and E. S. Jung, “User Experience for Autonomous Vehicles,” *J Erg. Soc Korea*, vol. 36, no. 2, pp. 87–108, 2017.
- [36] S. E. Collins, K. Witkiewitz, and M. E. Larimer, “The theory of planned behavior as a predictor of growth in risky college drinking,” *J. Stud. Alcohol Drugs*, vol. 72, no. 2, pp. 322–332, 2011.
- [37] L. Buckley, S. A. Kaye, and A. K. Pradhan, “Psychosocial factors associated with intended use of automated vehicles: A simulated driving study,” *Accid. Anal. Prev.*, vol. 115, no. April, pp. 202–208, 2018.
- [38] N. McCarthy, “The Countries Best Prepared For Autonomous Vehicles,” 2018. .
- [39] “TAM_2015_Choi_Korea.pdf.” .
- [40] K. Kaur and G. Rampersad, “Trust in driverless cars: Investigating key factors influencing the adoption of driverless cars,” *J. Eng. Technology Management JET-*

- M*, vol. 48, no. April, pp. 87–96, 2018.
- [41] S. Osswald, D. Wurhofer, S. Trösterer, E. Beck, and M. Tscheligi, “Predicting information technology usage in the car: Towards a car technology acceptance model,” *AutomotiveUI 2012 - 4th Int. Conf. Automot. User Interfaces Interact. Veh. Appl. In-cooperation with ACM SIGCHI - Proc.*, no. January 2014, pp. 51–58, 2012.
 - [42] M. Ghazizadeh, J. D. Lee, and L. N. Boyle, “Extending the Technology Acceptance Model to assess automation,” *Cogn. Technol. Work*, vol. 14, no. 1, pp. 39–49, 2012.
 - [43] T. Zhang, D. Tao, X. Qu, X. Zhang, J. Zeng, H. Zhu “Automated vehicle acceptance in China: Social influence and initial trust are key determinants,” *Transp. Res. Part C Emerg. Technol.*, vol. 112, no. January, pp. 220–233, 2020.
 - [44] R. Madigan, T. Louw, M. Wilbrink, A. Schieben, and N. Merat, “What influences the decision to use automated public transport? Using UTAUT to understand public acceptance of automated road transport systems,” *Transp. Res. Part F Traffic Psychol. Behav.*, vol. 50, pp. 55–64, 2017.
 - [45] B. S. Hein, Daniel; Rauschnabel, Philipp A.; He, Jun; Richter, Lars; Ivens, “What Drives the Adoption of Autonomous Cars?,” 2018. [Online]. Available: <https://fis.uni-bamberg.de/handle/uniba/45797>. [Accessed: 02-Mar-2020].
 - [46] J. F. C. Carley Ward, Martina Raue, Chaiwoo Lee, Lisa D’ Ambrosio, “Acceptance of Automated Driving Across Generations: The Role of Risk and Benefit Perception, Knowledge, and Trust,” 2017.
 - [47] L. Moták, E. Neuville, P. Chambers, F. Marmotion, F. Moneger, F. Coutarel, M. Izaute “Les variables prédictives des intentions d’utilisation d’une navette autonome : aller au-delà du MAT et de la TCP ?,” *Rev. Eur. Psychol. Appl.*, vol. 67,

- no. 5, pp. 269–278, 2017.
- [48] A. Z. Benleulmi and T. Blecker, “Investigating the Factors Influencing the Acceptance of Fully Autonomous Cars,” *Hambg. Int. Conf. Logist.* - 23, pp. 99–115, 2017.
 - [49] K. M. B, T. Nagami, Y. Sugase, and A. Takemura, “Human-Computer Interaction. User Interface Design, Development and Multimodality,” vol. 10271, pp. 593–608, 2017.
 - [50] J. M. Müller, “Comparing technology acceptance for autonomous vehicles, battery electric vehicles, and car sharing-A study across Europe, China, and North America,” *Sustain.*, vol. 11, no. 16, 2019.
 - [51] S. Koul and A. Eydgahi, “Utilizing technology acceptance model (Tam) for driverless car technology adoption,” *J. Technol. Manag. Innov.*, vol. 13, no. 4, pp. 37–46, 2018.
 - [52] M. M. Rahman, M. F. Lesch, W. J. Horrey, and L. Strawderman, “Assessing the utility of TAM, TPB, and UTAUT for advanced driver assistance systems,” *Accid. Anal. Prev.*, vol. 108, no. November, pp. 361–373, 2017.
 - [53] A. Massey and S. J. Miller, “Tests of Hypotheses Using Statistics,” *Math. Dep. Brown Univ. Provid. RI 2912*, pp. 1–32, 2016.
 - [54] K. Kaur and G. Rampersad, “Trust in driverless cars: Investigating key factors influencing the adoption of driverless cars,” *J. Eng. Technol. Manag. - JET-M*, vol. 48, no. November 2017, pp. 87–96, 2018.
 - [55] X. Li, T. J. Hess, and J. S. Valacich, *Why do we trust new technology? A study of initial trust formation with organizational information systems*, vol. 17, no. 1. 2008.

- [56] M. Dikmen and C. M. Burns, "Trust in autonomous vehicles: The case of Tesla Autopilot and Summon," *2017 IEEE Int. Conf. Syst. Man, Cybernetics*, pp. 1093–1098, 2017.
- [57] M. Kim, J. Park, J. Oh, W. Lee, and D. Chung, "Research in Transportation Business & Management Identifying and prioritizing the benefits and concerns of connected and autonomous vehicles : A comparison of individual and expert perceptions," *Res. Transp. Bus. Manag.*, no. January, p. 100438, 2020.
- [58] T. Imai, "Legal regulation of autonomous driving technology: Current conditions and issues in Japan," *IATSS Res.*, vol. 43, no. 4, pp. 263–267, 2019.
- [59] U. S. Census, "U.S. and World Population Clock," 2020. .
- [60] B. für politische Bildung, "Bevölkerung mit Migrationshintergrund I In absoluten Zahlen, Anteile an der Gesamtbevölkerung in Prozent, 2018," 2019. [Online]. Available: <https://www.bpb.de/nachschlagen/zahlen-und-fakten/soziale-situation-in-deutschland/61646/migrationshintergrund-i>. [Accessed: 06-Apr-2020].
- [61] Qualtrics.XM, "Der Stichprobenrechner von Qualtrics," 2020. [Online]. Available: <https://www.qualtrics.com/de/erlebnismanagement/marktforschung/stichprobenrechner/>.
- [62] W. H. Frey, "The foreign-born share of U.S. population still remains the highest since 1910," 2019. [Online]. Available: <https://www.brookings.edu/blog/the-avenue/2019/10/01/us-foreign-born-gains-are-smallest-in-a-decade-except-in-trump-states/>. [Accessed: 06-Feb-2020].
- [63] U. S. Census, "QuickFacts Rhode Island," 2019. [Online]. Available: <https://www.census.gov/quickfacts/RI>.

- [64] Niedersachsen Klar, “Statistische Informationen über die Bevölkerung des Landes Niedersachsen.” [Online]. Available: https://www.niedersachsen.de/startseite/land_leute/das_land/zahlen_fakten/bevolkerung/statistische-informationen-ueber-die-bevoelkerung-des-landes-niedersachsen-19947.html.
- [65] Statista, “Total population in Denmark from 2010 to 2020, by age group,” 2020. [Online]. Available: <https://www.statista.com/statistics/570654/total-population-in-denmark-by-age/>. [Accessed: 03-Mar-2020].
- [66] *Autonomous Driving Technical, Legal and Social Aspects*, 1st ed. 20. Berlin, Heidelberg: Springer Berlin Heidelberg : Imprint: Springer, 2016.
- [67] Survey Monkey, “What is a Likert scale?,” *Survey Monkey.com*, 2018. [Online]. Available: https://www.surveymonkey.com/mp/likert-scale/?utm_expId=.i0iggfDmTnW1fu17LcS81w.0&utm_referrer=https%3A%2F%2Fwww.google.com.au%2F.
- [68] Qualtrics, A. Q. Randomization, S. Up, and Q. Randomization, “Question Randomization,” 2018. [Online]. Available: <https://www.qualtrics.com/support/survey-platform/survey-module/block-options/question-randomization/>.
- [69] Australian Bureau of Statistics, “Survey Testing,” *Australian Bureau of Statistics*, 2018. [Online]. Available: <https://www.abs.gov.au/websitedbs/D3310114.nsf/home/Basic+Survey+Design+-+Survey+Testing>.
- [70] Engineering Statistics Handbook, “7.2.1.3. Anderson-Darling and Shapiro-Wilk

tests.” .

- [71] S.Wilk, “The Shapiro-Wilk and related tests for normality Given a sample $X_1, \dots, X_n$,” vol. 1, pp. 1–12, 2015.
- [72] Engineering Statistics Handbook, “1.3.5.16. Kolmogorov-Smirnov Goodness-of-Fit Test.” .
- [73] N. Bergman, “Section 13,” *Cambridge Bible. Hebr. Workb.*, pp. 98–107, 2012.
- [74] Chelsea Goforth, “Using and Interpreting Cronbach’s Alpha,” *University of Virginia Library*, 2015. [Online]. Available: <https://data.library.virginia.edu/using-and-interpreting-cronbachs-alpha/>.
- [75] M. T. and R. Dennick, “Making Sense of Cronbach’s Alpha,” *International Journal of Medical Education*. 2011; 2:53-55 Editorial. [Online]. Available: <https://www.statisticshowto.com/cronbachs-alpha-spss/>. [Accessed: 03-Mar-2020].
- [76] J. A. G. & R. R. Gliem, “Calculating, Interpreting, and Reporting Cronbach’s Alpha Reliability Coefficient for Likert-Type Scales,” *2003 Midwest Research to Practice Conference in Adult, Continuing, and Community Education*, 2003. [Online]. Available: <https://scholarworks.iupui.edu/bitstream/handle/1805/344/Gliem+&+Gliem.pdf?sequence=1>. [Accessed: 04-Apr-2020].
- [77] University of Zurich (UZH), “FAKTORENANALYSE,” 2018. [Online]. Available: https://www.methodenberatung.uzh.ch/de/datenanalyse_spss/interdependenz/reduktion/faktor.html.
- [78] C. Werner and F. Universität, “Explorative Faktorenanalyse: Einführung und Analyse mit R,” pp. 1–15, 2014.

- [79] A. G. Yong and S. Pearce, “A Beginner’s Guide to Factor Analysis: Focusing on Exploratory Factor Analysis,” *Tutor. Quant. Methods Psychol.*, vol. 9, no. 2, pp. 79–94, 2013.
- [80] M. Lovric, S. Analysis, and F. Primal, “International Encyclopedia of Statistical Science,” *Int. Encycl. Stat. Sci.*, no. December, 2011.
- [81] B. B. Gerstman, “14 : Correlation,” *StatPrimer*, vol. 1, pp. 1–9, 2003.
- [82] S. Cangur and I. Ercan, “Comparison of model fit indices used in structural equation modeling under multivariate normality,” *J. Mod. Appl. Stat. Methods*, vol. 14, no. 1, pp. 152–167, 2015.
- [83] A. Tarhini, K. Hone, and X. Liu, “The effects of individual differences on e-learning users’ behaviour in developing countries: A structural equation model,” *Comput. Human Behav.*, vol. 41, no. October, pp. 153–163, 2014.
- [84] M. Wainberg, A. N. Pala, F. Cournos, and K. McKinnon, “Validação do questionário de estigma sexual na doença mental (MISS-Q) em uma amostra de adultos brasileiros em atendimento psiquiátrico,” *J. Bras. Psiquiatr.*, vol. 66, no. 3, pp. 131–138, 2017.
- [85] M. Hair, J. F., Hult, G. T. M., Ringle, C. M., & Sarstedt, “Partial least squares structural equation modeling (PLS-SEM),” *Sage Publ.*, no. June 2016, pp. 1–329, 2014.
- [86] M. Zeise, *Führungsfähigkeiten und Basisfähigkeiten als Determinanten des Unternehmenserfolgs: Theoretische Aspekte und Ergebnisse einer empirischen Studie unter mittelständischen Unternehmen*. Rainer HAMpp Verlag, 2008.
- [87] D. J. Henseler and D. Aufbau, “Einführung in die PLS-Pfadmodellierung,” no. 2003,

pp. 70–75, 2005.

- [88] J. Reinecke and A. Pöge, “Strukturgleichungsmodelle,” *Handb. der sozialwissenschaftlichen Datenanalyse*, pp. 775–804, 2010.
- [89] K. D. Kubinger, D. Rasch, and M. Šimečková, “Testing a correlation coefficient’s significance: Using $H_0: 0 < \rho \leq \lambda$ is preferable to $H_0: \rho = 0$,” *Psychol. Sci.*, vol. 49, no. 2, pp. 74–87, 2007.
- [90] G. Eichner, “Grundlagen der Datenanalyse mit R Statistik und Simulation mit R Lineare Modelle mit R : Regression und Varianzanalyse Ausgewählte statistische Verfahren mit R,” no. R 1, 2012.
- [91] S. Jeworutzki, “Visualisierung statistischer Daten mit R,” no. August, 2010.
- [92] O. Torres-Reyna, “Exploring Data and Descriptive Statistics (using R) Data Analysis 101 Workshops.”
- [93] L. Meier, “ANOVA: A Short Intro Using R,” 2018.
- [94] ThatRnerd, “Analysis of Variance (ANOVA) in R,” 2016. [Online]. Available: <https://www.youtube.com/watch?v=qrP7evoNCy4>. [Accessed: 04-Dec-2020].
- [95] M.-R. P. & Statistics, “ANOVA, ANOVA Multiple Comparisons & Kruskal Wallis in R | R Tutorial 4.9 | MarinStatsLectures|,” 2013. .
- [96] C. F. Dormann and C. F. Dormann, “Multiple Regression in R,” *Parametr. Stat.*, pp. 309–346, 2017.
- [97] ironfrown, “R Stats: Multiple Regression - Variable Selection,” 2016. [Online]. Available: <https://www.youtube.com/watch?v=HP3RhjLhRjY&t=182s>.
- [98] D. K.-S. und Beratung, “Die Explorative Faktorenanalyse mit R für die Untersuchung von Fragebögen,” 2019. [Online]. Available:

- <https://www.youtube.com/watch?v=NFPGQcqlfO8>. [Accessed: 04-Apr-2020].
- [99] J. Anglim, “EFA, CFA, Reliability, Correlation, Regression using R,” 2016. [Online]. Available: <https://www.youtube.com/watch?v=rpFL5hI5qzw&t=285s>.
- [100] W. Revelle, “Using R to score personality scales *,” pp. 1–11, 2013.
- [101] N. E. Helwig, “Data , Covariance , and Correlation Matrix Copyright c 2017 by Nathaniel E . Helwig,” pp. 1–40, 2017.
- [102] C. Werner, “Strukturgleichungsmodelle mit R und lavaan analysieren : Kurzeinfuehrung,” vol. 17, pp. 1–9, 2012.
- [103] A. Monecke and F. Leisch, “SemPLS: Structural equation modeling using partial least squares,” *J. Stat. Softw.*, vol. 48, no. 1989, 2012.

* Abbreviations from chapter 8 (Bibliography) are not included in the list of abbreviations of this thesis.