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25th of October 2023

Anja Büchler

ACCEPTANCE OF E-MOBILITY IN INDIA

by

Anja Marlen Büchler

A thesis submitted to the University of Plymouth in partial fulfilment for the degree of

DOCTOR OF PHILOSOPHY

Plymouth Business School

October 2023

I dedicate this thesis and my doctorate in deep solidarity and love to my beloved father, Helmut Barucha, who passed away much too early.

You have been always my great idol and you will remain so forever.

You must be the change you wish to see in the world.

Mahatma Gandhi

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Author´s Declaration

At no time during the registration for the degree of Doctor of Philosophy has the author been registered for any other University award without prior agreement of the Doctoral College Quality Sub-Committee. Work submitted for this research degree at the University of Plymouth has not formed party of any other degree either at the University of Plymouth or at another establishment.

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Abstract

Acceptance of e-mobility in India by Anja Marlen Büchler

India signed in 2015 the historic Paris climate agreement together with more than 170 nations in order to fight against global warming and to reduce CO_2-emissions in order to control global warming caused by greenhouse effect. The transportation sector was in 2021 the second biggest source of CO_2-emissions worldwide. Decarbonising this sector will have a major effect on the worldwide greenhouse gas emissions. That is the reason why this sector will be challenged by the pressure through politics and legal demands for CO_2-neutral and emission free vehicles. India is also facing those challenges. At the Glasgow Climate Change Conference in 2021 India announced to be climate neutral in 2070. There is no single best solution to decarbonising the transportation sector, but since passenger cars are the major source of CO_{2}- emissions within the Indian transportation sector, the share of electric passenger cars is supporting to decrease greenhouse gas emissions.

The purpose of this research is to identify and define the key influencing factors towards the acceptance behaviour of electric passenger cars out of a customer´s perspective in order to promote the sales of electric passenger cars in India.

Through a systematic literature review and conducted expert interviews 14 influencing factors towards the acceptance behaviour of electric passenger cars have been identified, as well as gaps in the state of the art.

A structural equation modelling was applied using the variance-based method to operationalize the complex Technology Acceptance Model of this research. Moreover, 24 research hypotheses have been outlined by the researcher which have been empirically validated and thus either confirmed or falsified through the data out of the field research.

For the field research an online questionnaire was conducted with 232 participants. There were unexpected findings in this research, such as that driving range does not have a major impact on the general behavioural intention to use electric passenger cars; however, hypotheses such as that governmental incentives and a sufficient charging infrastructure do positively influence the acceptance behaviour towards electric passenger cars, have been confirmed. Thus, the findings out of this research will help to address the right topics to promote electric passenger cars successfully in India, to reduce CO_2-emissions in India and to contribute combating global warming. This thesis will derive design parameters for policy makers and other utilities in order to understand existing gaps in the expansion of e-mobility in India and in order to show recommendations for action.

Abbreviations

AB	Appealing Brand
AU	Anxiety of Usage
AVE	Average recorded Variance
BB	Behavioural Intention to Buy
BU	Behavioural Intention to Use
CAGR	Compound Annual Growth Rate
CB-SEM	Covariance-based Structural Equation Model
CI	Charging Infrastructure
CIMO	Context/Intervention/Mechanism/Outcome
CO_2	Carbon-Dioxide
CT	Charging Time
DR	Driving Range
EB	Ecological Belief
E-mobility	Electromobility
EV(s)	Electric Vehicle(s)
FAME	Faster Adoption and Manufacturing of Hybrid & Electric Vehicle
GDP	Gross domestic product
GI	Governmental Incentives
GST	Goods and service tax
IG	Image
KPI	Key Performance Indicator
NDC	Nationally Determined Contribution
NEMMP	National Electric Mobility Mission Plan
OEM	Original Equipment Manufacturer

PC	Purchasing Cost
PE	Perceived Ease of Use
PI	Personal Innovativeness
PLS	Partial Least Square
PV	Perceived Visibility
RQ	Research question
SEM	Structural Equation Model
SLR	Systematic Literature Review
SN	Subjective Norm
TAM	Technology Acceptance Model
TCO	Total Cost of Ownership
TK	Technological Knowledge
TPB	Theory of Planned Behaviour
TRA	Theory of Reasoned Action
TR	Technological Risk
VIF	Variance Inflation Factor
V-SEM	Variance-based Structural Equation Model
WLTP	Worldwide harmonized Light vehicles Test Procedure

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1. Introduction

1.1. Introduction

The purpose of this research is to identify and define key influencing factors that increase the acceptance behaviour of potential customers in India with regard to electric passenger cars in order to promote the sales of electric passenger cars in India, to support the ambitious climate targets and challenges of the Indian government and to make recommendations for action for stakeholders within the Indian automotive industry. India being the third biggest CO_2- emitter worldwide pledges to become climate neutral in 2070 (Nandi, 2021; World Population Review, 2022). In 2021 the transportation sector was responsible for 9% of India´s greenhouse gas emissions of which passenger cars were the biggest polluter of CO_2 with 41% (Statista, 2022c; Statista, 2021a). The transportation sector will continuously be challenged by the increasing focus on environmental and climate change parameters.

Therefore, it is important to reduce the CO_2-emissions of the road transportation sector, especially of the passenger cars in order to achieve India´s climate goal to become climate neutral by 2070. Thus, the transition from diesel and gasoline-powered vehicles to electric passenger cars in India can contribute to solve the challenging climate targets of the Indian government and to contribute combating global warming by reducing CO_2-emissions.

To identify and to define the key influencing factors towards the acceptance behaviour of electric passenger cars in India well-known and established tools and methods will be applied combining qualitative and quantitative research approaches. A systematic literature review followed by qualitative expert interviews with 7 experts situated in the field of automotive industry in India will bring insights about which influencing factors regarding the acceptance behaviour of electric passenger cars exists. In total 14 influencing factors were identified. Those factors will be used to further develop and adapt the well-known Technology Acceptance Model to the research topic.

According to the Technology Acceptance Model the likelihood of intention to use a new technology and later the usage behaviour depends on two important factors, perceived usefulness and perceived ease of use. Over time, the model was continuously studied and expanded with new influencing factors.

Accordingly, 24 research hypotheses will be established by the author for the developed Technology Acceptance Model. A structural equation modelling will then be applied using the variance-based method to operationalize the complex Technology Acceptance Model of this research. The Technology Acceptance Model and the 24 research hypotheses will be empirically validated and thus either confirmed or falsified through the data out of the conduced field research of this research. For the field research an online questionnaire will be developed. As addressees of the questionnaire and as possible customer target group, young Indian professionals with a higher level of education will be selected.

The results and findings of this research will be of considerable use not only for the Indian government in regard to their climate targets, but also for the Indian automotive industry such as for Original Equipment Manufacturers (OEMs) or automotive suppliers, but also for policy makers, regulators, other stakeholders since this research gives insights of the acceptance behaviour towards electric passenger cars of possible Indian customers.

This chapter gives an overview of the thesis and is structured into 9 sub-chapters. The next section provides background information to this research.

1.2. Background to the Research

The government of India established the National Electric Mobility Mission Plan 2020 (NEMMP) to improve national energy security, decrease adverse environmental impacts from road transportation sector and to push domestic manufacturing capabilities for electric passenger cars (Patnaik *et al.*, 2021).

That is the reason why Prime Minister Narendra Modi projected at the annual meeting of the confederation of Indian Industry in April 2017 that India will have only electric cars by 2030, with "not a single petrol or diesel car" being sold in the country by that time (Ghoshal, 2017). However, in early 2018, the target of 100% electric cars by 2030 was lowered to 30%, but this vision of electric mobility nevertheless remains very ambitious, especially in light of the fact that the National Electric Mobility Mission Plan launched in 2013, which envisioned six to seven million electric and hybrid vehicles by 2020, fell far short (Carpenter, 2019).

These goals set by politics have to be realized in daily life and must be accepted by Indian car users. Increasing the acceptance behaviour of electric passenger cars in India will support the plans of the NEMMP and will contribute to decrease the share of India´s CO_2 emissions. The following sections explains the reason of choosing India for this research.

1.3. Why India?

7.41 million new electric passenger cars have been sold worldwide in 2022 (Statista, 2023a). Thereof the top 3 biggest markets are China with 4.59 million sold electric passenger cars, the USA with 0.79 million and Germany with 0.46 million sold electric passenger cars (Statista, 2023a). Whereas in 2022 41,675 new electric passenger cars have been sold in India (EVreporter, 2023). However, India was selected for this research since the breakthrough of the acceptance of electric passenger cars in India would bring great potentials to the car manufactures to promote electric passenger cars and since it would contribute to India´s but also to the worldwide ambition to decrease CO_2 emissions. The reasons for selecting India were the followings:

1) 2nd most populated country in the world (United Nations, 2023)

2) High GDP (gross domestic product) growth rates

3) Very young growing population

4) 3rd biggest emitter of CO_2 worldwide (World Population Review, 2022)

5) Six Indian metropolises are at the world`s 10 most polluted cities (Thiagarajan, 2022)

India is the second most populated country in the world with 1,412,320 inhabitants in 2022 (United Nations, 2023). In 2022 India had an annual GDP growth rate of +6.6%, while China had +4.4%, the United States of America (USA) +1.0% and Germany -0.3% (International Monetary Fund, 2023). Furthermore, the average age in India is 2022 compared to other countries very young with 27.9 years and the age distribution remains skewed in favour of the younger age group (United Nations, 2023). In comparison the average age of China´s population is 38.5 years, in Germany 44.8 years and in the USA 37.9 years (United Nations, 2023).

In addition, India has great potential when it comes to influence CO_2 reduction. With the latest CO_2 emission numbers from the Glasgow Climate Change Conference in November 2021 India is still considered the third largest emitter of CO_2 emissions. After China and USA, India has the third-highest emissions of greenhouse gases. In 2020 China holds a global share of 32.5% with 11,680.42 million tons, the USA had a share of 12.6% with 4,535.30 million tons and India had a global share of 6.1% with 2,411.73 million tons (World Population Review, 2022).

On top of that, six Indian metropolises are among the world`s 10 most polluted cities, including the Indian capital Delhi (Thiagarajan, 2022). Here the air pollution is a serious issue, and the poor air quality remains a big problem - the consequences of industry and traffic.

All in all, those facts should emphasize the selection of India since it is holding a huge potential for the Indian automotive industry and by electrifying the passenger car market in India improvements of its CO_2-emissions. Especially since the ongoing trend towards e-mobility and the Indian governments ambitious sales targets for electric passenger cars are coming up against a steadily growing, young society with strong GDP growth rates. The following section outlines the research problem.

1.4. Research problem

There are ambitious goals by the Indian government in terms of market share of electric passenger cars by 2030 in India and consequently of reducing the share of India´s CO_2-emissions. However there is still a lack of acceptance behaviour for electric passenger cars in India since the annual share of electric cars in new passenger car registrations in 2022 was at a low level of 1.4% (Statista, 2023b; EVreporter, 2023) and since there is a lack of studies about the acceptance behaviour of electric passenger cars in India as stated in chapter 4. Finding a solution to the above research problem will benefit the electric passenger car market and the Indian automotive industry to promote electric passenger cars and contribute India on the way towards the reduction of its carbon footprint. The next section presents the research question.

1.5. Research question

The following research question was developed to answer the research problem.

Which are the key influencing factors regarding the acceptance behaviour of electric passenger cars in India from the customers` point of view?

Addressing this research question can leap forward to increase the share of electric passenger cars in India and to fight against greenhouse gases. The research aims and objectives will be outlined in the next section.

1.6. Research aims and objectives

The following research aims and objectives are in line with the above research question:

- Review general existing influencing factors regarding the acceptance behaviour of electric passenger cars through a literature survey.
- Validate those identified influencing factors regarding the acceptance behaviour of electric passenger cars through expert interviews.
- Establish research hypotheses based on the identified influencing factors regarding the acceptance behaviour of electric passenger cars in India.
- Develop a Technology Acceptance Model regarding the acceptance behaviour of electric passenger cars in India.
- Operationalise and structure the identified influencing factors regarding the acceptance behaviour of electric passenger cars in India.
- Conduct an online questionnaire as field research with possible Indian customers for electric passenger cars.
- Empirically validate the data out of the online questionnaire.

- Demonstrate the impact of the defined influencing factors towards the acceptance behaviour of electric passenger cars in India out of the perspective of possible customers.
- Falsify or confirm the research hypotheses.

The economic and ecological relevance of this research question is of course to find levers regarding the acceptance behaviour of electric passenger cars, to reduce CO_2-emissions, but also, to decrease air pollution in India, especially in the big, densely populated cities and to support the ambitious target of the Indian government to achieve a share of 30% of sold electric passenger cars until 2030. The next section shows the concept and structure of this thesis.

1.7. Concept and structure of thesis

This thesis is divided into 7 chapters. Chapter 1 gives an overview of the structure of the thesis and the characteristics of the research. The research problem and objectives will be explained, and background information of the research will be given.

Chapter 2 presents the research boundaries and provides background information to understand the Indian market better and which market environment the research question meets in line with the objective of this thesis.

Chapter 3 demonstrates the theoretical background of the Technology Acceptance Model used in this research.

Chapter 4 provides the identification and definition of the influencing factors towards the acceptance behaviour of electric passenger cars through a systematic literature review and through expert interviews.

Chapter 5 explains the research methodology and presents the research methods, which have been used in this thesis.

Chapter 6 presents the empirical evaluation of this research and the quality assessment of the developed Technology Acceptance model, as well as the empirical result using the variance-based structural equation modelling software SmartPLS.
Chapter 7 summarises the research conducted for this thesis and presents its findings and implications for the Indian automotive industry to promote electric passenger cars. Moreover, this chapter presents the limitations of the research and proposes 7 topics for further research.

1.8. Relevance and contribution

India signed in 2015 the historic Paris climate agreement together with more than 170 nations in order to fight against global warming and in order to reduce greenhouse gas emissions. The transportation sector was 2021 the second biggest source of CO_2-emissions worldwide with 20% (Statista, 2022d). Decarbonising this sector will have a major effect on the worldwide greenhouse gas emissions. That is the reason why this sector will be challenged by the pressure through politics and legal demands for CO_2-neutral and emission free vehicles. This is characterized by stricter regulatory CO_2-targets for vehicles and direct and indirect governmental emission reduction instruments such as entry restrictions on diesel and gasoline powered vehicles in city centres as well as special incentives to buy low-emission vehicles.
India is also facing those challenges. At the Glasgow Climate Change Conference India announced by when it wants to be climate neutral: in the year 2070 (Nandi, 2021). According to Modi, India wants to reduce its carbon footprint with the focus on the Indian transportation sector, which is responsible for 9% of India´s greenhouse gas emissions (Statista, 2022c). There is no single best solution to decarbonising the transportation sector, but since passenger cars are the major source of CO_{2}- emissions

within the Indian transportation sector, the increase of sold electric passenger cars in India are contributing to decrease greenhouse gas emissions.

Therefore, it is critical to success why possible customers in India are accepting or rejecting electric passenger cars in order to support the goal of the Indian government to have a share of electric passenger cars of 30% until 2030. It will also help the car industry to design attractive electric passenger cars that fit Indian customer requirements and to promote the sales of electric passenger cars.

The developed Technology Acceptance Model towards the acceptance behaviour of electric passenger cars in India and the findings in regard to the research hypotheses will help to address the right topics to promote electric passenger cars successfully, to reduce CO_2-emissions in India and to contribute combating global warming. This chapter ends with the conclusion in the next section.

1.9. Conclusion

Chapter 1 gave an overview of the structure of the thesis and the characteristics of the research. The research problem and objectives were explained, and background information of the research was given, as well as a justification for the selected research topic. Finally, the ecological relevance of the research topic was provided. The following chapter will explain the research boundaries.

2. The Indian (electric) passenger car market (research boundaries)

2.1. Introduction

In line with the objective of this thesis and in relation to the research question of which are the key influencing factors regarding the acceptance behaviour of electric passenger cars in India, this chapter provides an overview about the most important background information in order to understand the Indian market and which market environment the research question meets. That information is general data about the size of the country, its population, the Indian economy and information about factors that generally influence the purchasing behaviour in India, but also data about the Indian passenger car market. Moreover, those data will be set in context to the biggest electric passenger car markets China, the USA and Germany for an indication of relevance.

The thesis is situated in the field of e-mobility within the automotive industry since this is a big challenge and a game changer for the whole industry. E-mobility, which is mostly known as electromobility, is a technology where an electric drive train is used rather than the fossil-fuelled cars for mobility purposes. This thesis focuses only on purely electric passenger cars and not on hybrid vehicles and also not on 2- or 3-wheelers in India. Purely electric passenger cars are equipped exclusively with an electric motor and receive their energy from a battery in the vehicle, which in turn is charged via the power grid. The battery can store recovered braking energy (recuperation). In addition, purely electric passenger cars no longer need a gearbox (Bundesministerium für Wirtschaft und Klimaschutz, 2021a). A hybrid passenger car combines electric and conventional drive and energy systems. The vehicle is equipped with both an internal combustion engine and an electric motor. If a larger battery is used that can be recharged via the power grid, it is referred to as a plug-in hybrid electric vehicle (Bundesministerium für Wirtschaft und Klimaschutz, 2021b).

2.1. General information about India

India is the second most populated country in the world with 1,412,320 inhabitants in 2022 and is projected to further grow and become the most populated country in the world with 1,509,296 inhabitants in 2030, s. table 1 (United Nations, 2023). The average age in India was in 2022 27.9 years and the age distribution remains skewed in favour of the younger age group with a predicted median age of 30.9 years and thus India is having the youngest population among the countries listed below in comparison (United Nations, 2023), s. table 2.

Table 1 Population India, China, USA and Germany 2022 & 2030

Source: own table, adapted from (United Nations, 2023)

Country	Population in 2022	Forecasted Population in 2030
India	1,412,320	1,509,296
China	1,425,925	1,416,866
USA	337,499	351,334
Germany	83,427	82,820

Table 2 Average age India, China, USA and Germany 2022 & 2030

Source: own table, adapted from (United Nations, 2023)

Country	Average age 2022	Forecasted average age 2030
India	27.9	30.9
China	38.5	42.7
USA	37.9	39.7
Germany	44.8	45.9

Despite the size of the country as shown in figure 1,3,287,590 km^2, India is a densely populated country with 469 inhabitants per km² (Worldometer, 2023; Statistisches Bundesamt, 2023c).

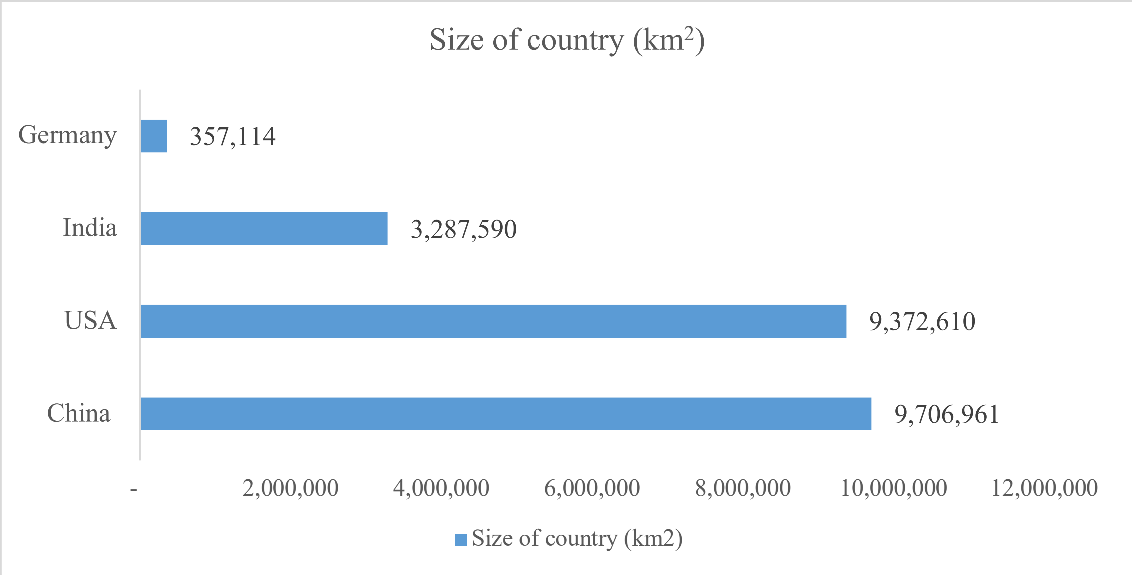

Figure 1 Size of country India, China, USA and Germany

Source: own figure, adapted from (Worldometer, 2023)

In comparison, the USA is having a population density with 36, China with 150 and Germany with 238 inhabitants per km² (Statistisches Bundesamt, 2023a; Statistisches Bundesamt, 2023b; Statistisches Bundesamt, 2023d).

35% of India´s population is living in urban areas; in the last 10 years this trend indicates an increase of urbanization by 4% (Statista, 2022e). The urbanization rates of the other compared countries are higher with 61% in China, 77% in Germany and 77% in the USA (Ritchie and Roser, 2019). There are in total 63 cities in India with a population above one million (Statistic Times, 2021). In 2022 India had a real GDP growth rate of +6.6 annual percent change, while China had +4.4, the USA +1.0 and Germany -0.3 (International Monetary Fund, 2023). Among those four countries India is predicted to have the strongest GDP growth of+ 6.2% until 2027 (International Monetary Fund, 2023), s. table 3.

Table 3 GDP Growth rates India, China, USA and Germany 2022 & 2027

Source: own table, adapted from (International Monetary Fund, 2023)

Country	GDP growth rate 2022	Forecasted GDP growth rate 2027
India	+6.6%	+6.2%
China	+4.4%	+4.6%
USA	+1.0%	+1.9%
Germany	-0.3%	+1.3%

The average income in India is 2,280 US$[1]. Putting this figure into perspective by looking on the figures of the compared countries, it is obvious that the income in India is at a lower scale, s. table 4.

Table 4 Average income India, China, USA, Germany

Country	Average income	Source
India	2,280 US$	(Statistisches Bundesamt, 2023c, p. 3; 8)
China	12,562 US$	(Statistisches Bundesamt, 2023d, p. 3;8)
USA	69,227 US$	(Statistisches Bundesamt, 2023a, p. 3;8)
Germany	51,238 US$	(Statistisches Bundesamt, 2023b, p. 3;8)

2.2. Indian passenger car market

The Indian passenger car market has been growing significantly over the past few years. The worst fall was with -21% from 2019 to 2020 due to Corona. However, the market recovered in 2021 with +27% vs. previous year due to relaxation in the Corona pandemic-induced restraints and since business in general revived. From 2020 until 2027 the amount of sold passenger cars in India is predicted to grow with a positive compound annual growth rate (CAGR) of +4.8% in India up to 3.37 million passenger

1 Exchange rate INR/US$= 0.0125; data from Oanda. Available at: https://www.oanda.com/currency-converter/de/?from=INR&to=USD&amount=1; (Accessed at: 04.04.23)

cars, as shown in figure 2 (Statista, 2023b). Since the data were produced in July 2023, the forecasted years of sold new passenger cars in India starting from 2023 onwards; the same applies for figure 3 since the data were produced also in July 2023. In Germany the market of sold new passenger cars in 2027 is projected to have 2.76 million vehicles, in the USA 15.91 million vehicles and in China 19.90 million vehicles (Statista, 2023b), as presented in figure 3. This outlook provides a projected CAGR in Germany from 2020 until 2027 of +0.75%, in the USA a CAGR of +3.1% and in China a CAGR with +3.9%. Resulting in the strongest predicted positive CAGR for India with +4.8% among those compared countries.

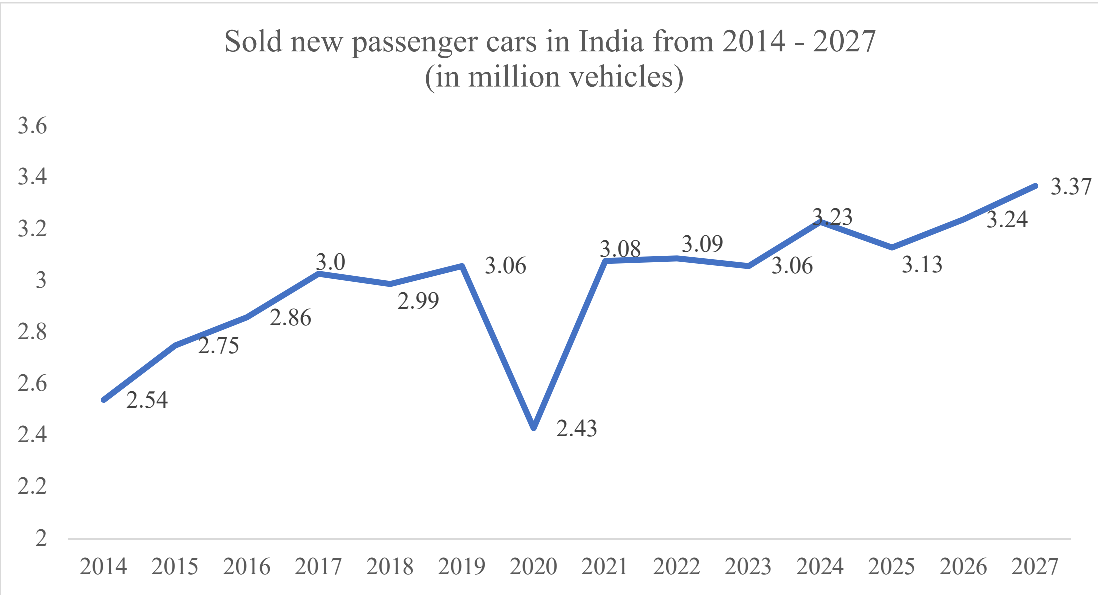

Figure 2 Amount of sold new passenger cars in India from 2014 – 2027 (in million vehicles)

Source: own figure, adapted from (Statista, 2023b)

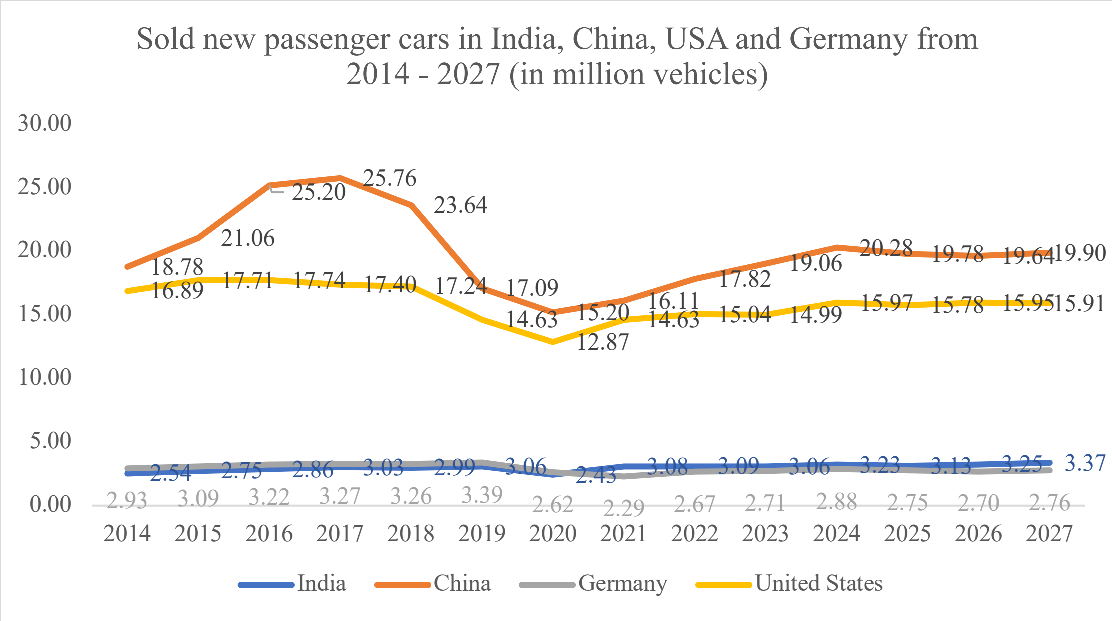

Figure 3 Amount of sold new passenger cars in India, China USA and Germany from 2014 – 2027 (in million vehicles)

Source: own figure, adapted from (Statista, 2023b)

The growth potential of the Indian passenger car market is also evident in the aspect of the amount of passenger cars per 1,000 inhabitants, s. table 5. For example, the size of the Indian passenger car market is comparable to the German market in absolute terms (s. figure 3), however looking on the small percentage of car-ownership of only 1.7% in India, the market holds great growth potential.

Table 5 Car-ownership in India, China, USA and Germany

Country	**Passenger cars per 1,000 inhabitants**	**Car-ownership**	**Source**
India	17	1.7%	(Statistisches Bundesamt, 2023c, p. 11)
China	99	9.9%	(Statistisches Bundesamt, 2023d, p. 11)
USA	381	38.1%	(Statistisches Bundesamt, 2023a, p. 11)
Germany	552	55.2%	(Statistisches Bundesamt, 2023b, p. 11)

Compared to China, USA and Germany the average price of a new passenger car in India was in 2022 with 7,520US$ the cheapest. However relative to the average income, the purchase of a new passenger car is in India most unaffordable, whereas in the USA it is most affordable, s. figure 4 and 5.

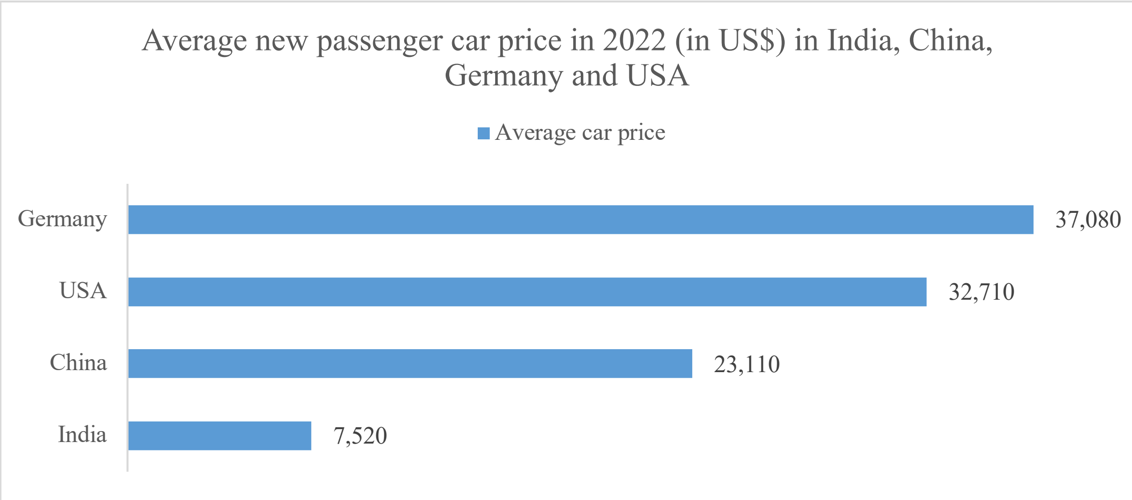

Figure 4 Average new passenger car price in 2022 (in US$) in India, China, USA and Germany

Source: own figure, adapted from (Statista, 2023b)

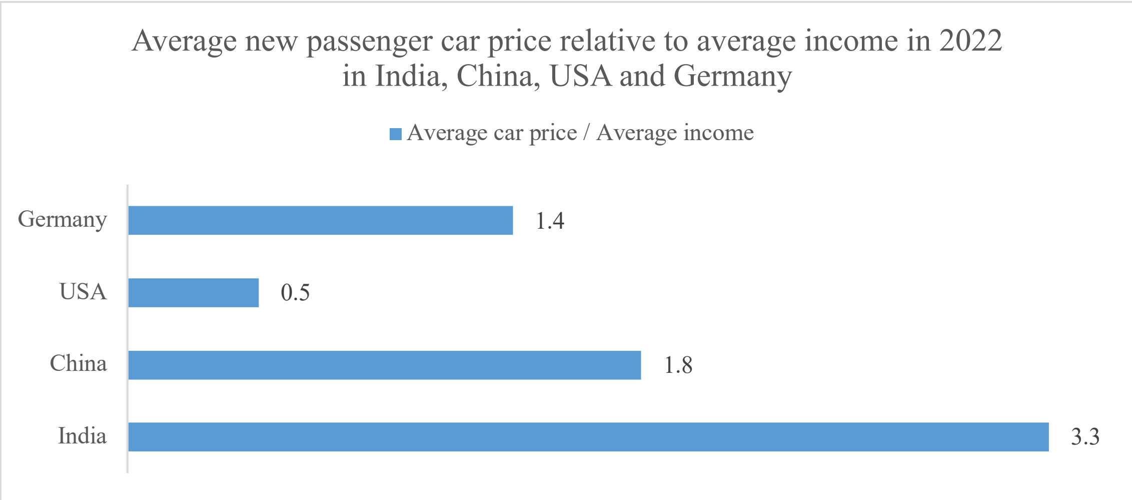

Figure 5 Average new passenger car price relative to average income in 2022 in India, China, USA and Germany

Source: own figure, adapted from (Statista, 2023b)

A study in 2021 analysed the age of potential new passenger car buyers. It showed that the group of potential new passenger car buyers between 25 - 34 years are with 41% the biggest one in India; also, higher compared to China, the USA and Germany, as shown in figure 6.

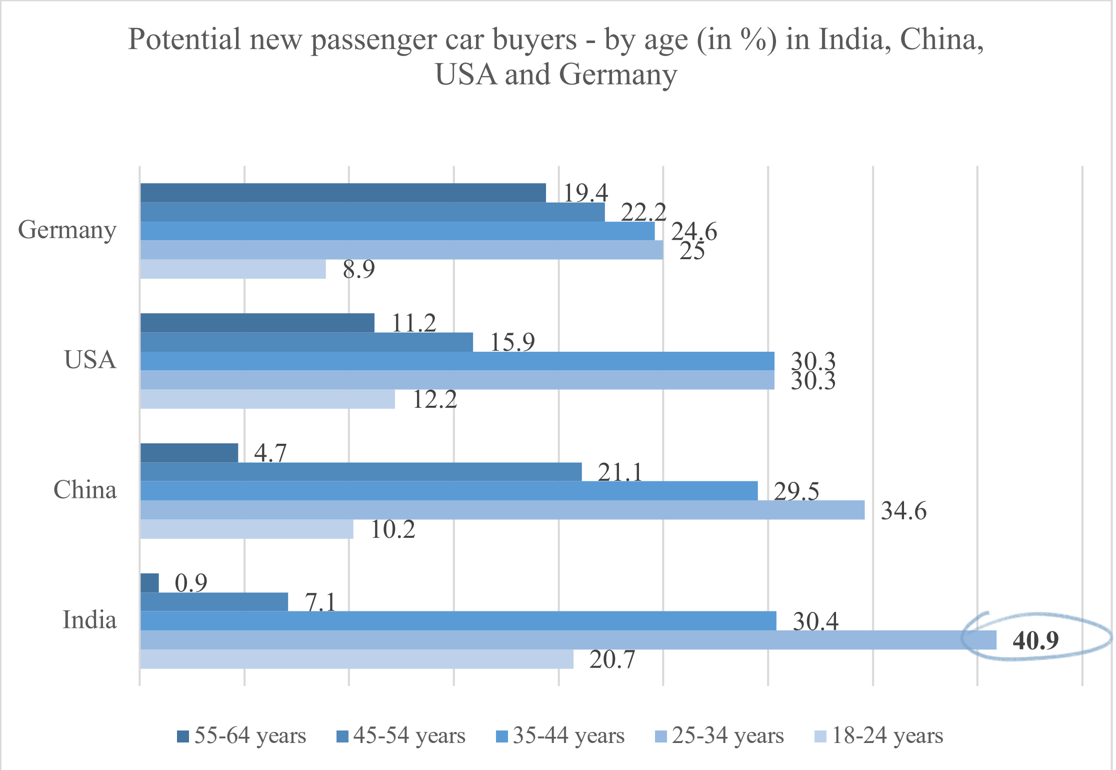

Figure 6 Potential new passenger car buyers– by age (in %) in India, China, USA and Germany

Source: own figure, adapted from (Statista, 2023b)

When it comes to the average daily one-way commuting distance, the length of daily commute by 70% of urban inhabitants in India is below 10 km; 22% travel between 10 km and 50 km and only 3% travel above 50 km (Statista, 2019a).

The average daily commuting distance in the USA is among those compared countries the highest with 66 km, followed by Germany with 17 km and China in super large cities 9.4 km and in very large cities 8.7 km (Flynn, 2023; Spiegel, 2020; Statista, 2022b).

2.3. Status-quo e-mobility in India

In 2022 41,675 new electric passenger cars have been sold in India (EVreporter, 2023). With 3.09 million sold passenger cars in India in 2022 (Statista, 2023b), this results in an electric passenger car share of 1.4%, which is compared to China, USA and Germany at a low level as stated in figure 7. In 2022 China sold 4.59 million electric passenger cars, USA 0.79 million and Germany sold 0.46 million electric passenger cars (Statista, 2023a). Figure 7 demonstrates the electric passenger cars share of China, USA, Germany and India in 2022 and the predicted share in 2027 of the compared countries. Comparing the current low electric passenger cars share in India with the ambitious target of the Indian government to achieve 30% electric passenger cars share until 2030, there is a huge gap and a long road ahead.

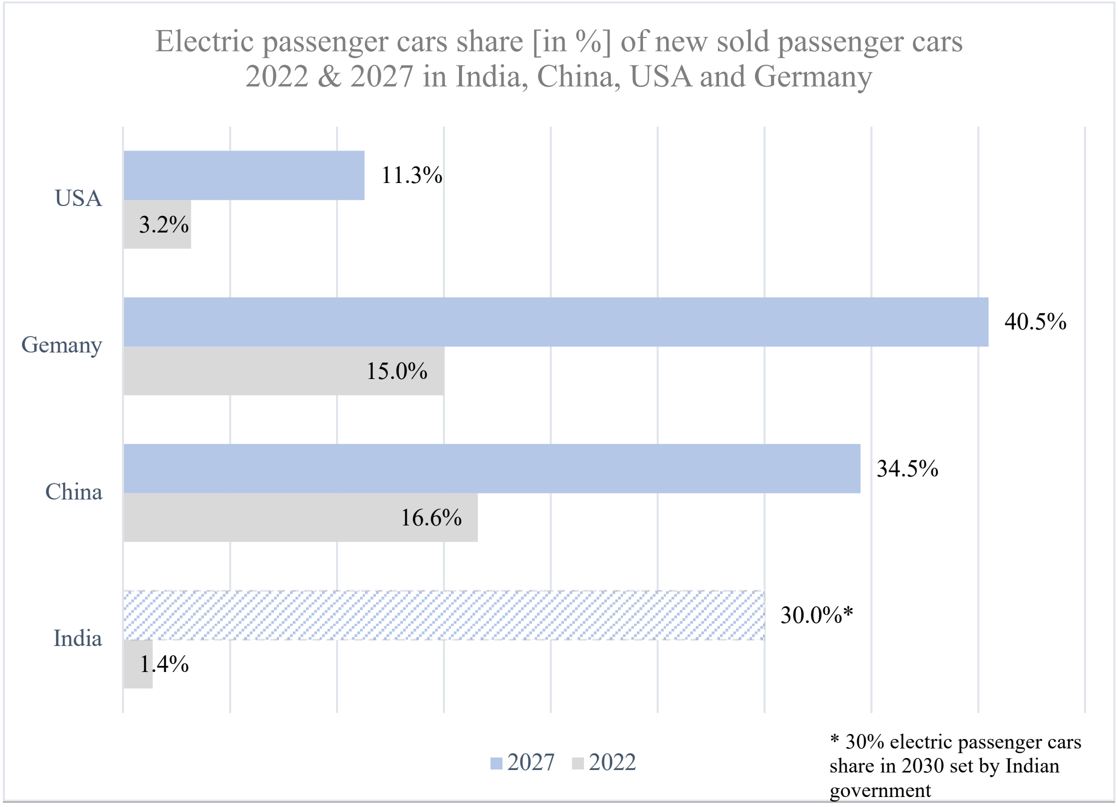

Figure 7 Electric passenger cars share of new sold passenger cars in 2022 & 2027 in India, China, USA and Germany

Source: own figure, adapted from (Statista, 2023b; Statista, 2023a)

2.3.1. Available electric cars

Currently, the majority of electric passenger cars on the Indian market are models from the two Indian manufacturers Mahindra Electric and Tata Motors. The cheapest one is the Tata Tigor EV with currently approx. 15,614 US$[23] and a range of 306 km

[2] Exchange rate INR/US$= 0.0125; data from Oanda. Available at: https://www.oanda.com/currency-converter/de/?from=INR&to=USD&amount=1; (Accessed at: 22.08.22)

[3] Data from Carwale; Available at: https://www.carwale.com/tata-cars/tigor-ev/; (Accessed at: 22.08.2022)

according to WLTP (Worldwide harmonized Light vehicles Test Procedure), while the most expensive one, the Porsche Taycan Cross Turismo, costs approx. 217,533 US$[4][5] with a range of 469 km according to WLTP. Those prices are compared to the average price of a new passenger car in India of 7,520 US$ quite high and therefore it is even more difficult to an Indian customer to afford an electric passenger car.

2.3.2. Current landscape of available charging infrastructure in India

There are several activities of different Indian governmental ministries and departments about the expansion of the charging infrastructure in the country. From governmental side there is the goal to promote the charging infrastructure in order to support the ambitious target to increase the market share of electric passenger cars in India. The government even established a committee to finalize the details for the charging infrastructure (Ministry of Power, 2021). The guidelines and standards were published by the Ministry of Power regarding tariff for supply of electricity, definitions of public charging stations and of battery swapping stations, as well as definitions of electric vehicle charging equipment. The key aspects are the following within the three phases (Ministry of Power, 2021, p. 55).

- "At least one Charging Station should be available in a grid of 3 km x 3 km in the cities and at every 25 km on highway, as well on roads"
- "Private charging at residences and offices shall be permitted and distribution companies may facilitate the same"
- "Phase I (1-3 years): 4 million new charging points including cities and connected expressways and important highways "

[4] Exchange rate INR/US$= 0.0125; data from Oanda. Available at: https://www.oanda.com/currency-converter/de/?from=INR&to=USD&amount=1; (Accessed at: 22.08.2022)
[5] Data from Carwale; Available at: https://www.carwale.com/porsche-cars/taycan-cross-turismo/; (Accessed at: 22.08.2022)

- “Phase II (3-5 years) – To target state capitals, university headquarters & important connected highways”

The current landscape of charging facilities in India is offering 1,742 public charging points (Business standard, 2022). According to a latest study, India needs to install up to 46,000 charging stations by 2030 in order to reach the global benchmark regarding the electric passenger car ratio (how many electric passenger cars per charging point) (The Hindu, 2022). Global benchmark in 2022 was Netherlands with 4 electric passenger cars per charging point; China is having a ratio of 8, the USA a ratio of 24 and Germany a ratio of 26 (Statista, 2022f).

2.3.3. Current governmental incentives

In 2015, the Indian government launched Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicle (FAME) scheme under which the government has set aside subsidies to provide discounts on purchase of electric passenger cars (two-, three- and four-wheelers). The aim is to incentive progressive introduction of electric passenger cars in India; the focus is here more on the expansion of affordable and environmentally friendly public transportation system for everyone. The first phase was initially approved for two years and has been extended from time to time. In 2019 the phase 2 of FAME has been approved for a period of three years. The ambitious target of the government is to sell 6 -7 millions of hybrid and electric vehicles (2-, 3- and 4-wheelers) year on year from 2020 onwards (Ministry of Heavy Industries, 2022a). Until 2021, 154 models (electric two-wheelers, three-wheelers, electric buses and electric cars) are available under the scheme of FAME and 180,614 vehicles have been sold till now. The scheme subsidies on a „per kWh of battery capacity” basis. 10,000 Indian rupees (125 US$)[6] per kWh for electric three-wheelers and electric four-wheelers with a cap at 20% of the cost of vehicle and 15,000 Indian rupees (187.5 US$)[7] per kWh for electric two-wheelers (Ministry of Heavy Industries, 2022b).

On top of that also the expansion of a solid and an area-wide charging infrastructure will be supported by FAME. Furthermore, the GST-tax (goods and service tax) on electric vehicles was reduced from 12% to 5%, as well as on charging stations for electric passenger cars from 18% to 5% (Ministry of Heavy Industries, 2022b) .

2.4. Conclusion

Chapter 2 provided an overview of key background information related to the research question and to better understand Indian market conditions.

India´s population will continue to grow and will become the most populated country in the world in 2030. Being a very densely and very young populated country, the trend towards urbanization and further mega cities will continue. Furthermore, among the compared countries India is having the strongest GDP growth rate with +6.2% until 2027 from which of course the car industry can also benefit. Additionally, it was shown that the passenger car market will grow until 2030 and that huge sales potential are possible based on the present car-ownership of only 1.7%.

However, there are still a lot of topics to be addressed in order to close the gap between today´s electric passenger cars share of 1.4% and the ambitious goal of the Indian government to achieve 30% share of electric passenger cars until 2030. The current offered electric passenger cars in India are at a relative high price level, especially in the light of the average income in India. Also, the daily one-way commuting distances

[6] Exchange rate INR/US$= 0.0125; data from Oanda. Available at: https://www.oanda.com/currency-converter/de/?from=INR&to=USD&amount=1; (Accessed at: 22.08.22)

[7] Exchange rate INR/US$= 0.0125; data from Oanda. Available at: https://www.oanda.com/currency-converter/de/?from=INR&to=USD&amount=1; (Accessed at: 22.08.22)

differs from other big electric passenger car markets such as the USA or Germany. Additionally, the scarcity of public charging points remains a major obstacle to the government´s green e-mobility targets.

Looking on the forecasted figures regarding population, GDP and new passenger car market growth, there is a huge potential for the car industry in this country. This growth implies that the transportation sector will continue to grow in importance, making the need for decarbonization all the more important in India in order to meet the ambitious target to become climate-neutral in 2070. Since the transportation sector is responsible for 9% of India´s greenhouse gas emissions, whereof the road transport accounts 90% of the transportation sector´s final energy consumption (Statista, 2022c; NewClimate Institute and Climate Analytics, 2020). Therefore, addressing the right influencing factors about the acceptance behaviour of electric passenger cars leverages the market potential and supports the target to achieve 30% share of electric passenger cars until 2030.

The following chapter will present the theoretical background of the applied Technology Acceptance Model and its application over time.

3. Theoretical Background - Technology Acceptance Model

3.1. Introduction

The following chapter demonstrates the theoretical background of the Technology Acceptance Model used in this research. After showing the general developing processes and the adaption of technologies, the significance of the acceptance of technologies and innovations will be described since this is the major key of a successful market penetration. The main models about the acceptance of technologies will be discussed before the "Technology Acceptance Model" (TAM) and its development over time will be explained in detail since this is the core model of this thesis. Moreover, justification for choosing TAM for this research is given.

3.2. Definition: Technology & Innovation

The term “technology” has been viewed and defined from many angles in literature resulting in many various definitions.

A technology can be "[...] Those devices, instruments and knowledge that mediate between input and output variables (process technology) and/or create new products and services (product technology)" (Tushman and Anderson, 1986, p. 440). A technology usually has both a (material) hardware component in the form of products and an (immaterial) software component consisting of knowledge, skills, processes and regularities (Rogers, 2003). Depending on its characteristics, technologies can therefore assume a more material or more immaterial character.

In his view of innovation, Rogers (2003) emphasizes the character of perceived novelty and describes innovations as "[...] Ideas, practices or objects that are perceived as new by an individual [...]. It is irrelevant whether this idea is 'objectively' new. The decisive factor is the perceived novelty" (Rogers, 2003, p. 11).

Innovation descend from the Latin word “innovare”, which means “innovate”. Innovation is crucial in business context since it is the base for creating sustainable value and to be strong against competition. However, when companies think about innovation they often associate it with something risky, costly and time consuming (Costello and Prohaska, 2013).
The economist Joseph Schumpeter (1883 - 1950), who is one of the 20th century's greatest intellectuals, defined innovation as the translation of new combinations into reality: "the doing of new things or the doing of things that are already done, in a new way" (Schumpeter, 1947, p. 151), always thinking of the first implementation of an innovation. Innovation thus comprises the following five cases for Schumpeter (Schumpeter, 1934; Schumpeter, 1939).

1. Production of a new product or a new product quality
2. Introduction of a new, as yet unknown production method (but does not have to be based on an invention)
3. Opening up a new market where an industry was not yet 'established' (whether or not it existed previously)
4. Opening up a new source of supply of raw materials or semi-finished products
5. Carrying out a reorganization (such as the creation or abolition of a monopoly position)

Rickards (1985) adds to the innovative character the novelty of the combination of end and means. According to his definition, innovation describes the process of comparing problems (and there with the need) with solutions which meet the respective problem in a new, previously unheard-of way (Rickards, 1985).

With a more complex model, Boer and During go beyond the relationship between ends and means by defining innovation as the generation of a new product-market-technology organization combination (Boer and During, 2001). Innovations are not realized as an end in themselves, but companies pursue certain goals with their realization. Albach (1994) describes the goal of innovation as "to overcome the limits and limitations of man and thus to improve his material and spiritual well-being" (Albach, 1994, p. 77).

3.3. Innovation Process

Innovation process can be understood as a guideline or standardization of innovation activities (Verworn and Herstatt, 2000). Innovation processes require an adapted process control; the special feature of the control of innovation processes in the area of production innovations lies in the uncertainty about the type and scope of the tasks to be performed, the high complexity of the area of application and its environment within the production as well as the often-associated high risk (Boer and During, 2001).

Boer and During structure an innovation process into three categories: problem solving, internal diffusion, and organizational adaptation (Boer and During, 2001), as presented in figure 8. At the beginning of the process is an initiating trigger – an urge or an opportunity to innovate. After the innovation problem has been defined, new ideas and opportunities are developed, evaluated and selected. This results in the applications stage, where the innovation is assed in practice. The next step is the internal diffusion as [..] “the ongoing process of communication and information processing that acts as the ‘glue’ tying together the other activities“ (Boer and During, 2001, p. 92).

The organizational phase determines the success or failure of an innovation if the innovation will be adapted by the management processes and by the organizational arrangements; this results in the final outcome of the implemented solution.

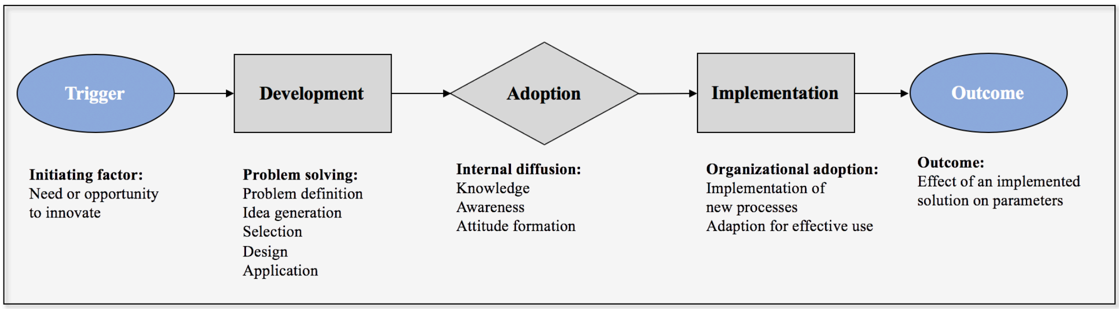

Figure 8 Innovation process phases

Source: own figure, adapted from (Boer and During, 2001, p. 91)

3.4. Theory and models about acceptance of technologies and innovation

Studies on the acceptance of innovations make particularly frequent use of the major theories of social psychology, such as the "Theory of Reasoned Action" and the "Theory of Planned Behaviour". These two theories are designed to explain human behaviour as a whole and can therefore be applied to the acceptance of innovations. In contrast, the theory of innovation diffusion focuses specifically on the process of innovation adaptation. As a rule, the basis for the application of the theories is individual data, e.g., Data obtained from surveys. In the area of innovation diffusion, aggregated data is also used. In addition, the analysis here is often carried out from a company perspective.

Particularly much research on the acceptance of technological innovations has been conducted in the field of information technology over the last 40 years. The introduction of computers in companies as well as the spread of various programs to make work easier have increased the need for studies. To explain the acceptance of information systems, the "Technology Acceptance Model" was developed on the basis of the Theory of Reasoned Action and the Theory of Planned Behaviour. This model was initially only used in the narrower field of information technology.

3.4.1. Theory of Reasoned Action

The Theory of Reasoned Action (TRA) is drawn from social psychology and it forms as a general behaviour model in the area of image research a major approach how to describe human behaviour; therefore, it is a one of the most fundamental and influential theories (Venkatesh *et al.*, 2003).

Fishbein and Ajzen (1975) developed a model where salient beliefs influence deliberately the behaviour of individuals. The core constructs are “attitude towards behaviour” and “subjective norm”. The model is based on the emotional assessments and perceptions (of the respective person), which precede the attitude and which directly determine the individual behaviour via the behavioural intent (Schierz, 2008). The basic assumption is that a person's opinion directly influences his or her attitude. The attitude in turn determines the behavioural intention and thus the individual behaviour. Opinions are derived from evaluations of the consequences of behaviour (Ajzen and Fishbein, 1980). Persons who expect the same consequences can have different attitudes if they evaluate the consequences differently or if their opinion is different. Moreover, the attitude may remain the same even if personal views change. In most situations, a small number of views are crucial for forming attitudes (Ajzen and Fishbein, 1980).

Besides attitude, the subjective norm, the perception of social pressure is an important determinant of behavioural intention and behaviour. A person's behaviour is thus influenced by what he or she thinks his or her environment expects of him or her. This social pressure can of course be perceived in different ways and to different degrees. According to TRA, the attitude towards behaviour and the subjective norm together form the intention of use. The intention of use, in turn, is the direct determinant of behaviour and thus allows the prediction of behaviour (Ajzen and Fishbein, 1980). According to this theory, behaviour becomes predictable by referring back to the determinants of behaviour (attitude and subjective norm) and the determinants of attitude (opinions). „In a similar fashion, personality variables and traditional attitudes are sometimes viewed as residues of past experience or are assumed to influence the person's interpretation of his environment and thus the beliefs he holds" (Ajzen and Fishbein, 1980, p. 90 f.).

The external influences are deliberately excluded in the models of Ajzen and Fishbein, because the researchers assume that they only have an indirect influence on one of the two variables, attitude or subjective norm. External variables are linked to opinions that underlie a behaviour. Thus, opinions can provide insights into influencing factors and increase the understanding of the behaviour (Ajzen and Fishbein, 1980). Figure 9 gives an overview about the core constructs and the respective dependency and relation (Fishbein and Ajzen, 1975).

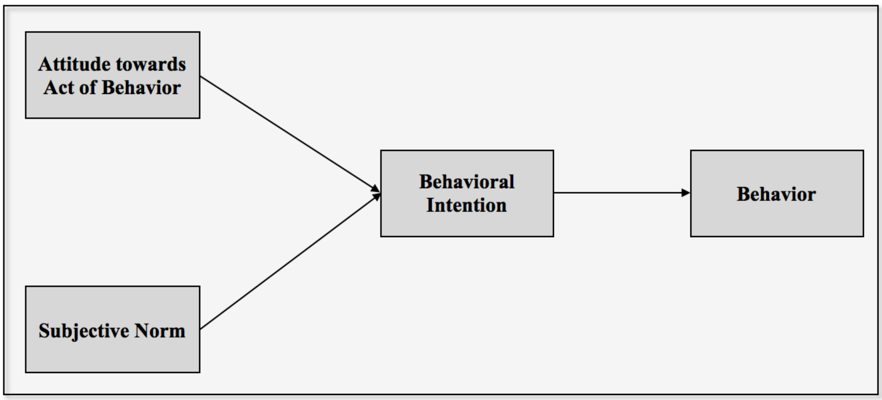

Figure 9 Theory of Reasoned Action

Source: own figure, adapted from (Fishbein and Ajzen, 1975, p. 15 ff.)

3.4.2. Theory of Planned Behaviour

The Theory of Planned Behaviour (TPB) after Ajzen (1991) is an extension of the Theory of Reasoned Action by the element of Perceived Behavioural Control (Ajzen, 1991). Here, perceived behavioural control is added as a third factor influencing behavioural intention, as shown in figure 10.

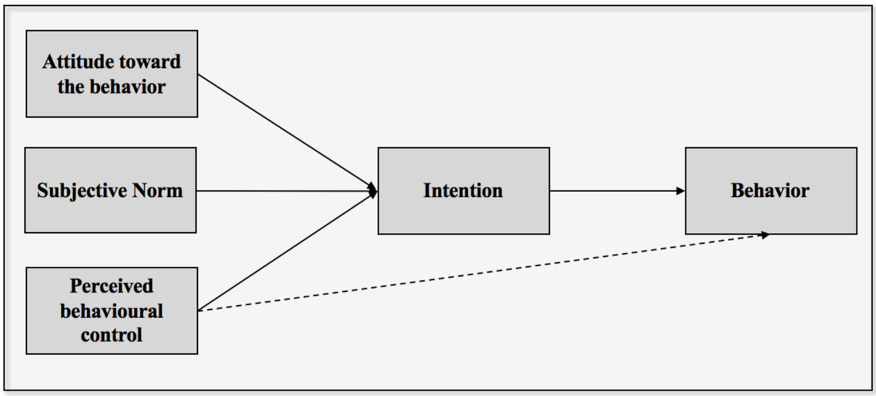

Figure 10 - Theory of Planned Behaviour

Source: own figure, adapted from (Ajzen, 1991, p. 182)

In the model of TPB, the behavioural intention is now influenced by the constructs of individual attitude, the subjective norm and the perceived behavioural control. The additional construct of perceived behavioural control is intended to explain the behavioural intention for all those situations in which the individual is influenced in his decision by the conditions necessary for the execution of the action (Ajzen, 1991). In contrast to the structures of individual attitude and the subjective norm already known from TRA, the additional construct of perceived behavioural control determines actual behaviour directly, in addition to the indirect effect via the behavioural intention (Ajzen, 1991). This can be explained that the higher subjectively perceived behavioural control of the individual, the greater the willingness to invest effort. The person who is more confident in successfully accomplishing the specific task within the scope of his or her abilities will show a correspondingly higher degree of persistence than the person who is less confident and uncertain about the positive outcome of his or her efforts. Furthermore, Perceived Behavioural Control usually shows a high correlation with Actual Behavioural Control and can be used as its substitute or approximate value (Ajzen, 1991). Both the Theory of Reasoned Action and its extension, the Theory of Planned Behaviour, are fundamental models for describing and mapping human behaviour (Bandura, 1982).

3.4.3. Technology Acceptance Model

The "Technology Acceptance Model" was developed as part of the PhD thesis of Davis et al. Published in 1989 and it is an adaption of TRA. So far, the TAM has mainly been used in the field of business informatics since it was initially tailored for modelling user acceptance of information systems (Davis, 1989).
“The goal of TAM is to provide an explanation of the determinants of computer acceptance that is general, capable of explaining user behaviour across a broad range of end-user computing technologies and user populations, while at the same time being both parsimonious and theoretically justified” (Davis, Bagozzi and Warshaw, 1989, p. 485). TAM is a model specially adapted to the study of technology acceptance, while both the TRA and the TPB are general models for understanding human behaviour (Venkatesh, Davis and Morris, 2007).

3.4.3.1. Structure of Model

According to TAM, the use of a person's interest in a technology depends on two factors: perceived usefulness and perceived ease of use, as presented in figure 11. Perceived usefulness is defined as the degree to which people are convinced that using a particular system increases their work performance and thus benefits them. Perceived ease of use describes the degree of physical or mental effort that accompanies a person's use of a particular system (Davis, 1989).

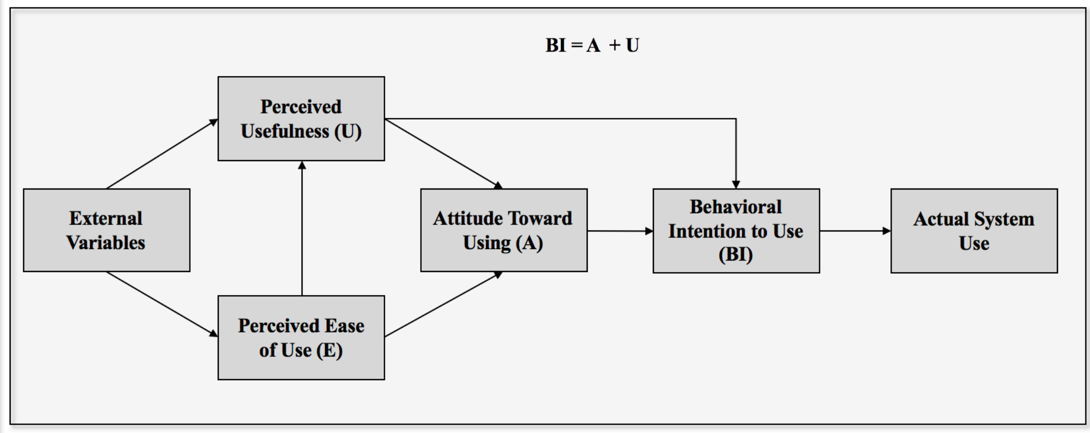

Figure 11 - Technology Acceptance Model

Source: own figure, adapted from (Davis, 1989, p. 320)

With the two constructs of Perceived Usefulness and the Perceived Ease of Use an Attitude towards Use is first formed, which is an essential predicator for the Actual Use of the System.

The resulting Attitude forms the Behavioural Intention to Use which directly affects the Actual Use of the System - in analogy to the Theory of Reasoned Action.

Davis (1989) was able to show that both the construct of Perceived Ease of Use and the Attitude toward Using have a direct impact on Perceived Usefulness (Davis, 1989) (Venkatesh and Davis, 2000), because a system with otherwise unchanged conditions the simpler it is to operate (Davis, 1989). Furthermore, Davis was able to demonstrate a direct effect of Perceived Usefulness on Behavioural Intention to Use (without the intermediate construct of Attitude toward Using).

Additionally he showed that the Perceived Ease of Use influences more the Actual System Use compared to the Perceived Ease of Use – this was also demonstrated in later studies (Davis, 1989). Davis eliminated the influence of Subjective Norm compared to TRA because its impact on the system usage is too small and since it is according to Fishbein and Ajzen acknowledge one of least understood aspects of TRA (Davis, Bagozzi and Warshaw, 1989).

In addition to what Davis considers to be the inadequate justification for the influence of the subjective norm in TRA's model, Davis criticizes the fact that it is not possible to distinguish between the direct influence of the subjective norm on behavioural intent and indirect influence via attitude toward using (Davis, Bagozzi and Warshaw, 1989). Critics of the model point out, however, that the selected influencing factors of the TAM are not sufficient to adequately reflect a complex issue such as acceptance formation (Amberg, Hirschmeier and Wehrmann, 2004).

The authors have taken this objection into account by including further influencing variables in the model. In a follow-up study, for example, they operationalized the external stimuli that were initially not specified in the original model; this extended model is called TAM 2, as illustrated in figure 12.

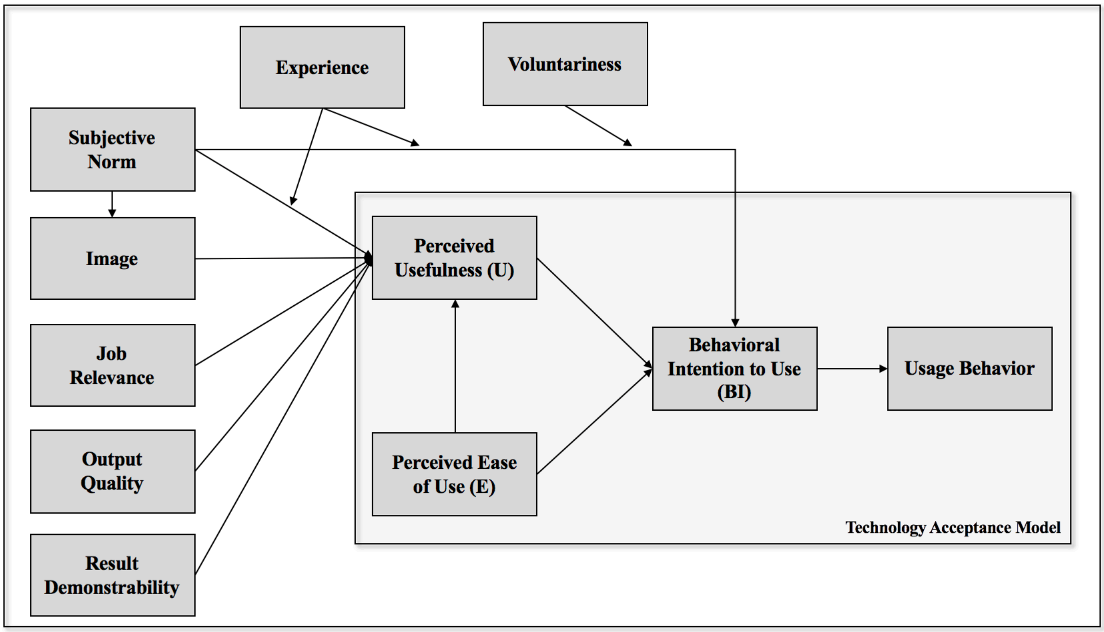

Figure 12- Technology Acceptance Model 2

Source: own figure, adapted from (Venkatesh and Davis, 2000, p. 188)

It explains the influence of social and cognitive-instrumental process variables both on the perceived benefit and directly on the intention of use. By social process variables Venkatesh and Davis (2000) understand the subjective norm, the voluntariness of use and the image of the information system. Cognitive instrumental process variables are the relevance of the system for the occupational field of activity, the quality of results and the perceptibility of the results of the information system. The results of the study show that social process variables exert a strong influence especially at the beginning, but this influence decreases with increasing experience with the system. The correlation is influenced by the voluntary nature of the use. The effect of the cognitive-instrumental process variable is stable over time and independent of the voluntary nature of its use. This is where the third further development of the model (TAM 3) by Venkatesh and Bala (2008) comes in, s. figure 13. The focus shifts from explaining how and why acceptance is achieved to the evaluation of targeted intervention options. In order to achieve this goal, six factors are included in the model that can serve as levers for influencing acceptance (Venkatesh and Bala, 2008):

1. The self-confidence of a user in handling the information system
2. The exercise of external control
3. The system fear of a user
4. A playful approach of the user to the information system
5. The perceived pleasure of using the information system
6. The user-friendliness of the information system

All six factors are integrated into the model as direct influences on the perceived ease of use.

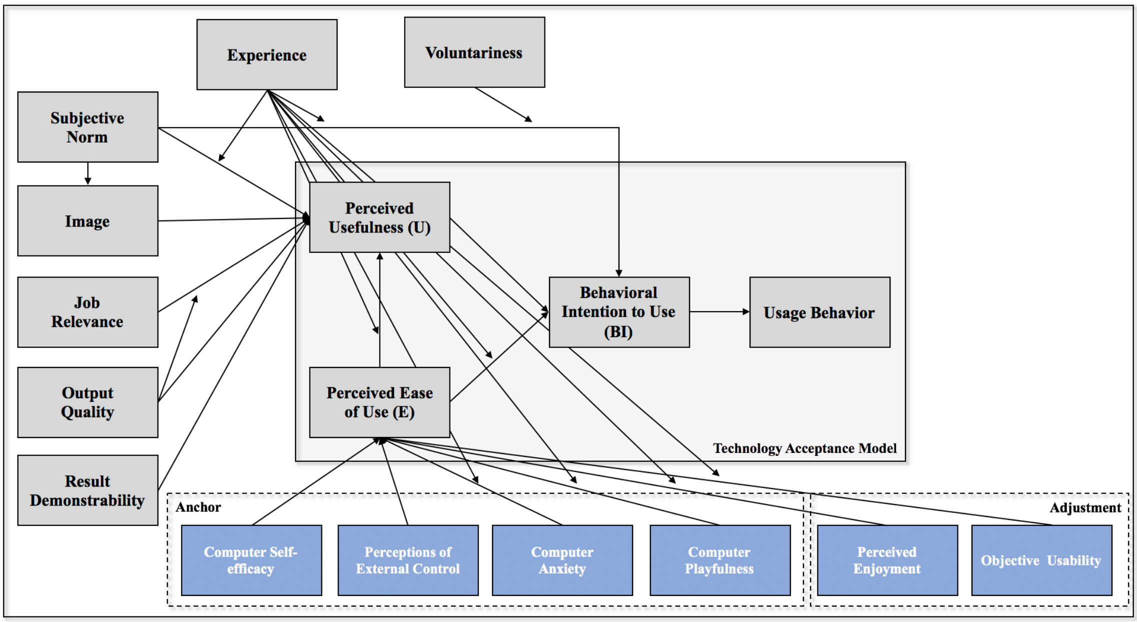

Figure 13 - Technology Acceptance Model 3

Source: own figure, adapted from (Venkatesh and Bala, 2008, p. 280)

3.4.3.2. Current State of Research of TAM

The following chapter demonstrates why TAM has been chosen for this research. First the current state of research will be shown based on publications which used TAM. Afterwards the development of TAM, as well as the adaptions throughout the years will be presented. Finally, the gap of research of TAM and its extensions will be demonstrated.

For analysing the numbers of publications using TAM, the well-known research database “Web of Science” was used, which is covering the world’s top science and technology books, journals and conference papers. The database includes from 1970 – 2020 in total 1.7 billion cited references, over 155 million records and over 34,000 journals (Web of Science Group, 2020). The query for “TAM” on Web of Science on March 30th, 2020 dropped out 14,605 results:

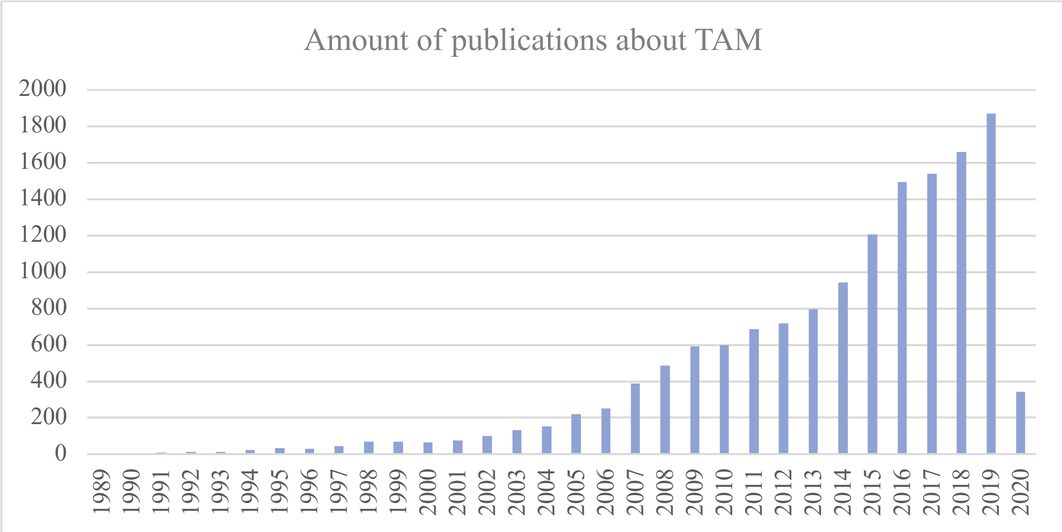

Figure 14 – Total amount of TAM publications listed by year of publishing[8]

Source: own figure

Figure 14 demonstrates the continuously growth and importance of TAM and indicates that this over 30-year-old model is still a base of worldwide research in the field of technology acceptance.

Moreover, by analysing the categories in Web of Science, it becomes clear that the usage of TAM in in the context of communication and computer systems is still present today, as well as the application in Management. This may be because the increased use of new information and communication technologies in both the private and professional spheres has led to the need to understand the human acceptance factors relevant for successful introduction and to design the corresponding information systems, accordingly, as shown in figure 15.

[8] Source: own figure

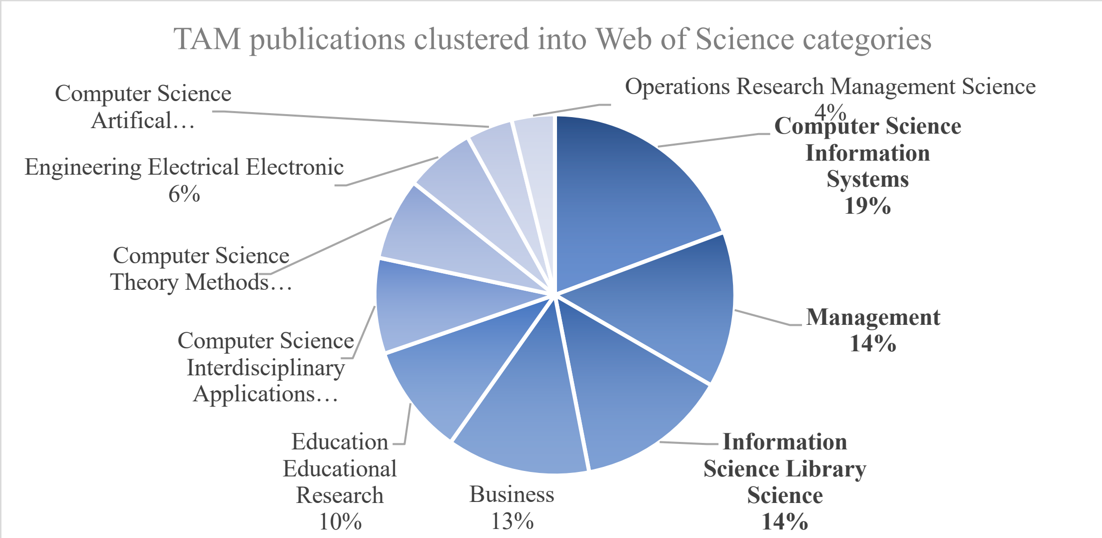

Figure 15- TAM publications clustered into Web of Science categories

Source: own figure

USA, China and Taiwan have published the most records about TAM; India takes the 11th place with 3% of the total TAM publications in Web of Science, as presented in figure 16.

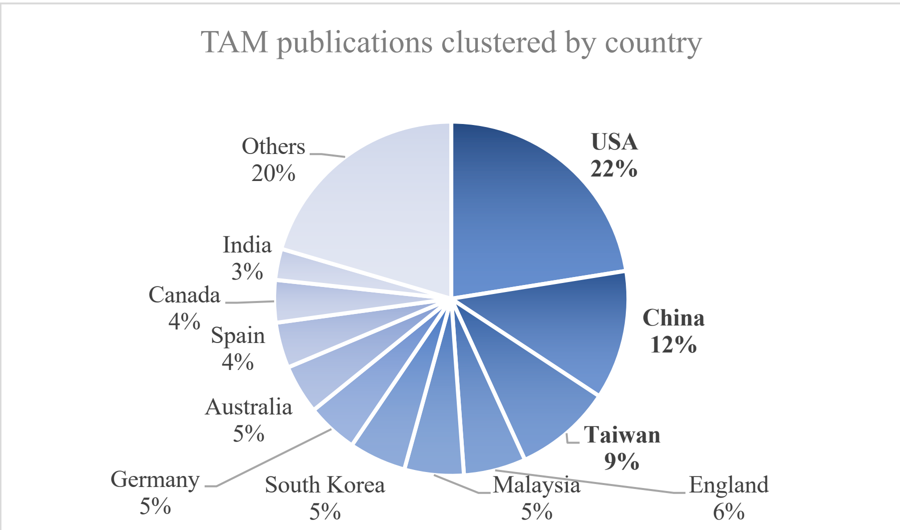

Figure 16 – TAM publications clustered by country/regions

Source: own figure

3.4.3.3. *Chronological Development of TAM Research*

Lee et al. (2003) describe the development of research on TAM over time using four developmental phases. They distinguish the introduction phase, the validation phase, the extension phase and the development phase of the model (Lee, Kozar and Larsen, 2003). The development of the TAM is summarized in figure 17.

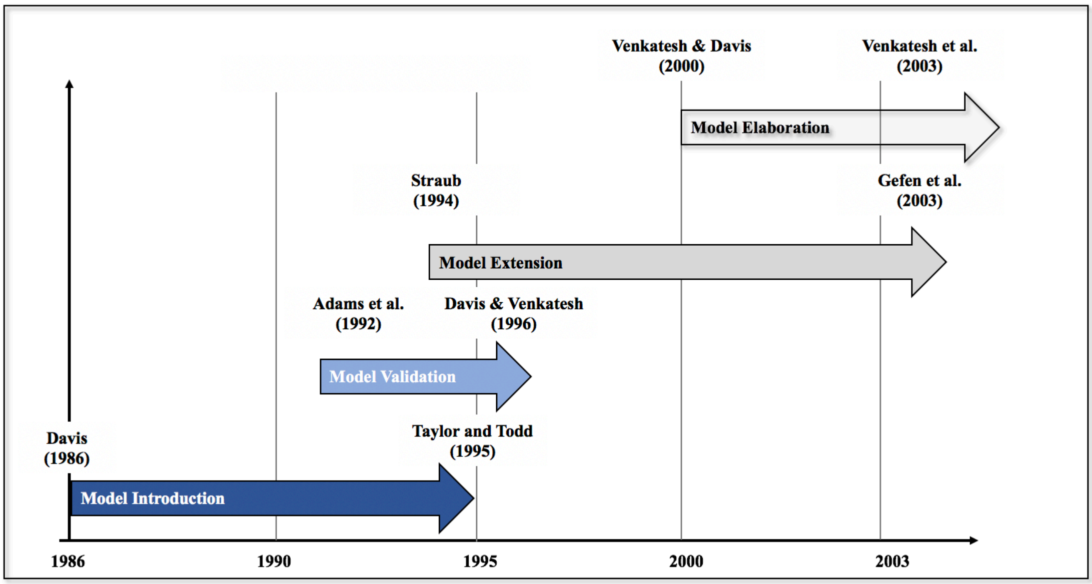

Figure 17 - Chronological development of TAM research

Source: own figure, adapted from (Lee, Kozar and Larsen, 2003)

In the introductory phase, the majority of the published studies are complete replication studies of the original model (Adams, Nelson and Todd, 1992) or comparisons between the TAM and the 'Theory of Reasoned Action' (TRA) developed by Ajzen and Fischbein (1980) (Taylor and Todd, 1995).

In the validation phase, however, the main focus is on ensuring the stability of the model. In the majority of studies, the TAM proved to be a consistent and valid instrument for measuring the acceptance of new information technology (Davis and Venkatesh, 1996).

The aim of most of the studies in the extension phase was to explore the limits of the TAM's application possibilities. In this phase, additional variables were included in the model in order to explain differences in acceptance in the use of information technology (Venkatesh and Davis, 2000).

Straub et al. for example compared TAM for IT adoption across Switzerland, Japan and the United States due to the fact that the most TAM researchers have applied the model until then only for North America (Straub, Keil and Brenner, 1997). The results of the study suggested that the TAM model may not predict IT adoption equally well across cultures (Straub, Keil and Brenner, 1997). From the development of the Technology Acceptance Model 2 by Venkatesh and Davis (2000) and, at the latest, the proposal for an integrated model (Unified Theory of Acceptance and Use of Technology) by Venkatesh et al. (2003), it can be spoken of a phase of model elaboration of TAM in which an increasingly context-specific application of TAM has taken place (Venkatesh and Davis, 2000; Venkatesh *et al.*, 2003). Thus, Venkatesh and Davis (2000) succeeded in further increasing the explanatory power of the model by including further constructs within TAM 2 (Venkatesh and Davis, 2000).

3.5. Conclusion

This chapter presented the theoretical background of the Technology Acceptance Model which is used for this research. One reason for using TAM was that this methodology is still a popular, growing and flexible methodology. Moreover, it will be applied not only in computer sciences and communication systems, wherefrom it originates, but also in management. This justifies the application of this method for this present research.

The original TAM model is the base for developing the Technology Acceptance Model for electric passenger cars in India, s. chapter 5.3. and it will be extended by further external influencing factors, which will be identified through the conducted systematic literature review and the conducted expert interview in the next chapter 4.

The following chapter will present a conducted systematic literature review based on defined research question. The goal is to identify what kind of major influencing and rejecting factors are present in literature and to define which influencing factors are crucial to further analyse in the context of this thesis to study the acceptance behaviour towards electric passenger cars in India using the Technology Acceptance Model.

4. Systematic literature review

4.1. Introduction

There are classic customer surveys available when it comes to the question of purchase reasons or purchase barriers regarding electric passenger cars. However, such research is only published for the biggest markets of electric passenger cars such as China, Germany and USA, but not for India.

In China for example people purchase electric passenger cars due to the environmental friendliness (66%), governmental incentives (60%) and because charging costs less than petrol (59%) (Statista, 2019c). Obstacles are with 49% the lack of public charging points, 44% of short battery life and 32% are waiting until the technology is more developed (Statista, 2019b).

A latest study in Germany from 2021 showed in that people buy electric passenger cars because of ecological aspects (55%), followed with 20% because of tax incentives and 8% because of the pioneering spirit of electric passenger cars (Statista, 2021b). Reasons to not buy electric passenger cars in Germany are with 71% the high purchasing price, 64% lack of public charging points and 62% more expensive electricity prices (Statista, 2023c).

Reasons to buy an electric passenger car in the USA are environmental concerns (62%), lower fuel costs (54%) and no congestion charge (32%) (The Automobile Association, 2022). Barriers to not buy an electric passenger car in the USA are 61% the insufficient charging infrastructure, 55% distance on a full charge and 52% costs of purchase, owning and maintenance (Bartlett, 2022).

In addition to those classic customer surveys and in order to analyse what are the key influencing factors about the acceptance behaviour of electric passenger cars, the author of this thesis conducted a systematic literature review approaching the subject step by step in an iterative and systematically process starting from extracting knowledge from existing literature. The goal was to gain deep knowledge and understanding of the major influencing factors that exists in the context of acceptance behaviour of electric passenger cars. Since e-mobility is continuously evolving, the author of the thesis analysed existing literature in total two times in an iterative process in order to validate the findings and results. The first systematic literature review (SLR) was conducted in January 2019 and the results were validated afterwards through qualitative expert interviews. The second systematic literature review, also analysing grey literature, was conducted in October 2022 to substantiate the findings. The next section explains how a systematic literature review is structured and how the author of the thesis conducted the review.

4.2. Structure of systematic literature review

The literature review was conducted using the method of a systematic literature review. "Systematic reviews are undertaken to clarify the state of existing research and the implications that should be drawn from this" (Feak and Swales, 2009, p. 3). A SLR tries to use a methodological formal approach in order to decrease distortions and to improve the dependability of a literature selections (Tranfield, Denyer and Smart, 2003). A SLR combines qualitative and quantitative assessment to analyse a special theme (Brewerton and Millard, 2001). A SLR will be conducted through different phases, which will be defined within the literature as shown in figure 18 (Fink, 2014; Guba, 2008; Tranfield, Denyer and Smart, 2003).

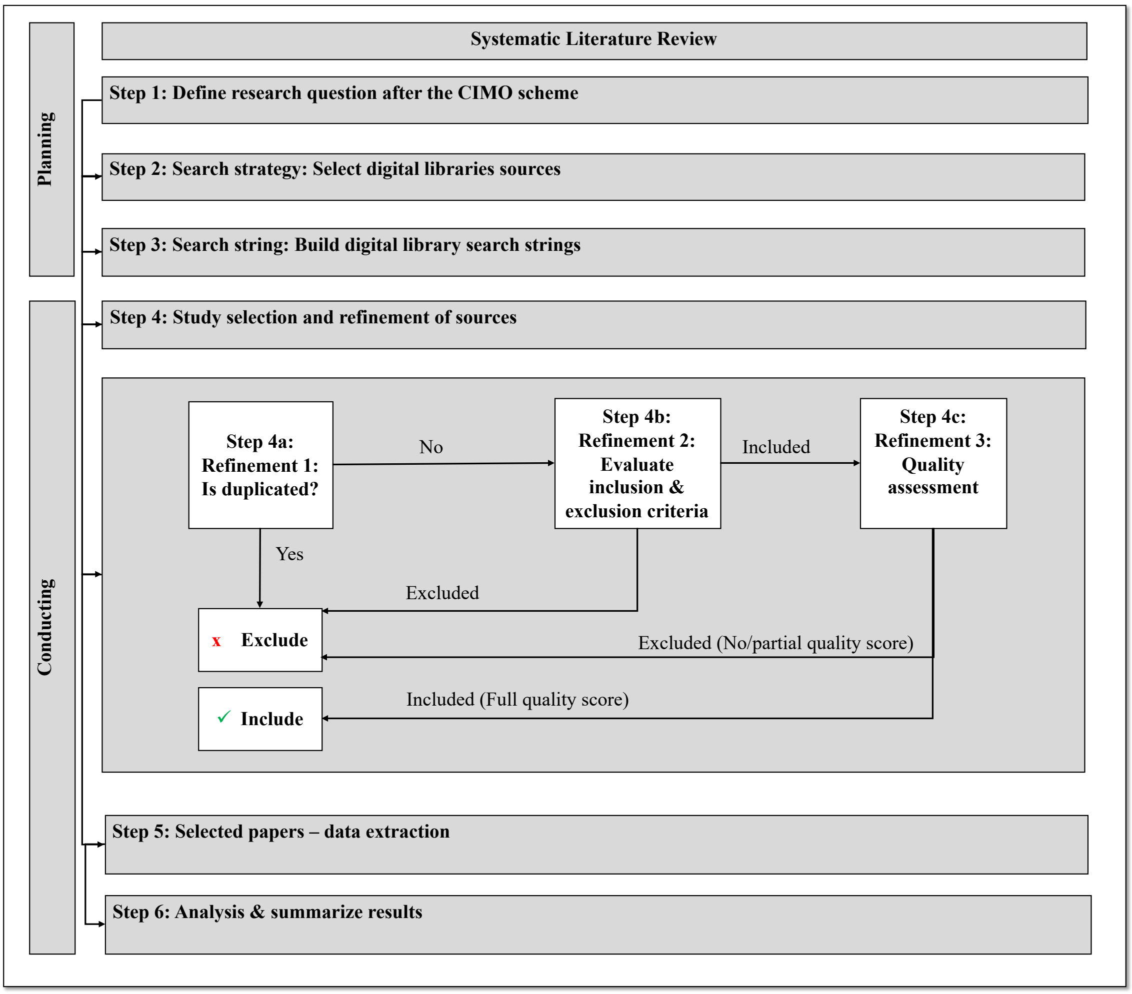

Figure 18 Structure of systematic literature review

Source: own figure

The target is to present how other studies and publications have addressed the topic of the acceptance of e-mobility and what has been determined as key factors (obstacles and incentives) towards the acceptance of electric passenger cars. This has been done in order to determine knowledge gaps and to contribute for further research related to the acceptance of e-mobility.

4.2.1. Definition of research questions after CIMO-scheme

Specifying the research questions is the most important part of any SLR and therefore the first step before conducting a SLR. In order to define clearly and answerable research questions Briner et al. developed the “CIMO- scheme” for economics: (Briner, Denyer and Rousseau, 2009, p. 25).

“Context”. Which stakeholders (individuals, dealings, institutions, social frameworks etc.) are being analysed?
“Intervention”. The outcome of what occasion or activity is analysed?
“Mechanisms”. What are the structures that describe the relations between interventions and outcomes? On what terms are these structures being activated or not activated?
“Outcomes”. What are the outcomes of the intervention? How will the effects be assessed? What are the planned or not planned effects and side effects?
The research question (RQ) for defining the search string in chapter 4.2.3 is the following:
RQ: Which factors are influencing the acceptance behaviour of customers towards electric passenger cars?

4.2.2. Search strategy: Select digital libraries sources

After defining the research question, the selection of sources for the systematic literature review is described. The author of this thesis conducted the first systematic literature review in January 2019 using two electronic literature databases “Web of Science” and “Scopus”. Those databases are the biggest worldwide-used citation databases and are the most respected ones for peer-reviewed literature. Since e-mobility is continuously evolving, the SLR was conducted a second time in October 2022, this time also including grey literature by using the online database “Base-search”[9].

[9] Base-search is a search engine especially for academic web resources and provides more than 240 million documents from more than 8,000 content providers. BASE is operated by Bielefeld University Library.

„Grey literature is information produced outside of traditional publishing and distribution channels, and can include reports, policy literature, working papers, newsletters, government documents, speeches, white papers, urban plans, and so on“ (McKenzie, 2022). Grey literature can be more current and provides insights into actual topics in research. However grey literature does not go through a peer review process and therefore the quality is not yet assured and can vary (McKenzie, 2022).

4.2.3. Search string: Build digital library search strings

After the literature databases and other research sources have been selected, the search terms were defined. For this purpose, the research topic and research questions are broken down into equal-ranking blocks of terms. This approach is called block-building method (Guba, 2008). Based on the defined research question, the first step is to determine the search parameters. The aim is using a key word matrix to achieve the largest number of synonyms for the part key words. For each of these topic blocks, text words, synonyms, generic terms, subordinate terms, related terms phrases and controlled vocabulary are identified from the thesauri of the databases to be searched. A word list can help to systematically define the right search terms. After defining the word list, Boolean operators (AND, OR and NOT) support the search queries for the databases. Those simple words are used as conjunctions to combine or exclude keywords in order to make the search queries more precise (Alderman, 2014). Table 6 presents the block-building method “Factors influencing the acceptance behaviour of customers towards electric passenger cars” using the Boolean operators. The term “India” was deliberately left out in the block-building method in order to increase the search range since there are very limited publications available about this topic in India. Moreover, there are good research available on the relevant influencing factors in other big electric passenger car markets such as in USA, China or in Germany, where it makes sense to draw conclusions from for the Indian market.

Table 6 Block building method "Acceptance of e-mobility"

Source: own figure

Topic	Factors influencing the acceptance behaviour of customers towards electric passenger cars			
Core concept of the topic	Acceptance	Electric passenger cars	Customer	Methodology
Synonyms	Approval, admission, acknowledgment, compliance, consent, confirmation, agreement	Electric vehicles, Electric automobile, EVs, full battery electric vehicles	Purchaser, buyer, client, shopper, end-user	Approach
Generic term	Adoption	E-mobility	Consumer	Technique
Subordinate term	Affirmation	Alternative powered vehicles	Driver, vehicle owner	Mode, procedure
Related term	Reception	New drive, new automotive technology	Prospect	Process

4.2.4. Study selection and refinement of sources

With this step the conducting phase of the systematic literature review starts. The search items will be used to search for the relevant papers in Web of Science, Scopus and in Base-search. The author conducted the first SLR in January 2019. The query on Web of Science dropped out 989 results and the query on Scopus 1,115 publications. In October 2022 the SLR was conducted a second time also analysing grey literature using Base-search as online database. This time, Web of Science dropped out 1,059 results, Scopus 1,277 results and Base-search 355 results. The next step is to further narrow down the results by refining them through the following steps.

- Step 4a: Refinement: Check duplications

In this refinement step duplications of the selected publications within the databases were deleted.

- Step 4b: Refinement: Evaluate inclusion & exclusion criteria

The author decided to include the papers with the following inclusion criteria:

- The paper published in the timeframe between 2012 and 2022 because the most publications have been published during that time and since e-mobility only really took off with the successful launch of the Tesla Model S in 2012
- The contents of the article are available
- The article is written in English
- The paper provides background which is required to answer the defined research questions
- The article is accessible in the database

The author decided to exclude the papers with the following exclusion criteria:

- The papers not in the timeframe between 2012 - 2022
- Several versions of the paper
- Not associated with the defined research questions
- Not in English

- Step 4c: Refinement: Quality assessment

The last step of the refinement phase is the quality assessment to further narrow down the selected papers through quality criteria (QR). The author defined the following quality criteria:

- QR 1: The paper gives the description of the research questions defined

- QR 2: The paper provides the work been done within the timeframe from 2012 - 2022 in the field of acceptance of electric passenger cars
- QR 3: The paper gives details of the methodologies used for analysing the acceptance behaviour of electric passenger cars

Weights were assigned in the following manner:

- 1, if a question was completely explained
- 0.5, if a question was described to a certain extent
- 0, if the selected paper did not provide any details about the quality criteria

Only papers with the full quality score (3) were included as selected papers.

4.2.5. Selected papers – data extraction

After all refinement steps, there were in total the following number of selected papers. In January 2019, there were 77 in Web of Science and 85 in Scopus, in October 2022 there were 86 in Web of Science, 96 in Scopus and 24 in Base-search. The overlap between Web of Science and Scopus regarding the query in January 2019 was 113 publications, with 23 unique sources in Web of Science and 26 ones in Scopus. In October 2022 the overlap in the two databases were 127 publications, with 26 unique sources in Web of Sciences and 29 ones in Scopus.

4.2.6. Further refinement of the selected papers by the author

After all refinement steps and the quality check, the author decided to review the top 15 most cited publications in Web of Science and Scopus, as well as the latest three publications in Web of Science and Scopus and the latest three papers in Base-search (grey literature). Top 15 most cited publications since the "citation impact is an important indicator of scientific contribution because it is valid, relatively objective and, with existing databases and search tools, straightforward to compute" (Nosek *et al.*, 2010, p. 1292). Moreover, the author decided to review the latest three publications in Web of Science and Scopus since the publications, especially from 2022, are too new being not in the top highest ranked citation list but being very important in regards of the latest trends and findings about the topic of e-mobility. Finally, the author reviewed the latest three publications in grey literature since grey literature provides insight into current research topics.

4.2.7. Analysis of selected papers & summary of results

In the last step of the SLR, the content of the selected 21 publications was finally analysed. The researcher identified not only the influencing factors towards the acceptance behaviour of customers towards electric passenger cars, but also analysed the following questions:

- Is there a regional focus of publications about the topic of acceptance of electric passenger cars?
- Which methodologies were used in this context to analyse the acceptance behaviour towards electric passenger cars?
- What is the added value and the limitations of the findings?

The analysed and identified influencing factors were clustered by the author into the headline "TAM categories" in order use them afterwards for developing the technology acceptance model regarding the acceptance behaviour of electric passenger cars in India (s. chapter 5.3.). The following content analysis and review of the final 21 selected papers was done alphabetically (by author). The first section presents the Top 15 most cited publications in Web of Science and Scopus, the second section the three latest papers in Web of Science and Scopus and the last section the top latest publications in grey literature (Base-search).

4.2.7.1. Review top 15 most cited publications in Web of Science & Scopus

Egbue and Long (2012) conducted a survey among students and university staff in the USA in order to explore the consumer attitudes and perceptions about electric passenger cars. In their findings the following identified influencing factors towards the acceptance of electric passenger cars which were common among the surveyed group were identified. The surveyed group mentioned the costs of electric passenger cars (initial costs), as well as the charging infrastructure and tax credits to subsidize the costs of electric passenger cars as major influencing factors towards the acceptance of electric passenger cars.
Although the publication from Egbue and Long is dated back to 2012, the paper is the most cited one in the Top 15 ranking list and the identified major challenges will be still mentioned in newer publications, which will be presented later in this review. Limitations are of course that the surveyed group is limited only to students and to staff from university, where especially age and income vary (Egbue and Long, 2012).
The author categorized the identified influencing factors as follows: **Purchasing Costs and Governmental Incentives**.

Sierzchula et al. (2014) analysed the influence of financial incentives on the acceptance behaviour towards electric passenger cars through a literature review and a multiple linear regression analysis of 30 national vehicle market shares in 2012. The result was that especially financial incentives and local presence of electric passenger cars have an impact on the electric passenger car adoption rate (Sierzchula *et al.*, 2014).

Limitations are that Sierzchula et al. have not conducted an own field study and only used data from existing literature and derived more general influencing factors towards the acceptance behaviour of electric passenger cars by analysing 30 different countries without focusing on a specific target group. This makes it difficult to derive if those identified influencing factors can be also applied to the Indian market, especially since India was not among those 30 different countries; however, the results give a good indication about which challenges are common among many countries. The findings of this study were categorized from the author as follows: **Governmental Incentives and Perceived Visibility of Usage**.

Graham-Rowe et al. (2012) conducted a qualitative analysis in UK based on a semi-structured interview with consumers driving plug-in battery-electric and battery electric passenger cars. 20 consumers could experience and drive a plug-in battery-electric vehicle and 20 consumer a full battery electric vehicle throughout a period of 7 days. Afterwards they were asked about their experience. Most of the participants felt good by driving because they associated environmental benefits and a positive effect on their social status by using this technology. Meaning, the subjective norm, the perception of social pressure is an important determinant of behavioural intention and behaviour. On the other side, concerns were mentioned about the financial implications of purchasing a plug-in battery-electric or a battery electric vehicle, the uncertainty about the durability of the vehicles and its components, range anxiety (which means the fear of a car customer in regard to restricted driving range of electric passenger cars), lack of confidence in driving plug-in battery-electric or a battery electric vehicle and the concern about the impression of choosing an plug-in battery-electric or a battery electric vehicle (Graham-Rowe *et al.*, 2012). Advantages of this study by Graham-Rowe et al. were of course the real driving experience of the participants and the wide age range

(between 24 and 70 years), which gives more insights into different perception and awareness of driving experience.
However, restrictions of the survey were that they have not focused purely on full battery electric passenger cars and that the group of 40 participants was quite small in order to draw general conclusions regarding the acceptance behaviour towards electric passenger cars.
The identified influencing factors out of this study were categorized from the author as follows: **Subjective Norm, Purchasing Costs, Technological Risk and Technological Knowledge, Driving Range** (range anxiety)**, Anxiety of Usage and Visibility of Usage**.

Saxena et al. (2015) focused in their study on concerns like range anxiety and battery degradation towards the adoption of electric passenger cars. They analysed real travel data from electric passenger cars drivers in the USA in order to find out if batteries of electric passenger cars meet daily travel needs. They proofed that batteries of electric passenger cars with high energy capacity continue to provide sufficient buffer charge for unanticipated long-distance trips (Saxena *et al.*, 2015). Yet, Saxena et al. only analysed travel data and did not consider consumer perceptions towards concerns about range anxiety. However, with data from 159,844 households of a random sample of drivers in the USA, the study is representative. The author of this thesis classified the identified influencing factors out of this study as follows: **Driving Range**.

Franke and Krems (2013) studied psychological range levels by using electric passenger cars via a field trial with 40 electric passenger cars being leased by early adopter customers in Berlin. After 6-month field trial users were satisfied with utilizing approximately 79-80% of their available range, however different personalities by the users and their technological knowledge about the electric passenger cars do play a role in range utilization. Advantage of this study is of course the field trial and the long period of driving experience; nonetheless the 40 participants only drove electric passenger cars from the brand BMW, which means that the results of the study relate only to this brand (Franke and Krems, 2013). The analysed influencing factor in this field trial by Franke and Krems was classified from the author of this thesis as follows: **Driving Range**.

Wang et al. (2019) focused in their study on the assessment of incentive policy towards the adoption of electric passenger cars. This has been done with the help of a multiple linear regression method utilizing the data of 30 different countries and their EV market share in the year 2015 (Wang, Tang and Pan, 2019). The main incentives promoting the acceptance of e-mobility were incentives such as priority road lanes for electric passenger cars, direct subsidies, tax incentives and waivers on fees (e.g., tolls and ferries). The results by Wang et al. are representative analysing 30 different countries; however, they have not considered socio-economic factors and perceptions of consumers.

On top of that, India was not included in their study, which of course makes it difficult to derive a statement for the Indian market. The categorization by the author of this thesis of the analysed influencing factor is: **Governmental Incentives**.

Noel et al. (2019) focused in their survey on range anxiety; this factor seems to be the most pressing barrier in regard to the adoption of electric passenger cars. Noel et al. conducted a survey with nearly 5,000 respondents in 17 cities in five Nordic countries (Iceland, Sweden, Finland, Denmark and Norway) (Noel *et al.*, 2019). Noel et al. investigated that the psychological and technical explanations for range anxiety are not complete and that range anxiety acts as a rhetorical construction (Noel *et al.*, 2019). Yet, Noel et al. focused on Nordic countries, like Denmark, Sweden or Finland, which are having a very good charging infrastructure. Denmark for example is having an electric passenger cars ratio of 14 (14 electric passenger cars per one charging point), which is much more better than in the USA, Germany and by far better than India (Iotkovska, 2022). However, since semi-structured interviews have been conducted this gives a good picture on consumer perceptions in those five Nordic countries. The analysed influencing factor in this study by Noel et al. was classified from the author of this thesis as follows: **Driving Range**.

The review of Rietmann and Lieven (2019) investigated the effectiveness of monetary incentives, traffic regulation and charging infrastructure on the market share of electric passenger cars in 20 different markets. Through a covariance approach it was shown that especially monetary incentives in interaction with charging infrastructure positively influence the share of electric passenger cars. Moreover, it recommends the urge for stronger stakeholder-engagement from both private and public areas (Rietmann and Lieven, 2019). Limitations of the study by Rietmann & Lieven is that feedback by consumers about concerns towards the adoption of electric passenger cars have been included; nonetheless India was among the 20 markets, which means that the findings from the study could also be applied to the Indian market. The author of this thesis categorized the identified influencing factors out of this study as follows: **Governmental Incentives**.

The journal article by Zhuge and Shao (2019) targeted on six common aspects (acquisition cost, car usage, social impact, eco-consciousness, monetary incentives and non-monetary incentives) which influence the buying behaviour of electric passenger cars in Beijing (China) based on a questionnaire survey using the multinomial logit model (MNL). It turned out that the vehicle price and the usage (operating cost, refuelling/charging time, charging/refuelling infrastructure, driving range) are the most potentially influencing factors to buy an electric vehicle in Beijing, followed by social impact and eco-consciousness (Zhuge and Shao, 2019). Advantage of this study is that various factors have been analysed towards the adoption of electric passenger cars and that also socio-demographic attributes (gender, age and income) have been considered. Limitations are that the data have been collected in 2015 – 2016 and that e-mobility is of course continuously evolving. The identified influencing factors out of this study were categorized from the author as follows: **Purchasing Costs, Charging Infrastructure, Charging Time, Driving Range**, **Subjective Norm, Image and Ecological Belief**.

Langbroek et al. (2016) measured the effectiveness of policy incentives towards the attractiveness of electric passenger cars in Stockholm, Sweden used a stated choice experiment in which the participants were asked to buy in a fictive situation either an electric passenger car or a conventional one. Gain of this study was that also real customers and drivers of electric passenger cars were among the 269 participants, nonetheless that only the city Stockholm was covered (Langbroek, Franklin and Susilo, 2016). The author of this thesis clustered the identified influencing factors towards the adoption of electric passenger cars thusly: **Governmental Incentives**.

Kim et al. (2017) investigated influencing factors towards the adoption of electric passenger cars through a panel data analysis between 2011 and 2015 in 31 different countries. This study found out that the vehicle price of an electric passenger car and the driving range influence the share of electric passenger cars in the markets. Moreover, the availability, meaning the number of available models of electric passenger cars in the market positively influences the market share (Kim, Lee and Lee, 2017). Advantage of this research is the comprehensive data set over a long period from 2011 to 2015; however, that was the time when electric passenger cars started to have meaningful sales.

The identified influencing factors out of this study were categorized from the author as follows: **Purchasing Costs, Charging Infrastructure and Perceived Visibility of Usage.**

Krupa et al. (2014) conducted an online survey in the USA with 1,000 participants to analyse factors influencing the potential for adopting e-mobility. The key findings were that tax incentives and manufacturer rebates (up-front incentives) are having the strongest effect on consumer awareness towards the acceptance of e-mobility (Krupa *et al.*, 2014). Added value of this study is the comprehensive consumer survey, disadvantage is that the data were collected in 2011, which might be outdated. The analysed influencing factor in this study by Krupa et al. was classified from the author of this thesis as follows: **Governmental Incentives**.

Plötz et al. (2014) conducted a consumer study that focused on the early adopters for electric passenger cars in Germany. Via paper- and online-questionnaire they analysed different data sets about socio-demographic characteristics of car owners, attitudinal characteristics of consumers with high interest in electric passenger cars and the economic evaluation. The key result of their studies were that in Germany the major potential customers for electric passenger cars are men in midlife with families living in more rural, sub-urban areas and that governmental incentives are having a strong effect on this target group towards the adoption of e-mobility (Plötz *et al.*, 2014). Limitation of the survey by Plötz et al. is the high percentage of men (91%) participated in the survey, which leads to a statistical bias. The identified influencing factor out of this study was categorized from the author as follows: **Governmental Incentives**.

Another study in Beijing by Shi et al. (2019) analysed the minimum range which an electric passenger car requires to fulfil all the travel demands of a vehicle at the individual level of its consumer. Shi et al. conducted a comprehensive study analysing vehicle travel data of both taxi fleets (11,881 taxis over a period of three weeks) and data of private drivers of electric passenger cars (104 vehicles during a period of 10 month).

The result was that the majority of the taxi drivers need a battery range between 100 and 200 miles and with the current battery technology at that time this is sufficient for 78% of the taxis. However, the majority of the private consumers require only less than 50 miles and with the current battery technology at that time this is sufficient for 77% of the private users (Shi *et al.*, 2019). Moreover, they found out that home charging as an additional opportunity parallel to public charging infrastructure and an increase of the public charging infrastructure can reduce the minimum required battery ranges (Shi *et al.*, 2019). However, it must be taken into account that the major focus on this study was on taxis since the data set was significantly larger and that China is having a good charging infrastructure with 8 electric passenger cars per charging point (Statista, 2022f).

The author of this thesis categorized the identified influencing factors out of this study as follows: **Driving Range, Charging Infrastructure**.

Morton et al. (2016) focused in their study in the UK on the influence of consumer innovativeness towards the adoption of electric passenger cars (Morton, Anable and Nelson, 2016). 506 consumers participated and completed on their own a paper-based survey. The result was that the personal innovativeness of consumers is a significant driver of adopting electric passenger cars. The study of Morton et al. focused only on one influencing factor towards the acceptance of electric passenger cars, however there are only few surveys on the impact of consumer innovativeness; this gap will be closed by Morton et al. The identified influencing factor out of this study was classified from the author as follows: **Personal Innovativeness**.

4.2.7.2. Review of three latest publications in Web of Science & Scopus

The review of the three latest publications about the topic of acceptance of e-mobility showed the following results.

Chinen et al. (2022) conducted an empirical study in China with 420 electric passenger car owners about the perception of remanufactured batteries. Chinen et al. investigated the perceptions, acceptance, purchase intention and willingness-to-pay for remanufactured batteries for electric passenger cars (Chinen *et al.*, 2022).

It turned out that consumers' price consciousness and perceived benefits positively impact the purchase intention (Chinen *et al.*, 2022). Moreover, the perceived technological risk negatively influence the purchasing intention of consumers (Chinen *et al.*, 2022).

The study of Chinen et al. contributes to higher resource efficiency and the sustainability of electric passenger cars by analysing the first time if remanufactured batteries influence the purchasing behaviour of electric passenger car consumer since the growing demand of electric passenger cars heavily rely on limited raw material. However, the focus was only on remanufactured batteries of electric passenger cars and not on the whole technology, which makes it difficult to draw conclusions for the Indian market, which is on a different level compared to China in terms of e-mobility.

The author of this thesis categorized the identified influencing factors out of this study as follows: **Purchasing Costs, Technological Risk**.

Mutavdžija et al. (2022) made a survey in Croatia with randomly 578 selected participants using linear regression in order to assess selected factors for promoting the purchase of an electric passenger car. The conclusion was that the main barriers against the adoption of electric passenger cars are lack of charging infrastructure and the cost of battery replacement (Mutavdžija, Kovačić and Buntak, 2022). Gain of this study is that Mutavdžija et al. conducted the first study on attitudes and perceptions of Croatian customers towards the acceptance of electric passenger cars in order to promote the share of electric passenger cars; because in 2020 Croatia only had a share of electric passenger cars of 1.47% of newly registered vehicles, which is comparable to India´s share.

The identified influencing factor out of this study was classified from the author as follows: **Charging Infrastructure, Technological Risk**.

Ju and Hun Kim (2022) investigated the concerns and perception of South Korean and USA millennial drivers (24 – 40 years) interested in electric passenger cars by using a structural equation model. Ju and Hun Kim used a web-based survey with a total of 291 participants from the USA and 325 respondents from South Korea. It turned out that the ecological belief was strong connected to perceived usefulness of electric passenger cars, whereas purchasing costs, as well as technological risk are linked with resistance to the adoption of electric passenger cars (Ju and Hun Kim, 2022).

Advantage of this study is the comparison of two countries with different cultural backgrounds and the pre-selection of the participants through a questionnaire to identify their degree of interest into electric passenger cars; nonetheless only few influencing factors towards the adoption of electric passenger cars have been investigated. The identified influencing factor out of this study was classified from the author as follows: **Ecological Belief, Purchasing Costs and Technological Risk**.

4.2.7.1. Review of three latest publications in in grey literature

The review of the three latest publications about the topic of acceptance of e-mobility in Base-search (grey literature) brought the following results.
Mohammadzadeh et al. (2022) analysed key factors promoting the adoption of electric passenger cars based on literature. The focus was on an overview of governmental incentive policies in various countries, the total cost of ownership of electric passenger cars, as well as the growth of the market share of electric passenger cars in different countries. (Mohammadzadeh *et al.*, 2022). One take away of the paper was that pricing incentives and the access to public charging stations are major factors to promote e-mobility successfully. Additionally, the total costs of ownership of electric passenger cars were mentioned as a strong tool to promote e-mobility and that the first (mostly high) purchase price of electric passenger cars is one big barrier. Limitations of the study are that the literature review of the investigation of total costs of ownership also includes studies about plug-in hybrid vehicles and that for India for example only studies have been conducted on two- and three-wheelers, but not on electric passenger cars. However, the paper of Mohammadzadeh et al. (2022) conducted a comprehensive literature review analysing many different countries which are all at a different stage of diffusion of the adoption of electric passenger cars.
The identified influencing factors out of this paper was classified from the author as follows: **Governmental Incentives, Charging Infrastructure, Purchasing Costs**.

Gupta et al. (2022) studied different barriers towards the acceptance of electric passenger cars in India. They identified the barriers through literature review and through expert interviews using a multi-criteria decision method (Analytical hierarchy process) to rank the barriers in terms of their importance (Gupta, Tyagi and Anand, 2022). Gupta et al. identified three categories of barriers: Economical, infrastructural and technical barriers.

Through the subjective judgements of the selected 10 experts, the barriers were ranked as follows. Lack of public infrastructure was mentioned by 50% of the participants, followed by high purchasing costs with 23%. The limitation in terms of range, as well as in battery life were ranked lowest with less than 6% of experts agreeing. The study of Gupta et al. tries to propose a strategy for Indian stakeholders which are interested into promoting e-mobility, however the limitation is that only experts have been interviewed without a field trial of possible customers.

The author of this thesis categorized the identified influencing factors out of this study as follows: **Charging Infrastructure, Purchasing Costs**.

Anastasiadou and Gavanas (2022) analysed through a systematic literature review research papers, in total 61 peer reveiwed articles, to identify key influencing factors towards the acceptance of electric passenger cars and categorizing them afterwards through a PESTLE (Political–Economic–Social–Technological–Legal–Environmental) approach (Anastasiadou and Gavanas, 2022). Political aspects, such as purchase subsidies, tax reductions or investment into public charging infrastructure were mentioned mostly in the reviewed articles, followed by technological aspects, such as availability of charging infrastructure, charging time and electric vehicle range and social aspects, such as social status, personal attitude toward environmental concerns. Advantage of this study is of course the comprehensive systematic literature review, which has been conducted focusing only on recent papers; this gives latest insights into the acceptance behaviour towards e-mobility which is a continuously evolving technology. Nonetheless, the focus was only on the review of recent scientific literature and no filed trial with neither expert nor costumers has been carried out. This leads to the fact, that the findings and results were quite generic, and it makes it difficult to derive recommendations for how promoting electric passenger cars for a specific market. Thus, the author of this thesis categorized the identified influencing factors out of this study as follows: **Governmental Incentives, Charging Infrastructure, Charging Time, Driving Range, Subjective Norm, Image, Ecological Belief.**

Summarized the conducted SLR identified the following 13 influencing factors towards the adoption of electric passenger cars out of a customer´s perspective as shown in table 7.

Table 7 Identified influencing factors through conducted SLR *(continued on p. 62)*

Source: own table

Identified influencing factor through SLR	**Source**
1. Subjective Norm	(Graham-Rowe *et al.*, 2012, p. 144 f.; Zhuge and Shao, 2019, p. 199) (Anastasiadou and Gavanas, 2022)
2. Personal Innovativeness	(Morton, Anable and Nelson, 2016, p. 18)
3. Charging Infrastructure	(Zhuge and Shao, 2019, p. 199) (Kim, Lee and Lee, 2017) (Shi *et al.*, 2019, p. 352) (Mutavdžija, Kovačić and Buntak, 2022) (Mohammadzadeh *et al.*, 2022) (Gupta, Tyagi and Anand, 2022) (Anastasiadou and Gavanas, 2022)
4. Charging Time	(Zhuge and Shao, 2019, p. 199) (Anastasiadou and Gavanas, 2022)
5. Image	(Zhuge and Shao, 2019, p. 199) (Anastasiadou and Gavanas, 2022)
6. Ecological Belief	(Zhuge and Shao, 2019, p. 199) (Ju and Hun Kim, 2022)

	(Anastasiadou and Gavanas, 2022)
7. Anxiety of Usage	(Graham-Rowe *et al.*, 2012, p. 144 f.)
8. Technological Risk	(Graham-Rowe *et al.*, 2012, p. 144 f.) (Chinen *et al.*, 2022) (Mutavdžija, Kovačić and Buntak, 2022) (Ju and Hun Kim, 2022)
9. Technological Knowledge	(Graham-Rowe *et al.*, 2012, p. 144 f.)
10. Governmental Incentives	(Egbue and Long, 2012, p. 724) (Sierzchula *et al.*, 2014) (Wang, Tang and Pan, 2019, p. 597) (Rietmann and Lieven, 2019, p. 66) (Langbroek, Franklin and Susilo, 2016) (Krupa *et al.*, 2014) (Plötz *et al.*, 2014, p. 96) (Mohammadzadeh *et al.*, 2022) (Anastasiadou and Gavanas, 2022)
11. Purchasing Costs	(Egbue and Long, 2012, p. 724) (Graham-Rowe *et al.*, 2012, p. 144 f.) (Zhuge and Shao, 2019, p. 199) (Kim, Lee and Lee, 2017) (Chinen *et al.*, 2022) (Ju and Hun Kim, 2022) (Mohammadzadeh *et al.*, 2022) (Gupta, Tyagi and Anand, 2022)
12. Driving Range	(Graham-Rowe *et al.*, 2012, p. 144 f.) (Saxena *et al.*, 2015) (Franke and Krems, 2013) (Noel *et al.*, 2019, p. 105) (Zhuge and Shao, 2019, p. 199) (Shi *et al.*, 2019, p. 352) (Anastasiadou and Gavanas, 2022)
13. Perceived Visibility of Usage	(Sierzchula *et al.*, 2014) (Graham-Rowe *et al.*, 2012, p. 144 f.) (Kim, Lee and Lee, 2017)

Figure 19 summarizes the overall conducted systematic literature review.

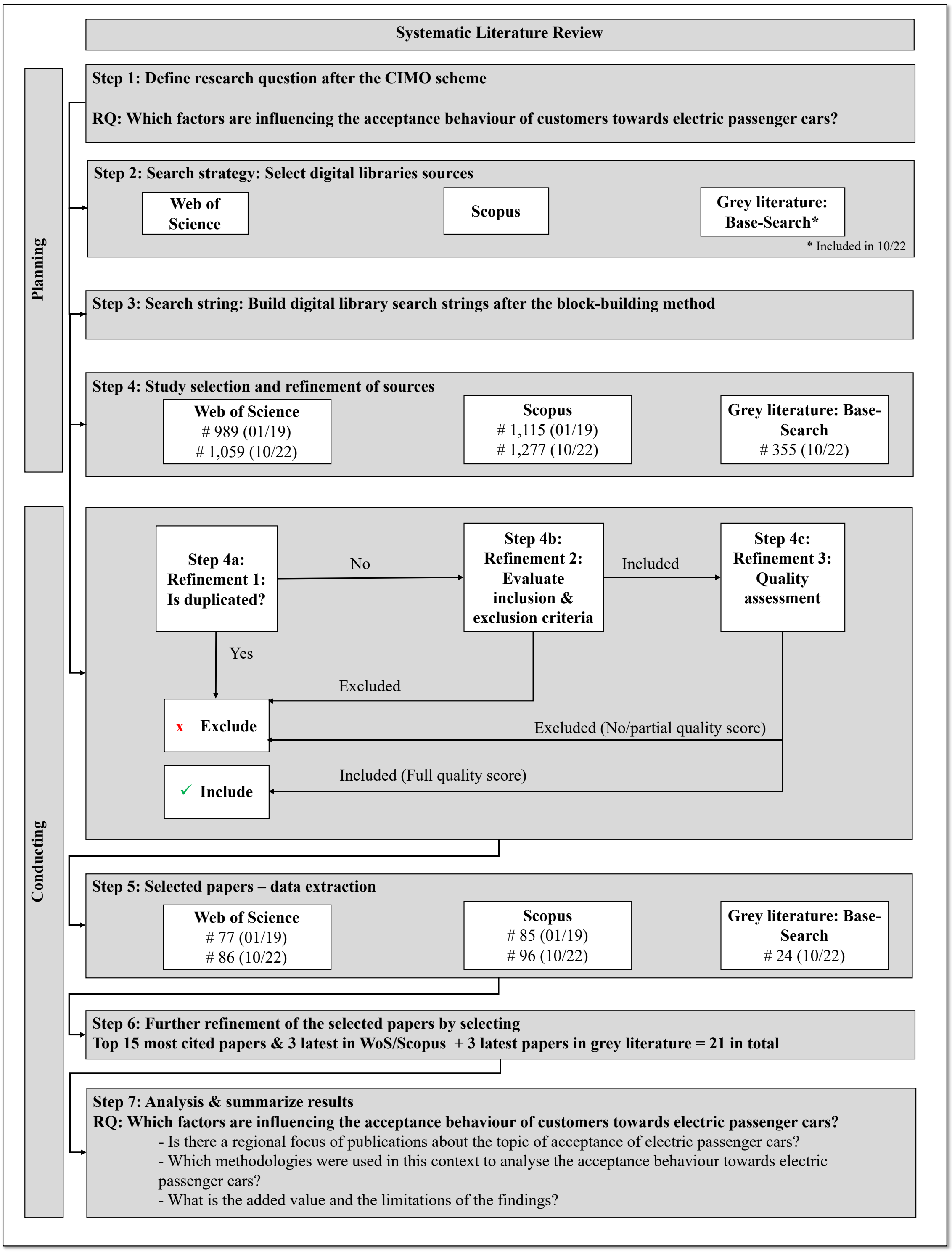

Figure 19 Systematic literature review

Source: own figure

The next section describes the conducted expert interviews which have been carried out in addition to the systematic literature review in order to identify key factors towards the acceptance behaviour of electric passenger cars.

4.3. Expert interviews for insights into influencing factors towards the adoption of electric passenger cars in India

In addition to the SLR, expert interviews were conducted in summer 2019 by the author to gain qualitative insights into which factors are important to successfully promote electric passenger cars in India out of the view of the selected experts. The goal was to understand if there are additional factors which are specific important for an Indian customer. Those experts have been selected through the author´s professional network in automotive industry and through the author´s academic network from university in southern Germany, a global centre of premium car manufacturers. The task of the experts was to list various challenges and barriers that are obstructing propagation of e-mobility in India. All experts are from different companies, such as from Bosch, Mercedes-Benz, Tata, Bharat Benz, as well as from the chamber of commerce and industry in Mumbai. Finally, 7 experts have been selected and the interviews have been conducted via telephone or via a questionnaire through e-mail.

The author of this thesis selected the experts based on the following criteria:

Experts must have acquired knowledge by working and living for at least one year in India or with the focus on the Indian market for passenger cars or in administration or legislation of passenger traffic in India.

The most positive attributes linked to the adoption of electric passenger cars agreeing by the experts were: Subjective norm, image, governmental incentives and appealing brand; meaning the image and the origin of the brand. The biggest negative attributes linked to electric passenger cars were mentioned as follows: Purchasing costs and lack of public charging infrastructure. The experts mentioned the same influencing factors as identified through the systematic literature review; the only new influencing factor is appealing brand, which has been added as 14th factor to the 13 identified factors out of the SLR. Summarized, this research will analyse 14 influencing factors towards the adoption of electric passenger cars in India, as shown in table 8. Those 14 influencing factors will be used to develop and further extend the Technology Acceptance Model towards the acceptance behaviour of passenger cars in India as presented in chapter 5.3.

Table 8 Identified influencing factors through conducted SLR & expert interviews *(continued on p. 66)*

Source: own table

Identified influencing factor through SLR	**Source**
1. Subjective Norm	(Graham-Rowe *et al.*, 2012, p. 144 f.; Zhuge and Shao, 2019, p. 199) (Anastasiadou and Gavanas, 2022)
2. Personal Innovativeness	(Morton, Anable and Nelson, 2016, p. 18)
3. Charging Infrastructure	(Zhuge and Shao, 2019, p. 199) (Kim, Lee and Lee, 2017) (Shi *et al.*, 2019, p. 352) (Mutavdžija, Kovačić and Buntak, 2022) (Mohammadzadeh *et al.*, 2022) (Gupta, Tyagi and Anand, 2022) (Anastasiadou and Gavanas, 2022)
4. Charging Time	(Zhuge and Shao, 2019, p. 199) (Anastasiadou and Gavanas, 2022)
5. Image	(Zhuge and Shao, 2019, p. 199) (Anastasiadou and Gavanas, 2022)
6. Ecological Belief	(Zhuge and Shao, 2019, p. 199) (Ju and Hun Kim, 2022) (Anastasiadou and Gavanas, 2022)
7. Anxiety of Usage	(Graham-Rowe *et al.*, 2012, p. 144 f.)
8. Technological Risk	(Graham-Rowe *et al.*, 2012, p. 144 f.) (Chinen *et al.*, 2022) (Mutavdžija, Kovačić and Buntak, 2022) (Ju and Hun Kim, 2022)
9. Technological Knowledge	(Graham-Rowe *et al.*, 2012, p. 144 f.)
10. Governmental Incentives	(Egbue and Long, 2012, p. 724) (Sierzchula *et al.*, 2014) (Wang, Tang and Pan, 2019, p. 597) (Rietmann and Lieven, 2019, p. 66) (Langbroek, Franklin and Susilo, 2016) (Krupa *et al.*, 2014) (Plötz *et al.*, 2014, p. 96)

	(Mohammadzadeh *et al.*, 2022) (Anastasiadou and Gavanas, 2022)
11. Purchasing Costs	(Egbue and Long, 2012, p. 724) (Graham-Rowe *et al.*, 2012, p. 144 f.) (Zhuge and Shao, 2019, p. 199) (Kim, Lee and Lee, 2017) (Chinen *et al.*, 2022) (Ju and Hun Kim, 2022) (Mohammadzadeh *et al.*, 2022) (Gupta, Tyagi and Anand, 2022)
12. Driving Range	(Graham-Rowe *et al.*, 2012, p. 144 f.) (Saxena *et al.*, 2015) (Franke and Krems, 2013) (Noel *et al.*, 2019, p. 105) (Zhuge and Shao, 2019, p. 199) (Shi *et al.*, 2019, p. 352) (Anastasiadou and Gavanas, 2022)
13. Perceived Visibility of Usage	(Sierzchula *et al.*, 2014) (Graham-Rowe *et al.*, 2012, p. 144 f.) (Kim, Lee and Lee, 2017)
14. Appealing Brand	Expert interviews

4.4. Gaps in the state of the art

Besides the analysis of which are the key influencing factors towards the acceptance behaviour of electric passenger cars in existing literature, the conducted systematic literature review also identified research gaps and limitations of the reviewed studies. First of all, the systematic literature review demonstrated the lack of literature with the focus on the Indian passenger car market. The major focus on adoption of electric passenger cars is on the US, Chinese and UK electric passenger car market and less on emerging countries, such as India. Secondly, the analysed publications did not apply the Technology Acceptance Model for analysing the adoption towards electric passenger cars. Used methods were for example qualitative studies based on questionnaires, case studies, multiple linear regressions or literature reviews. Additionally, insights about

which are the key influencing factors towards electric passenger cars were mostly gained through interviewing experts or stakeholder rather than on focusing on customer groups. Less field trials were conducted targeting customers or possible customers of electric passenger cars. This research tries to close those gaps.
The last section of this chapter ends with the conclusion.

4.5. Conclusion

The results out of the systematic literature review demonstrated that there are many external factors which influence the adoption rate of electric passenger cars. On the one hand the literature review showed that there are still a lot of barriers in the customers thinking that have to be smoothened out. Driving range, lack of charging infrastructure, purchasing costs of electric passenger cars, technological risk and knowledge, as well as anxiety by driving electric passenger cars are the most common barriers towards purchasing an electric passenger car. On the other hand, financial incentives, especially through government policies, could support high electric passenger car adoption rates, such as tax incentives for subsidizing the higher costs of electric passenger cars or exemption or/and waivers on fees like parking, ferries, bus lanes etc. Moreover, social and individual factors do influence positively the acceptance of electric passenger cars, such as subjective norm, image of choosing an electric vehicle, the visibility of the electric passenger car usage, personal innovativeness and especially the ecological belief of the consumer. One additional influencing factor which was mentioned by the experts during the conducted expert interview was "appealing brand"; meaning the assumption that the brand image and reputation, be it a dedicated electric passenger car brand like Tesla or an Indian brand, do influence the adoption of e-mobility.

Summarized, the SLR presented the key influencing factors towards the acceptance behaviour of electric passenger cars and identified research gaps. The next chapter presents the research methodology and methods.

5. Research methodology

5.1. Introduction

This chapter explains the research methodology and presents the research methods which have been used in this thesis. First of all, the structural equation modelling will be presented which operationalize the Technology Acceptance Model. Afterwards, the established Technology Acceptance Model towards the adoption of electric passenger cars in India will be shown, as well as the research hypotheses on which the model is based. Finally, the conducted online questionnaire and the associated sampling method and process will be explained, as well as explanation is given for the selection of the sampling method, as well as limitations of the sampling method will be outlined.

5.2. Structural Equation Modelling

The method of structural equation modelling (also called causal analysis) was chosen to investigate the theoretical research model and to operationalize the Technology Acceptance Model. Structural equation models (SEM) enable the empirical verification and validation of theoretically ex ante derived statements about the interdependencies between several variables on the basis of empirical data (Chin and Marcoulides, 1998). They belong to the multivariate analysis methods and allow the parallel investigation of several statistical variables, whereas univariate analysis methods require a separate analysis for each investigated variable. Due to their ability to test theoretically suspected relationships, structural equation models have a theory-testing (confirmatory) character. Since, however, in many use cases the theoretical connection of the analysis problem has not yet been completely proven and certain model specifications are required, a combination of theory-checking and theory-building (explorative) procedures is often used, as for example in the present research model in the form of an extension of an existing model. SEM requires modelling with the help of path diagrams to investigate ex ante presumed, theoretically derived hypotheses. The result of this investigation is the path diagram (also called path model), which is used to visualize the dependency relations and thus the easier comprehensibility of the problem definition (especially complex) model structures. The formal equation structure can be evaluated by the graphic representation, which is of importance for the model estimation.

There are two main methods of structural equation modelling distinguish: covariance-based structural equation modelling (CB-SEM) and the variance-based (V-SEM), also called Partial Least Squares structural equation modelling. The covariance-based structural equation modelling was the more established and therefore dominant process for many years. However, in recent years the use of Partial Least Squares structural equation modelling became more popular, which led to numerous studies on the use of the method in different disciplines. This is mainly because in many research and decision situations the partial Least Squares Structural Equation Modelling is advantageous, e.g., when it comes to the illustration of complex decision problems in statistical models.

5.2.1. Structure of SEM

As explained in the previous chapter, structural equation models combine the idea of factor analysis with the methods of path analysis. In doing so, the dependency relationships between the latent variables of an explanatory model are estimated on the basis of the variances and co-variances between the model indicators. It is possible to distinguish between the components of the exogenous measurement model, the endogenous measurement model and the structural model, as shown in figure 20.

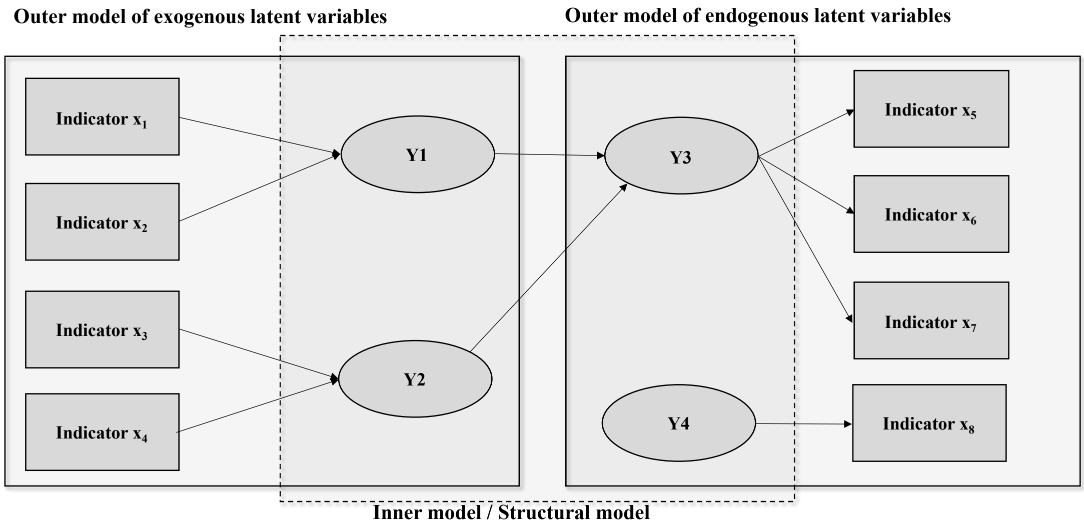

Figure 20 Example of a PLS model

Source: own figure

The structural model (also known as the inner model) specifies the dependencies and relationships between the latent variables that cannot be measured directly (Zinnbauer and Eberl, 2004).

The directional relationship (regression) between two latent variables is measured with the help of a so-called path coefficient n. Path coefficients usually represent partial standardized regression weights and can assume values between +1 and -1. They describe the factor by which the latent dependent variable changes with a change in the latent variable. A value of +1 means that an increase in the size of the independent variable by one standard deviation leads to an increase in the dependent variable by one standard deviation (Hair *et al.*, 2017).

In the measurement model (outer model), the relations between the manifest indicators (x_1, x_2 etc.) and the constructs that capture the latent variables are described. A distinction can be made between an exogenous measurement model to describe independent latent variables (Y1, Y2) and an endogenous measurement model to describe latent dependent variables (Y3, Y4) (Hair *et al.*, 2017). Since the explanation of these latent dependent variables is usually not completely successful in practice, a residual variance Yn is introduced that is due to reasons not considered in the model.

This highlights another important advantage of structural equation model: In addition to the combined analysis of the measurement model and the structural model, they are able to simultaneously consider residual errors, as well as the corresponding error terms of the observable indicators of the measurement model and to analyse them in one step.

5.2.2. Measurement of model constructs

According to the relation between construct and indicators, the operationalization of latent variables can be distinguished between the specification types of reflective and formative measurement, which will be discussed in more detail below. Operationalisation means the exploitation of a latent variable by the indicators describing it to explain the construct; table 9 gives an example. Here the identified influencing factor “Perceived Usefulness (PU)” is described by three manifest indicators (PU1, PU2 and PU3). In this research the manifest indicators are the questions, which have been asked in the conducted online questionnaire, s. appendix 2. That means the participants were asked for example if they agree or not agree to if it would be a reasonable decision to use electric passenger cars. The measurement of PU can now be defined either as formative or reflective measurement model, as described in the next section.

Table 9 Operationalisation of model constructs

Source: own table

	Construct (latent variable)	Measurement items (manifest indicators)
1	**PU: Perceived usefulness**	PU1 – It would be a reasonable decision to use electric passenger cars. PU2 – Electric passenger cars are a good innovation. PU3 – Electric passenger cars are useful.

5.2.3. Formative measurement models

In formative measurement models, in contrast to reflective measurement, a reversal of the causal relationship between construct and indicators is assumed. Here, the characteristics of the indicators cause the latent variable. Note here that the arrows point from the indicator variables to the constructs, indicating a causal (predictive) relationship in this direction (Hair *et al.*, 2017), as shown in figure 21.

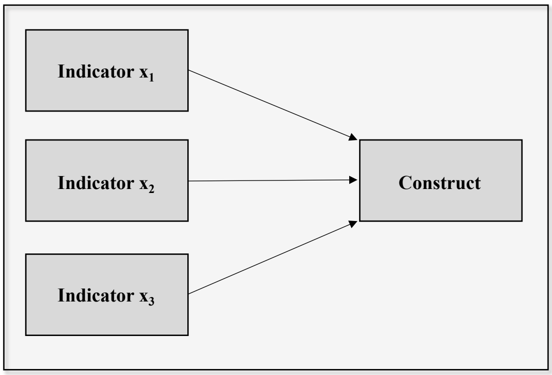

Figure 21 Formative measurement model

Source: own figure

5.2.4. Reflective measurement models

Reflective (or also causal) measurement models are characterized by characteristic of the assigned indicators which is caused by the latent variable. For reflective indicators, the arrows point from the construct to the indicators, which shows that the construct causes the measurement of the indicator variables (Hair *et al.*, 2017), s. figure 22.

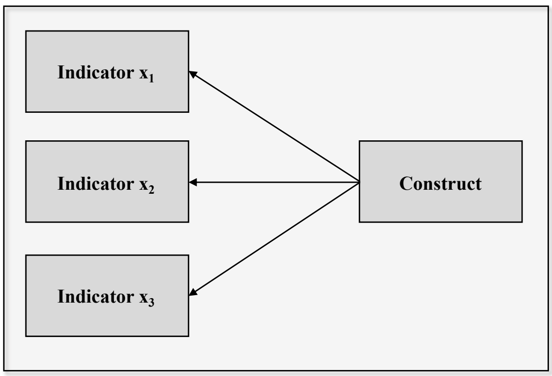

Figure 22 Reflective measurement model

Source: own figure

Table 10 gives an overview about how to distinguish between formative and reflective indicators. Those decision questions were used to categorise the constructs for the developed TAM of this thesis as either formative or reflective.

Table 10 Decision questions to distinguish between formative and reflective indicators

Source: own table

Decision question	**Author**
"Is it necessarily true that if one of the items (assuming all coded in the same direction) were to suddenly change in a particular direction, the others will change in a similar manner?" (reflective)	(Chin, 1998, p. 9)
Eliminating one indicator from the measurement model may change the meaning of the construct? (formative)	(Jarvis, MacKenzie and Podsakoff, 2003)
The direction of causality is from construct to measure? (reflective)	(Jarvis, MacKenzie and Podsakoff, 2003)
Constructs are developed as explanatory combinations of indicators which are explained by a combination of variables? (formative)	(Fornell and Bookstein, 1982)
Do the indicators have the same or a similar content or refer to a common topic? (reflective)	(Chin, 1998, p. 9)
Do the measures produce the construct so to speak? (formative)	(Bagozzi and Baumgartner, 1994)
Do the indicators have the same predictors and consequences? (reflective)	(Jarvis, MacKenzie and Podsakoff, 2003)

The next figure 23 illustrates the main difference of a reflective and a formative construct. In reflective constructs, the indicators have the same or similar content and consequences and if one indicator might change, the others will change in a similar way. Formative constructs will be explained by combining indicators and if one indicator would be eliminated, the meaning of the whole construct would change.

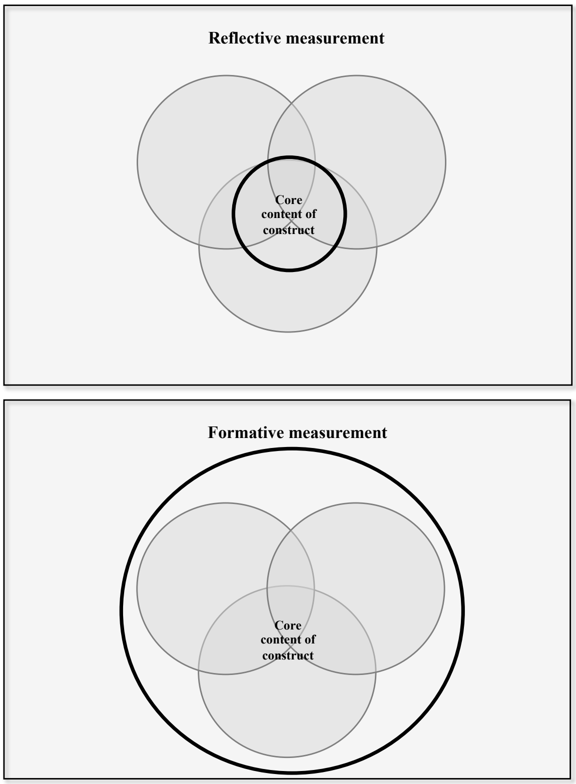

Figure 23 Difference between reflective and formative measurement

Source: own figure, adapted from (Hair et al., 2017, p. 42)

The following sections explains the covariance-based method within the structural equation model.

5.2.5. The covariance-based method

Within the structural equation models, a distinction can be made between covariance-based and variance-based methods. In the following sections the different procedures will be explained and compared before the selection of the used variant-based method in this research is justified.

Covariance-based method is based on the principle of confirmation and theory testing factor analysis (Reiter and Mühlhaus, 2014). The aim of the covariance-based procedures is the best possible estimation of the model parameters taking into account all information given in the covariance matrix, so that the difference between the

covariance matrix is generated by the empirical survey of the data and the covariance matrix assumed in model theory are minimal (Sosik, Kahai and Piovoso, 2009).
A continuous attempt is made to determine the adjustment function between the sample correlations and the estimated parameters (Chin and Marcoulides, 1998). A maximum likelihood function is used for this, therefore also known as parameter-oriented procedure. The covariance-based approach is particularly suitable, to test existing theories (Chin and Marcoulides, 1998). On the other hand, the process has fewer advantages for new measurements, insufficiently substantiated models or preliminary theories (Reiter and Mühlhaus, 2014).
Moreover, the covariance-based method requires certain preconditions; the data must be normally distributed, and the observations must be independent. Small case numbers of less than 200 observations represent a problem and it is also difficult to develop complex models (Hair, Ringle and Sarstedt, 2011). The next section explains the concept of variance-based methods.

5.2.6. The variance-based method

In contrast to covariance-based methods, variance-based methods aim to explain the variance by maximizing the covariance between latent exogenous and latent endogenous variables and thus the best possible reproduction of the initial data matrix (Herrmann, Huber and Kressmann, 2006). In contrast to covariance-based methods, the information of the covariance matrix is not used completely and only block wise; though this leads to more inaccurate estimated values, however, is consciously accepted (Herrmann, Huber and Kressmann, 2006).
The variance-analytical approach of structural equation models via the method of the "partial least squares” (PLS) is a regression-analytic approach that interprets the latent variable which is interpreted as a dimension that bundles the items behind it. In the PLS

procedure, the variances of the residuals of all dependent variables are minimized. This is done in a stepwise ("partial") manner according to the method of least squares.

A PLS path model consists of two elements. This is on the one hand the structural model (also called the inner model in PLS path models), which represents the constructs (circles or ellipses). On the other hand, there is the measurement model of the constructs (also called the outer model in PLS path models), which represents the relationships between the constructs and the indicators (rectangles).

Hair et al. (2012) found approximately over 200 PLS-SEM applications in their meta-analysis of top 30 top ranked Marketing journals published between 1981 and 2010. In 2010 alone, 51 new studies have been published (Hair *et al.*, 2012). The most common reason for using PLS was the non-normal distribution of variables (50%), small samples (46%), and formative measurement of latent variables (33%) (Hair *et al.*, 2012). Table 11 summarizes the advantages and disadvantages of covariance or variance-based SEM.

Table 11 Comparison covariance- and variance-based SEM

Source: own table

Criteria	**Covariance-based**	**Variance-based**
Research goals	Theory testing/confirmation	Exploratory, predicting key driver construct
Max. Required sample size	Large (≥ 200)	Small (≥30)
Distribution assumptions	Normal distribution	None
Complexity of model	Small – medium complexity	High complexity (10 x number of highest amounts of formative indicators, which are used for one single construct or 10 x number of highest number of indicators, which are used for one single construct)
Estimation principle	Minimization of the distance between model -theoretical and empirical covariance	Iterative and non-iterative least squares estimation
Research with moderation variables and multi-group analysis	Not possible	Possible
Use of formative or reflective constructs	Only reflective relations	Both (reflective and formative)
Software providers	LISREL, AMOS, M-PLUS, EQS	SmartPLS, PLS Graph, SPSS

The next section explains the choice of using a variance-based method for this research.

5.2.7. Choice of variance-based method for this research

The use of variance-based methods is particularly important in the mapping of attitudes, opinions, and behavioural traits as well as the associated interdependencies. In this case it will be clearly recommended to use variance-based methods (Chin, 2010). On top of that variance-based methods enable moderation variables and multi-group analysis, which will be done in this research project through the moderation variables gender and car-ownership. Moreover, covariance-based methods only use reflective relations of a structural equitation model. The developed and extended TAM of this research, s. chapter 5.3., is a very complex model both with formative and reflective variables, s. chapter 5.3.3. The goal of this research project is to develop and empirically test and validate a model to explain the technology acceptance of electromobility in India. The basis for this is the Technology Acceptance Model as explained in chapter 4, which has been empirically tested and confirmed many times in the past in literature. Due to the presented advantages of variant-based methods and the limitations of covariance-based methods, a variance-based PLS method was applied for this present research. For the empirical evaluation of the present research, the variance-based structural equation modelling software SmartPLS was used. SmartPLS is among the prominent software applications for Partial Least Squares Structural Equation Modelling (PLS-SEM). Since its launch in 2005 the software has gained popularity, especially because it is affordable to academics and researchers and because of its friendly user interface and advanced reporting features and the choice between formative or reflective models. The PLS-SEM can handle reflective and formative measurement models as well as single-item measurements, without additional requirements or limitations. Moreover, SmartPLS achieved a growing popular role in empirical research, especially as a key software for studies in marketing for national customer satisfaction index (Henseler, Ringle Christian and Sinkovics Rudolf, 2009). The developed TAM of this research will be presented in the following chapter.

5.3. Development of Technology Acceptance Model to study the Acceptance behaviour of electric passenger cars in India

After defining the 14 influencing factors towards the adoption of electric passenger cars, as presented in chapter 4, this chapter will present the adapted and extended Technology Acceptance Model towards the acceptance behaviour of electric passenger cars in India and how this model has been operationalized using structural equation modelling, as stated in chapter 5.2.

The base is the original TAM model of Davis (1989), s. figure 24, which was extended with the 14 defined influencing factors to the following new developed TAM for this research, s. figure 25.

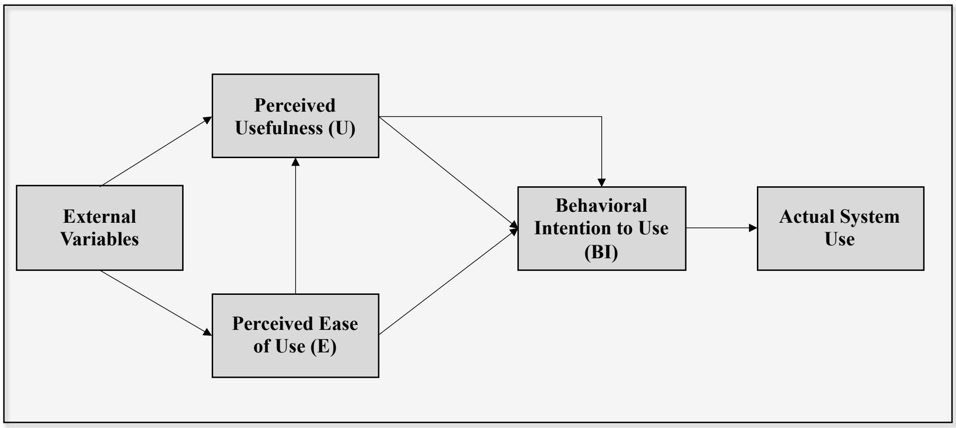

Figure 24 - Technology Acceptance Model

Source: own figure, adapted from (Davis, 1989, p. 320)

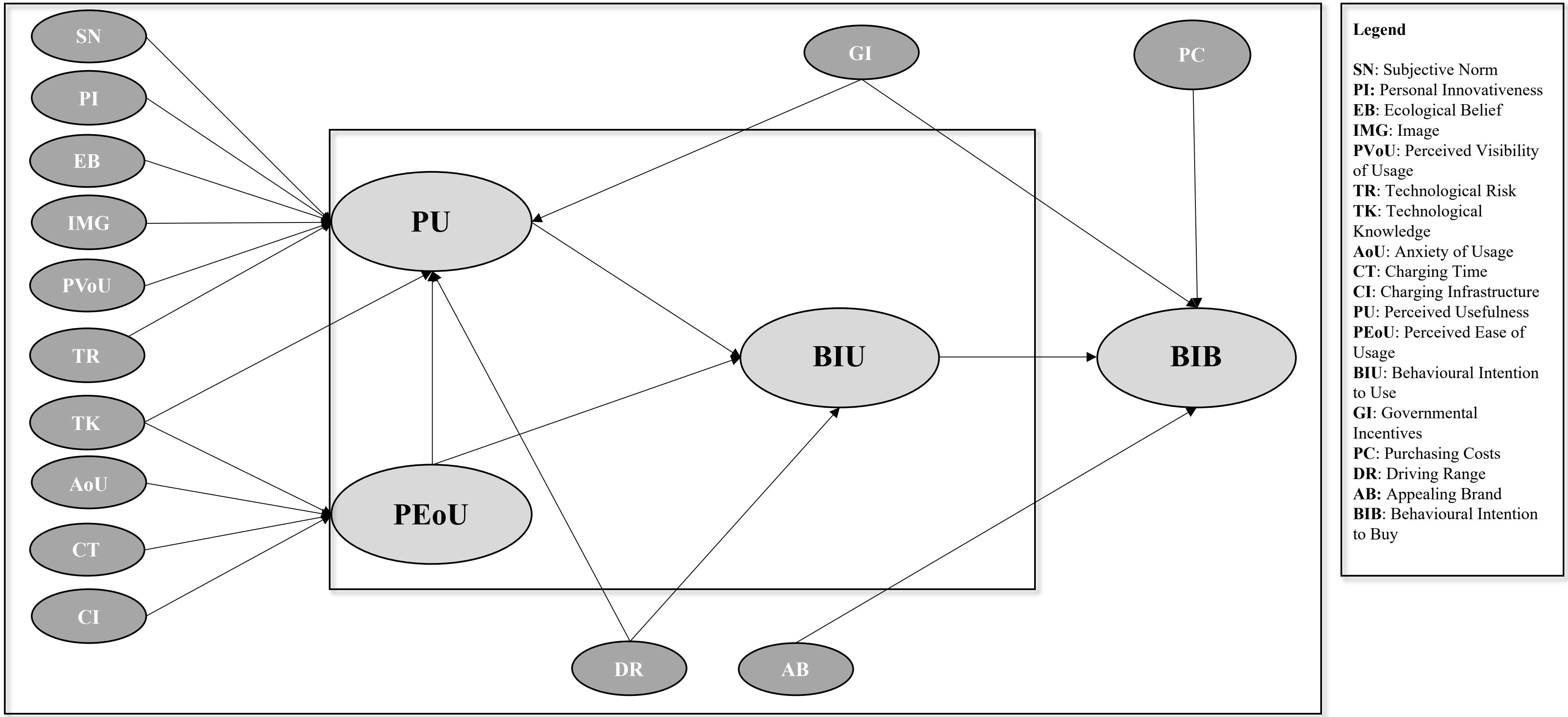

Figure 25 Technology Acceptance Model to study the acceptance behaviour towards electric passenger cars in India

Source: own figure

The next section presents the research hypotheses.

5.3.1. Hypothesis generation based on the defined influencing factors

In order to empirically validate the developed TAM of this thesis and to analyse the significance of each influencing factor, research hypotheses have been outlined from the researcher. The goal was to either confirm or falsify the research hypotheses. The hypotheses will be validated and empirically tested through the data out the conducted online questionnaire, s. chapter 6. The next section presents in detail each influencing factor and the associated hypothesis.

Perceived Usefulness (PU)

The construct of Perceived Usefulness is well known, tried and tested from previous TAM literature and one of the key factors from the original TAM by Davis (1989). The items were reformulated and adapted to the research subject of e-mobility resulting in the following hypothesis:

Hypothesis 1 (H1): *The higher the perceived usefulness, the higher the general behavioural intention to use electric passenger cars*.

Perceived Ease of Use (PE)

According to TAM by Davis (1989), the second major factor influencing the intention to use is the construct "perceived ease of use". The probability that a product is inversely related to the amount of cognitive effort of a consumer; a consumer must invest in understanding how the product works and interpreting its benefits. The hypotheses are the following:

Hypothesis 2 (H2): *The higher the perceived ease of use, the higher the general behavioural intention to use electric passenger cars.*

Hypothesis 3 (H3): *The higher the perceived ease of use, the higher the perceived usefulness of electric passenger cars.*

Behavioural Intention to Use (BU) and Behavioural Intention to Buy (BB)

For the construct of Behavioural Intention to use (BU) and the construct of Behavioural Intention to Buy (BB), which is also an integral part of all TAM-based studies, previous indicators were adapted to the context and the specific characteristics of electric passenger cars. The hypothesis is the following:

Hypothesis 4 (H4): *The higher the general behavioural intention to use electric passenger cars, the higher the behavioural intention to buy electric passenger cars*.

Subjective Norm (SN)

Subjective norm describes the extent to which a person expects his or her environment to support his or her actions. When the social value of a product is appreciated, the perceived benefit of the product increases. This influencing factor was identified in the reviewed papers in the scope of the conducted SLR in chapter 4 (Graham-Rowe et al., 2012; Zhuge and Shao, 2019; Anastasiadou and Gavanas, 2022). This leads to the following research hypothesis:

Hypothesis 5 (H5): *Subjective norm does have a positive influence on the perceived usefulness of electric passenger cars.*

Personal Innovativeness (PI)

The construct of the personal degree of innovation describes the willingness to adopt a new technology or innovation. The personal degree of innovation is reflected in the appeal of new products and technologies and the radiation on different user groups. Innovativeness is according to Rogers the interest in trying out new things, concepts, products and services and accept these also consequently (Rogers, 2003). Personal Innovativeness was also mentioned in (Morton, Anable and Nelson, 2016) in chapter 4.

Based on these findings, the following hypothesis can be formulated for this research work:

Hypothesis 6 (H6): *The higher the personal innovativeness level, the higher the perceived usefulness of electric passenger cars.*

Ecological Belief (EB)

Another important factor influencing the acceptance of electromobility is the ecological belief or attitude of potential consumers of electromobility and the tendency of a consumer to behave in an ecologically responsible manner (Roberts, 1995). Numerous studies demonstrated that environmental values are a key decision reason why consumer choose an electric passenger car and that the users explicitly show their “greenness” by buying an alternative powered vehicle (Zhuge and Shao, 2019; Ju and Hun Kim, 2022; Anastasiadou and Gavanas, 2022).

Hypothesis 7 (H7): *The higher the ecological belief, the higher the perceived usefulness of electric passenger cars.*

Image (IG)

Besides ecological belief and subjective norm, it is the image of electric passenger cars which should not be underestimated. Tesla is one popular example, that even not being the first vehicles on the market worldwide, the brand is so attracting and fascinating that a real cult has formed around Tesla and its community. The construct of image was also taken from existing literature out of the conducted SLR in chapter 4 (Zhuge and Shao, 2019; Anastasiadou and Gavanas, 2022). Small formulation changes were made in order to correspond to the research context of electric passenger cars. The research hypothesis is the following:

Hypothesis 8 (H8): *Image supports the perceived usefulness of electric passenger cars.*

Perceived Visibility of electric passenger car usage (PV)

The construct of perceived visibility of electric passenger car usage was also one aspect, which has been identified in the conducted SLR in chapter 4 (Sierzchula *et al.*, 2014; Graham-Rowe *et al.*, 2012; Kim, Lee and Lee, 2017) and which has already been dealt with in the literature as the construct of image. Especially in the early stage of market penetration, it is essential that the product is well perceived in public, well known and of course also special and new in its look and feel.

The look and feel of electric passenger cars, in particular at the beginning of the market penetration was also one key success factor of all electric passenger car brands. The car manufacturers are still discussing and driving different strategies when it comes to the topic of design of electric cars. Some brands are focusing on “purpose” design rather than the design of conventional vehicles or some only differentiated their electric passenger cars through special paints, trims or nomenclature. Purpose design means in this context a dedicated developed vehicle for an electric drive train without compromises (in functions, size, width and weight). Consequently, the research hypothesis is:

Hypothesis 9 (H9): *The higher the perceived visibility of electric passenger cars usage, the higher the perceived usefulness of electric passenger cars.*

Technological Risk (TR)

Since the market penetration of electric passenger cars is not yet completed especially for the mass-market buyer, there are still a lot of open questions and concerns at the possible customers. Lack of marketing or knowledge could be one driver why customers fear new innovations and why they prefer to keep the previous products. The constructs of technological risk and technological knowledge have also been dealt in the reviewed literature in chapter 4 (Graham-Rowe *et al.*, 2012; Chinen *et al.*, 2022;

Mutavdžija, Kovačić and Buntak, 2022; Ju and Hun Kim, 2022). Customers doubt the maturity and the reliability of the conventional products.

Hypothesis 10 (H10): *The higher the perceived technological risk, the lower the perceived usefulness of electric passenger cars.*

Technological Knowledge (TK)

Technological knowledge was further mentioned as one influencing factor towards the acceptance behaviour of electric passenger cars in the conducted SLR in chapter 4 (Graham-Rowe *et al.*, 2012). The following hypotheses arise for the construct perceived technological knowledge:

Hypothesis 11 (H11): *The higher the perceived technological knowledge about electric passenger cars, the higher the perceived usefulness.*

Hypothesis 12 (H12): *The higher the perceived technological knowledge about electric passenger cars, the higher the perceived ease of use.*

Anxiety of electric passenger cars Usage (AU)

The construct of anxiety of electric passenger car usage was adopted from literature in chapter 4 (Graham-Rowe *et al.*, 2012)**.** The handling and experience of driving electric passenger cars is a new topic for customers because there are still many possible customers who have not driven an electric vehicle yet. The hypothesis is the following:

Hypothesis 13 (H13): *The higher the anxiety of electric passenger car usage, the lower the perceived ease of use.*

Charging Time (CT)

Charging time (Zhuge and Shao, 2019; Anastasiadou and Gavanas, 2022) and charging infrastructure (Zhuge and Shao, 2019; Kim, Lee and Lee, 2017; Shi *et al.*, 2019;

Mutavdžija, Kovačić and Buntak, 2022; Mohammadzadeh *et al.*, 2022; Gupta, Tyagi and Anand, 2022; Anastasiadou and Gavanas, 2022) was mentioned as one of the essential key influencing factors towards the acceptance behaviour of electric passenger cars in the conducted SLR and expert interviews in chapter 4. From literature it was adapted in the context of network coverage, accessibility and technological infrastructure. The hypothesis is the following:

Hypothesis 14 (H14): *The quicker the charging time, the higher the perceived ease of use.*

Charging Infrastructure (CI)

The following hypothesis arises for the construct of perceived charging infrastructure:

Hypothesis 15 (H15): *The higher the availability of charging infrastructure, the higher the perceived ease of use.*

Driving Range (DR)

Driving range as one influencing factor towards the acceptance of electric passenger cars is still one popular discussion topic among possible customers or among car manufacturers and was mentioned as one key variable towards the acceptance behaviour of electric passenger cars in chapter 4 (Graham-Rowe *et al.*, 2012; Saxena *et al.*, 2015; Franke and Krems, 2013; Noel *et al.*, 2019; Zhuge and Shao, 2019; Shi *et al.*, 2019; Anastasiadou and Gavanas, 2022). Therefore, it is obvious that all car manufacturers are advertising the driving range of their electric passenger cars.

However, the needs, use cases and commuting habits differ significantly among customers; especially if the customers are living in rural areas or in big metropolitan areas. Sufficient driving range was therefore also mentioned during the expert interviews in chapter 4. This leads to the following research hypotheses:

Hypothesis 16 (H16): *The higher the perceived electric driving range, the higher the perceived usefulness.*

Hypothesis 17 (H17): *The higher the perceived electric driving range, the higher the general behavioural intention to use electric passenger cars.*

Appealing Brand (AB)

Next to the construct of image, the offer of electric passenger car brands and the appealing of the brand are very important in terms of acceptance of electric passenger cars. This has been also mentioned during the conducted expert interviews as stated in chapter 4. The hypothesis is the following:

Hypothesis 18 (H18): *The higher the perceived offer of electric passenger cars by Indian brands, the higher the behavioural intention to buy electric passenger cars*.

Governmental Incentives (GI)

Governmental incentives with respect to electric passenger cars was the most mentioned key driver that was named during the expert interviews and also in the conducted SLR in chapter 4 (Egbue and Long, 2012; Sierzchula *et al.*, 2014; Wang, Tang and Pan, 2019; Rietmann and Lieven, 2019; Langbroek, Franklin and Susilo, 2016; Krupa *et al.*, 2014; Plötz *et al.*, 2014; Mohammadzadeh *et al.*, 2022; Anastasiadou and Gavanas, 2022). Those either monetary or non-monetary incentives can play a major role in the acceptance of electric passenger cars also in other countries worldwide. Governmental incentives could be for example: exemption of vehicle registration tax, exemption of value added tax, exemption of the annual vehicle tax, free road/highway toll fees, exemption of parking fees in municipal areas, special reserved electric passenger cars number plates, tax reduction for company owned cars, monetary incentives by purchasing an electric vehicle such in Germany, financial support of fast charging stations and many more. This leads to the following two research hypothesises:

Hypothesis 19 (H19): *The higher the perceived governmental incentives, the higher the perceived usefulness of electric passenger cars.*

Hypothesis 20 (H20): *The higher the perceived governmental incentives, the higher the planned behaviour to buy an electric passenger car.*

Perceived Purchasing Costs (PC)

„Mass adoption of electric cars in India will not happen unless the gap in upfront prices of electric and ICE vehicles is brought down" said Shantanu Jaiswal, Head of Research at Bloomberg New Energy Finance (Bloomberg, 2020).

Since India is a price-sensitive market and since the prices of electric passenger cars are still quiet high, the construct of purchasing costs of electric cars has been analysed. Purchasing costs as key driver in the acceptance behaviour of electric passenger cars was mentioned the second most after the influencing factor governmental incentives in chapter 4 (Egbue and Long, 2012; Graham-Rowe et al., 2012; Zhuge and Shao, 2019; Kim, Lee and Lee, 2017; Chinen et al., 2022; Ju and Hun Kim, 2022; Mohammadzadeh et al., 2022; Gupta, Tyagi and Anand, 2022).

The following research hypothesis arises:

Hypothesis 21 (H21): *The higher the perceived purchasing costs, the lower is the general behavioural intention to buy electric passenger cars.*

The next section presents the research hypotheses using the moderation variables gender and car-ownership.

5.3.2. Using moderation variables such as gender & car-ownership

In addition to the direct influence of the constructs, e.g., the influence of subjective norm on the perceived usefulness of electric passenger cars, the effects of so-called moderator variables are also examined. Moderator variables describe a qualitative manifestation (e.g., gender) that affect the strength and/or direction of a path relationship.

This research used the moderation variable gender in order to investigate if there is a difference among the female and male surveyed group of this research. The focus was on the following three constructs: Subjective norm, ecological belief and purchasing costs. Venkatesh et al. (2000) for instance demonstrate in their observation of employees during the introduction of a new software technology that women are significantly more influenced by subjective norm and perceived behavioural intention than men (Venkatesh, Morris and Ackerman, 2000).

Hypothesis 22 (H22): *Gender moderates the influence of subjective norm on the perceived usefulness of electric passenger cars (stronger influence for women).*

Hypothesis 23 (H23): *Gender moderates the influence of ecological belief on the perceived usefulness of electric passenger cars (stronger influence for women).*

Hypothesis 24 (H24): *Gender moderates the influence of purchasing costs on the general behavioural intention to buy electric passenger cars (stronger influencer for women).*

Besides the variable gender, the research analysed the influence of car-ownership on the acceptance behaviour towards electric passenger cars in India. Since the car-ownership in India is only 1.7% (Statistisches Bundesamt, 2023c), this thesis analysed if there is a difference in the acceptance behaviour of a car-owner among the survey group in order to find out if the falsification and confirmation of the research hypotheses are different. Table 12 summarizes all the 24 established research hypotheses of this thesis.

Table 12 Summary research hypotheses (continued on p. 92)

Source: own table

H1	The higher the perceived usefulness, the higher the general behavioural intention to use electric passenger cars.
H2	The higher the perceived ease of use, the higher the general behavioural intention to use electric passenger cars.
H3	The higher the perceived ease of use, the higher the perceived usefulness of electric passenger cars.
H4	The higher the general behavioural intention to use electric passenger cars, the higher the behavioural intention to buy electric passenger cars.
H5	Subjective norm does have a positive influence on the perceived usefulness of electric passenger cars.
H6	The higher the personal innovativeness level, the higher the perceived usefulness of electric passenger cars.
H7	The higher the ecological belief, the higher the perceived usefulness of electric passenger cars.
H8	Image supports the perceived usefulness of electric passenger cars.
H9	The higher the perceived visibility of electric passenger car usage, the higher the perceived usefulness of Electric passenger cars.
H10	The higher the perceived technological risk, the lower the perceived usefulness of Electric passenger cars.
H11	The higher the perceived technological knowledge about Electric passenger cars, the higher the perceived usefulness.
H12	The higher the perceived technological knowledge about Electric passenger cars, the higher the perceived ease of use.
H13	The higher the anxiety of electric passenger car usage, the lower the perceived ease of use.
H14	The quicker the charging time, the higher the perceived ease of use.
H15	The higher the availability of charging infrastructure, the higher the perceived ease of use.

H16	The higher the perceived electric driving range, the higher the perceived usefulness.
H17	The higher the perceived electric driving range, the higher the general behavioural intention to use electric passenger cars.
H18	The higher the perceived offer of electric passenger cars by Indian brands, the higher the behavioural intention to buy electric passenger cars.
H19	The higher the perceived governmental incentives, the higher the perceived usefulness of electric passenger cars.
H20	The higher the perceived governmental incentives, the higher the planned behaviour to buy an electric passenger car.
H21	The higher the perceived purchasing costs, the lower is the general behavioural intention to buy electric passenger cars.
H22	Gender moderates the influence of subjective norm on the perceived usefulness of electric passenger cars (stronger influence for women).
H23	Gender moderates the influence of ecological belief on the perceived usefulness of electric passenger cars (stronger influence for women).
H24	Gender moderates the influence of purchasing costs on the general behavioural intention to buy electric passenger cars (stronger influencer for women).

The following section provides the operationalisation of the developed TAM.

5.3.3. Operationalisation of developed TAM

After establishing the Technology Acceptance Model for this research and after outlining the respective research hypotheses, the developed TAM was operationalized. To operationalise the influencing factors (constructs) and in order to identify the significance within the model, each construct has been described by so called measurement items (manifest indicators), that were expressed through questions within the online questionnaire among the surveyed group, s. chapter 5.2.2. and appendix 2.

The questions for each influencing factors (construct) were set up by the researcher and are based on a Likert scale ranging from 1 to 5, where 1 stands for strongly disagree, while 5 stands for strongly agree with the statement. Each construct is counted with the same weight and the questions (measurement items) are independent of the number of questions. The quality of each question has been assessed through respective Key Performance Indicators (KPIs), which will be explained later in chapter 6. Table 13 summarizes all constructs of the developed TAM research model and distinguishes between formative and reflective constructs. That means the manifest indicators, as shown in table 13, are exactly the questions in the conducted online-questionnaire; s. appendix 2.

Table 13 Summary constructs of developed TAM model *(continued on p. 94 ff.)*

Source: own table

	Constructs (latent variables)	Measurement items (manifest indicators)
1	**PU: Perceived usefulness** *(formative)*	PU1 – It would be a reasonable decision to use electric passenger cars. PU2 – Electric passenger cars are a good innovation. PU3 – Electric passenger cars are useful.
2	**PE: Perceived ease of use**	PE1 - Handling an electric vehicle is the same as handling a conventional vehicle. PE2 - I do not see big showstoppers in handling an electric vehicle. PE3 - Learning to operate an electric vehicle is easy for me.
3	**BU: Behavioural intention to use** *(formative)*	BU1 - I plan to use an electric vehicle in the future. BU2- I can imagine using an electric vehicle in addition to the conventional vehicle(s) in my/family household. BU3 – I can imagine using an electric vehicle spontaneously.
4	**BB: Behavioural intention to buy**	BB1 – I can imagine buying an electric vehicle. BB2 – I can imagine leasing an electric vehicle. BB3 – I can imagine paying an additional charge for an electric vehicle.

5	**SN: Subjective norm** *(formative)*	SN1- People around me (family/friends), who influence my behaviour, would like if I drive an electric vehicle. SN2- People, who are important to me, would like if I drive an electric vehicle. SN3- Social media do support the usage of electric passenger cars.
6	**PI: Personal innovativeness** *(formative)*	PI1- Among my friends/family members, I am usually the first to try out new technologies. PI2 - I look always for new, innovative products. PI3 - I enjoy experimenting with new products. PI4 - When I hear about new products, where I am interested in, I always try to test it out and where appropriate buy it. PI5- I would rather prefer to test new products personally than reading tests/customer feedbacks.
7	**EB: Ecological belief** *(formative)*	EB1- If I have the choice between two similar products, I choose always the more environmentally friendly one. EB2 - I do prefer purchasing products which are made out of recyclable material. EB3 - I try to act environmentally sustainable in my daily life. EB4 - I often accept a higher price in order to buy environmentally friendly products. EB5 - I did convince some of my friends/family members to avoid buying non-environmentally friendly products.
8	**GI: Governmental incentives**	GI1- In my point of view the government should reduce the purchasing costs of electric passenger cars through cash incentives. GI2 - In my point of view the government should reduce the purchasing costs of electric passenger cars through tax incentives. GI3 - I would purchase an electric vehicle if the government establish a malus system (e.g. higher taxes, higher costs, fines when buying a conventional vehicle). GI4 - I would consider buying an electric vehicle if I would receive non-monetary incentives such as extra road lanes within the city etc.

9	**TK: Technological knowledge** *(formative)*	TK1- I do know a lot about e-mobility. TK2- I do know more about e-mobility compared to my friends/family members. TK3- I follow news in the field of e-mobility.
10	**CI: Charging infrastructure**	CI1- It is easier for me to use an electric vehicle if a comprehensive and appropriate charging infrastructure is available. CI2 - Currently there is a lack of appropriate public charging infrastructure. CI3 - The current lack of home charging prevents me to buy an electric vehicle. CI4 - The fear of a not sufficient and stable national power grid prevents me to buy an electric vehicle. CI5 - I fear that not having access to a public charging station when I need it.
11	**CT: Charging time**	CT1 - I accept a full charging time of approx. 1 hour with a super charger. CT2 - I accept a full charging time of approx. 8 hours by charging at a usual home power outlet. CT3 - Since I would charge my electric vehicle either at home over night or during work, I do not care about the charging time.
12	**TR: Technological risk**	TR1- I do not believe that e-mobility is a matured innovation. TR2 - I do not believe that electric passenger cars have the same reliability than conventional vehicles. TR3 - There are still a lot of open and unanswered questions when it comes up to e-mobility.
13	**DR: Driving range**	DR1 - I accept a total driving range of electric passenger cars of minimum 70 – 100km. DR2 - I accept a total driving range of electric passenger cars of minimum150km. DR3 - I accept a total driving range of electric passenger cars of minimum 300km.

		DR4 - I accept a total driving range of electric passenger cars of minimum 600km. DR5 - I cannot accept losses regarding the total driving range of electric passenger cars compared to conventional vehicles.
14	**PC: Perceived purchasing costs**	PC1 - I would accept to pay an additional price of <5% for electric passenger cars vs. comparable conventional vehicles. PC2 – I would accept to pay an additional price of 5 – 10% for electric passenger cars vs. comparable conventional vehicles. PC3 – I would accept to pay an additional price of 11– 20% for electric passenger cars vs. comparable conventional vehicles. PC4- I don`t accept a higher price for electric passenger cars vs. Comparable conventional vehicles.
15	**IG: Image** *(formative)*	IG1- Using an electric vehicle would lead to a higher positive social reputation. IG2 – I would draw attention on me by using an electric vehicle. IG3 – My social environment would think that I do care about environment protection if I use an electric vehicle. IG4 - An electric vehicle is a status symbol.
16	**PV: Perceived visibility of usage**	PV1 – I prefer "purpose" design of electric passenger cars rather than the design of conventional vehicles. PV2 - Current electric passenger cars which are based on already existing conventional vehicles, should be differentiated through special paints/trims/nomenclature. PV3 - For me it is important that the look and field of an electric vehicle is special.
17	**AB: Appealing brand**	AB1 - I prefer a dedicated EV brand like Tesla if I would buy an electric vehicle. AB2 – I would prefer an Indian brand if I would buy an electric vehicle. AB3 – I do not care about the brand origin of electric passenger cars.
18	**AU: Anxiety of usage**	AU1- I am nervous while driving vehicles. AU2 – I am anxious while driving vehicles.

	(formative)	AU3 - I feel uncomfortable while driving vehicles. AOU4 - I feel uncomfortable while charging electric passenger cars.
19	**Gender**	Moderation variable on the constructs: Subjective norm Ecological belief Purchasing costs
20	**Car ownership**	Moderation variable to analyse difference in the acceptance behaviour of a car-owner with regard to all constructs

Figure 26 presents the final Technology Acceptance model towards the adoption of electric passenger cars with all influencing factors and the respective research hypotheses. The developed TAM of this research is a very complex structural equation model consisting of 18 constructs, two moderation variables and 66 latent variables. The next chapter will present the scope of the conducted online questionnaire.

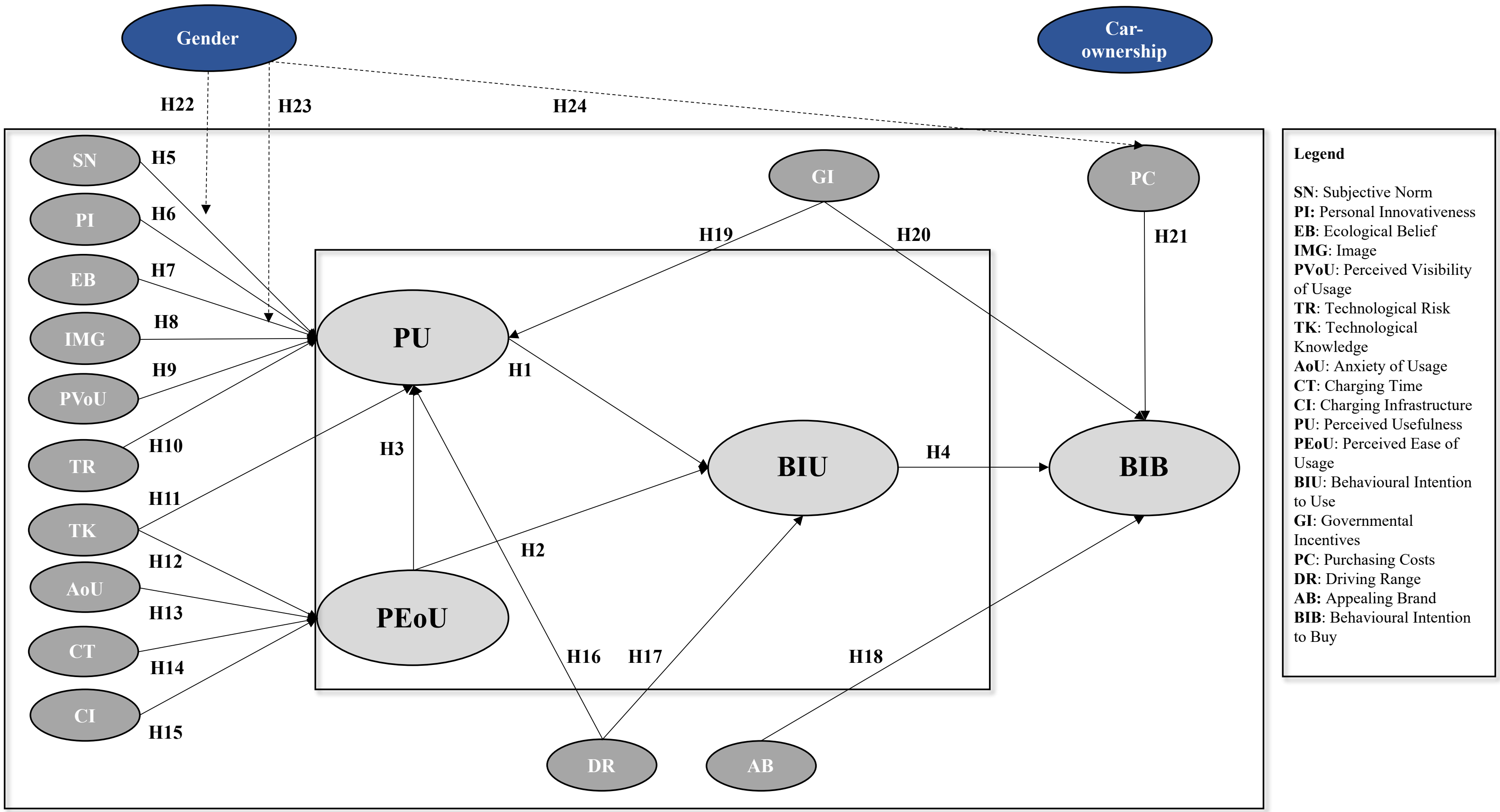

Figure 26 Technology Acceptance Model to study the acceptance behaviour towards electric passenger cars in India including research hypotheses

Source: own figure

5.4. Online-questionnaire

The previous chapter 5.3.3. explained the operationalization of the developed Technology Acceptance Model towards the acceptance behaviour of electric passenger cars in India and presented how each construct has been described through manifest indicators. Those indicators will be expressed by questions asked in the form of a conducted online questionnaire as field trial in this research, s. appendix 2.

This chapter will explain the scope of the conducted online-questionnaire, its sampling method and limitations. The data out of the online questionnaire will be later empirically evaluated in chapter 6 and will be therefore the base for answering the research question and aims as stated in chapter 1.5. and 1.6., as well for falsifying or confirming the outlined research hypotheses as presented in chapter 5.3.1. and 5.3.2.

The online questionnaire asked the participants questions in a precisely defined order for which the online survey provider "Limesurvey" [10] was used.

An online questionnaire for conducting the field research was chosen due to its easy implementation, its lower costs, its fast availability of data and high quality of data, as well as due to its easy international application.

The survey provider Limesurvey was chosen because it offers a comprehensive package of functions for designing comprehensive surveys that also meets scientific requirements. By providing the software and also the surveys on the own server, data protection can be guaranteed. In addition, Limesurvey is very flexible and can be adapted to individual (design) needs through different templates. After a short introduction into the structure of the program the individual steps are very easy to understand and sufficiently clear. Thus, Limesurvey is the program of choice in order to realize data protection-compliant and somewhat larger survey projects (Bosh, 2014).

[10] https://www.limesurvey.org

The questions in the online questionnaire were aimed at analysing the attitudes and perceptions of potential buyers of electric passenger cars in India towards the identified influencing factors such as ecological belief, purchasing costs or charging infrastructure; but also, towards socio-demographic data such as age, gender, education and income.

The participants were sensitized through an introduction text about the topic and the motivation of the researcher. On top of that the time specification of 15 minutes was checked through a pre-testing phase. Additionally, Amazon vouchers were raffled among all participants as an incentive and the offer was created to the participants to receive the anonymous results after finalizing the research if requested. 30% of all participants even wrote an individual E-Mail to the researcher for noting that they have successfully completed the survey and that the topic is very interesting and important for India; this confirms the motivation of the participants and the importance of this research topic. The respective sampling method will be presented in the next section.

5.4.1. Sampling method

The research was conducted during the period of February and May 2020. The questionnaire was sent to approx. 4,000 addressees in India via the business network LinkedIn.

LinkedIn is a social network for maintaining professional contacts, which was founded in 2003 and has been part of Microsoft since December 2016 (Golden, 2023). Users can choose between a free basic account and a paid premium account, which offers advanced features. The addressees were selected through a purposive sampling process since **Indian young professionals with a higher level of education** have been chosen by the researcher as addressees, whereof 232 participated and completed the questionnaire successfully. In the selection of the sample elements, a distinction can be made between probability selection and deliberate selection/non-probability selection. In so-called probability selection each element of the sample has the same probability of being drawn, whereas in the so-called deliberate selection, elements with certain characteristic and values are defined in advance. The next section provides the statistical data of the sample of this research.

5.4.2. Statistical data of sample

The following table presents the statistical data of the 232 participants in this research.

Table 14 Statistical data of sample of research (n= 232)

Source: own table

Feature	**Distribution**
Gender	21% female; 79% male
Age	18 – 43 years; Average: 27 years old
Level of higher education	7% Bachelor, 51% Master, 42% PhD
Average income	12,800 US$[11]
State	16% Maharashtra, 11% Karnataka, 9% Delhi, 9% West Bengal, 8% Uttar Pradesh,7% Tamil Nadu, 6% Gujarat, 5% Bihar, 5% Rajasthan, 4% Jharkhand, rest other (details s. Annex)
Car ownership	55% no; 45% yes Women: 57% no; 43% yes Men: 40% no; 60% yes

The following sections presents the justification of the sampling method and process.

[11] Exchange rate INR/US$= 0.0125; data from Oanda. Available at: https://www.oanda.com/currency-converter/de/?from=INR&to=USD&amount=1; (Accessed at: 22.08.22)

5.4.3. Justification of sampling method

The researcher analysed latest reports on electric passenger car ownership and studies about who is interested into buying an electric passenger car in order to get to know more about their demographics and to define criteria for the sample selection.

In 2020 owners of electric passenger cars in the USA earned more than $100,000, which is more than the average income in the USA of $ 69,227 (Statistisches Bundesamt, 2023a; Inspire, 2023). In Sweden a studied stated “a high level of education” is prominent among the early adopters of electric passenger cars (Vassileva and Campillo, 2017) and in Norway, “the drivers of electric passenger cars tend to have higher education than non-adopters and they report being “highly motivated” by environmental issues (alongside issues of cost)” (Sovacool *et al.*, 2018). By the question which age group is interested into buying electric passenger cars, 47% of millennials (ages 25 – 40) in the USA are interested into buying an electric passenger car, followed by Gen Z with 41% (Finlay, 2023).

That is the reason why the researcher has chosen Indian young professionals with a higher level of education (bachelor’s degree, master’s degree or PhD) through purposive sampling. The statistical data of the sample of this research confirms this selection.

First of all, the average age of 27 years of all participants matches to the group of millennials which tend to be more eager to go for electric passenger cars. Secondly, the average age of the participants matches to the biggest group of potential new passenger car buyers, which is with 41% between 25- 34 the biggest one in India (Statista, 2022g). Moreover, the average income of the surveyed group, also due to the higher level of education, is with 12,800 US$ much higher than the average Indian income with 2,280 US$ (Statistisches Bundesamt, 2023c), which also fits to the findings from the USA where owners of electric passenger cars earning more than the median in the USA.

Additionally, the present car ownership among this potential customer group is quite high with 45% in average, especially compared to the average car ownership of 1.7% (Statistisches Bundesamt, 2023c).

By the question where to find Indian young professionals with a higher level of education, the researcher has chosen the social network LinkedIn as tool to address the participants for the survey. LinkedIn holds a strong popularity as a business network in India, because India is second biggest market with 82 million users after the USA. China follows with 55 million registered members, respectively (Dixon, 2022). 58% of the Indian LinkedIn users are in the age group between 25 and 34 years and therefore in the group that is starting and growing their careers (Napoleon Cat, 2022). This age fits very well to the average age of 27 years of the surveyed group, s. table 14 and the average age in India with 27.9 years in 2022, s. table 2. Moreover, in the USA LinkedIn users have a higher average income with 75,000 US$ than the median in the USA with of $ 69,227 (Statistisches Bundesamt, 2023a; Inspire, 2023). This fact led to the assumption by the researcher that this is also the case in India (Osman, 2023), which was confirmed through the statistical data of the sample in this research; s. table 14. Further research into LinkedIn statistics found that more than 50% of adults in the USA who are having a bachelor's degree or even higher are using LinkedIn, whereases only 10% of the LinkedIn users whose education does not extend beyond high school use the site (Osman, 2023). The statistical data of the sample in this research also confirmed the finding since 51% of the participants hold even a master´s degree and 42% a PhD as stated in table 14. The following section provides the limitations of the sampling method and process.

5.4.4. Limitations of sampling method

Indian young professionals with a higher level of education do not represent of course the Indian population in all respects, but only with respect to those characteristics that are relevant to this research question. The characteristics that have been chosen by the researcher, as explained in chapter 5.5.3. can theoretically have an impact on the identified influencing factors under investigation in the developed Technology Acceptance Model. But of course, purposive sampling is prone to research bias because the selection of the sample group depends on the researcher´s subjective judgment. Moreover, the defined characteristics of an average electric passenger car driver or of a possible electric passenger car driver could differ in India; but since data was not available for an average Indian electric passenger car driver, the researcher derived the assumed characteristics from available data such as from the USA.

Even with 82 million LinkedIn users in India, the social network of course does not cover all Indian young professionals with a higher level of education; thus, not every Indian young professional with a higher level of education had the chance to participate in the study. Moreover, it was taken into account that only Indian young professionals with a higher level of education could participate with an access to the Internet. On top of that, there are also limitations by using an online questionnaire since no interviewer is provided on site. In a written survey the response rates are usually lower than in a personal interview. The incomprehensibility of the questionnaire, as it is not possible to ask an interviewer and therefore no additional explanations to the questions can be provided, is one reason for this. Other reasons may be the lack of motivation of the respondents, as the social contact and motivating words of the interviewer are missing, and the lack of interest in the topic of the questionnaire, as often only those interested take the time to participate in the survey. The next section ends with the conclusion of this chapter.

5.5. Conclusion

This chapter explained the research methodology for this thesis. A structural equation modelling was applied using the variance-based method to operationalize the complex Technology Acceptance Model of this research which consists of 18 constructs (whereof 10 are reflective and 8 constructs are formative ones), 2 moderation variables and 66 latent variables. For a corresponding analysis the variance-based method is clearly more suitable than a covariance-based method. On top of that, 24 research hypotheses have been outlined by the researcher on which the TAM of this research is based. Finally, the scope of the conducted online questionnaire was presented, including statistical data of the sample of this research, as well as explanations and shortcomings given towards the selected sampling method and sampling process. The next chapter presents the empirical evaluation of this research and the quality assessment of the developed Technology Acceptance Model, as well as the empirical results.

6. Empirical evaluation & results

6.1. Introduction

This chapter will explain the empirical evaluation process of the data out of the online questionnaire and thus the empirical results will be presented. The data of all complete 232 samples of the online questionnaire have been analysed using the tool SmartPLS, a well-known software application for Partial Least Square Structural Equation Modeling. Figure 27 and the following chapters will explain step by step the approach how the empirical evaluation has been conducted and validated in this present research.

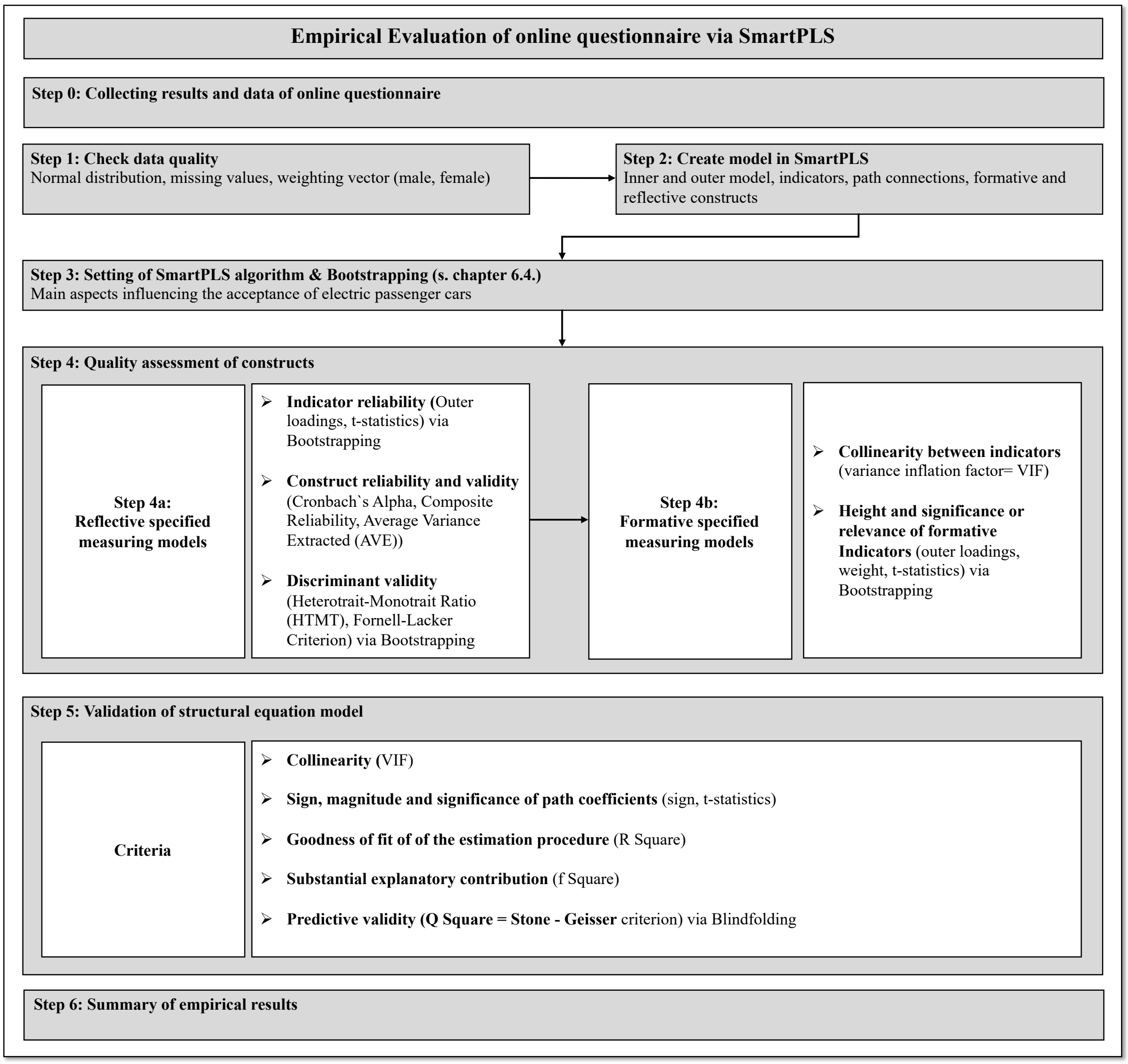

Figure 27 Process chart Empirical Evaluation of TAM model via SmartPLS

Source: own figure

6.2. Data Quality – Step 1

Smart PLS can evaluate non-normally distributed data without any problems, nevertheless it is important to look at the data quality via kurtosis and skewness. The next section explains the first step of checking the normal distribution in the data quality process.

6.2.1. Checking the normal distribution

The so-called “skewness” defines the slope of a curve and is a measure for the symmetry of a probability distribution. Gaussian normal distribution has a skewness of 0, in this case there is no skewness. Kline (2011) describes a skewness of greater than +3 or less than -3 as an extreme deviation from the normal distribution (Kline, 2011). SEM models using variant-based methods (Smart PLS) do not require strict distribution requirements, but a normal distribution is recommended (Kline, 2011).
Table 15 and 16 show the skewness of all indicators of the TAM. The indicators age (5.715), charging infrastructure 1 (CI1= 3.688) and charging infrastructure 2 (CI2= 9.441) are below normal distribution. The indicator age is explainable since the average age of all participants is 27 years. CI1 and CI2 will be further checked with the help of the quality assessments in the next steps.

Table 15 Overview skewness of developed TAM constructs

Source: own table, screenshot out of SmartPLS software

Delimiter: Semicolon
Value Quote Character: None
Number Format: US (example: 1,000.23)
Missing Value Marker: -99

Encoding: UTF-8
Sample size: 232
Indicators: 72
Missing Values: 360

Re-Analyze | Open External

Indicators: | Indicator Correlations | Raw File | Copy to Clipboard

	No.	Missing	Mean	Median	Min	Max	Standard Deviatior	Excess Kurtosis	Ske
Gender	1	0	1.207	1.000	1.000	2.000	0.405	0.123	
Age	2	0	27.767	27.000	5.000	61.000	5.833	5.715	
State	3	0	16.927	13.000	1.000	32.000	8.626	-1.199	
Education	4	0	4.366	4.000	2.000	6.000	0.643	0.206	-
Income	5	0	4.746	5.000	1.000	7.000	1.896	-1.029	-
Car	6	0	1.841	2.000	1.000	3.000	0.864	-1.597	
PU1	7	1	4.134	4.000	1.000	5.000	0.850	0.897	-
PU2	8	1	4.459	5.000	2.000	5.000	0.608	0.234	-
PU3	9	2	4.339	4.000	1.000	5.000	0.684	1.761	-
PE1	10	9	2.888	3.000	1.000	5.000	1.160	-1.054	
PE2	11	7	3.484	4.000	1.000	5.000	0.953	-0.285	-
PE3	12	10	4.081	4.000	2.000	5.000	0.749	-0.189	-
BU1	13	3	4.183	4.000	1.000	5.000	0.852	0.813	-
BU2	14	3	3.934	4.000	1.000	5.000	0.939	0.776	-
BU3	15	4	3.605	4.000	1.000	5.000	1.035	-0.423	-
BB1	16	1	4.100	4.000	1.000	5.000	0.844	1.551	-
BB2	17	5	3.330	3.000	1.000	5.000	1.046	-0.832	-
BB3	18	4	3.114	3.000	1.000	5.000	1.102	-0.747	-
SN1	19	3	3.668	4.000	1.000	5.000	0.918	0.400	-
SN2	20	4	3.754	4.000	1.000	5.000	0.937	0.434	-
SN3	21	2	3.983	4.000	1.000	5.000	0.854	0.596	-
PI1	22	3	3.707	4.000	1.000	5.000	1.116	-0.862	-
PI2	23	4	4.057	4.000	1.000	5.000	0.932	0.491	-
PI3	24	3	4.013	4.000	1.000	5.000	0.864	0.396	-
PI4	25	3	3.952	4.000	1.000	5.000	0.878	0.267	-

Delimiter: Semicolon
Value Quote Character: None
Number Format: US (example: 1,000.23)
Missing Value Marker: -99

Encoding: UTF-8
Sample size: 232
Indicators: 72
Missing Values: 360

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Indicators: | Indicator Correlations | Raw File | Copy to Clipboard

	No.	Missing	Mean	Median	Min	Max	Standard Deviatior	Excess Kurtosis	Ske
PI5	26	2	3.600	4.000	1.000	5.000	1.163	-0.870	-
EB1	27	1	4.368	4.000	2.000	5.000	0.720	0.227	-
EB2	28	3	4.227	4.000	1.000	5.000	0.788	1.505	-
EB3	29	0	4.310	4.000	3.000	5.000	0.655	-0.732	-
EB4	30	2	3.574	4.000	1.000	5.000	0.965	-0.681	-
EB5	31	0	3.841	4.000	1.000	5.000	0.931	-0.015	-
PC1	32	1	3.883	4.000	1.000	5.000	0.958	0.538	-
PC2	33	3	3.323	3.000	1.000	5.000	1.086	-0.803	-
PC3	34	3	2.476	2.000	1.000	5.000	1.030	-0.137	
PC4	35	7	3.062	3.000	1.000	5.000	1.198	-0.929	
TK1	36	2	3.452	4.000	1.000	5.000	1.040	-0.366	-
TK2	37	0	3.789	4.000	1.000	5.000	0.997	0.562	-
TK3	38	1	3.671	4.000	1.000	5.000	0.965	0.172	-
TR1	39	3	2.725	2.000	1.000	5.000	1.105	-0.776	
TR2	40	4	2.798	3.000	1.000	5.000	1.069	-0.885	
TR3	41	4	3.939	4.000	1.000	5.000	0.825	1.281	-
AU1	42	7	2.089	2.000	1.000	5.000	1.100	-0.600	
AU2	43	8	2.134	2.000	1.000	5.000	1.052	-0.550	
AU3	44	8	2.004	2.000	1.000	5.000	1.167	0.087	
AU4	45	38	2.371	2.000	1.000	5.000	0.977	-0.669	
DR1	46	13	2.795	3.000	1.000	5.000	1.201	-1.041	
DR2	47	16	3.245	3.000	1.000	5.000	1.143	-0.707	-

Table 16 Overview skewness of developed TAM constructs

Source: own table, screenshot out of SmartPLS software

Delimiter:	Semicolon	Encoding:	UTF-8
Value Quote Character:	None	Sample size:	232
Number Format:	US (example: 1,000.23)	Indicators:	72
Missing Value Marker:	-99	Missing Values:	360

Re-Analyze | Open External

Indicators: | Indicator Correlations | Raw File | Copy to Clipboard

	No.	Missing	Mean	Median	Min	Max	Standard Deviatior	Excess Kurtosis	Ske
DR2	47	16	3.245	3.000	1.000	5.000	1.143	-0.707	-
DR3	48	16	3.843	4.000	1.000	5.000	1.038	0.911	-
DR4	49	15	3.548	4.000	1.000	5.000	1.262	-1.041	-
DR5	50	18	3.178	3.000	1.000	5.000	1.035	-0.607	
CI1	51	6	4.385	5.000	1.000	5.000	0.881	3.688	-
CI2	52	1	4.632	5.000	1.000	5.000	0.677	9.441	-
CI3	53	3	4.070	4.000	1.000	5.000	1.043	0.191	-
CI4	54	3	3.620	4.000	1.000	5.000	1.189	-1.043	-
CI5	55	3	4.354	5.000	1.000	5.000	0.816	2.269	-
CT1	56	13	4.068	4.000	1.000	5.000	0.941	1.524	-
CT2	57	16	3.264	3.000	1.000	5.000	1.147	-0.864	-
CT3	58	15	2.682	2.000	1.000	5.000	1.193	-0.757	
GI1	59	3	3.996	4.000	1.000	5.000	0.969	0.221	-
GI2	60	5	4.216	4.000	1.000	5.000	0.846	2.027	-
GI3	61	6	3.226	3.000	1.000	5.000	1.211	-0.872	-
GI4	62	5	4.018	4.000	1.000	5.000	0.905	0.199	-
AB1	63	3	3.642	4.000	1.000	5.000	1.091	-0.482	-
AB2	64	5	3.515	3.000	1.000	5.000	1.025	-0.333	-
AB3	65	4	2.947	3.000	1.000	5.000	1.280	-1.129	
IG1	66	2	3.613	4.000	1.000	5.000	1.006	-0.043	-
IG2	67	3	3.524	4.000	1.000	5.000	1.035	-0.173	-
IG3	68	2	3.809	4.000	1.000	5.000	0.936	0.522	-
IG4	69	4	2.956	3.000	1.000	5.000	1.103	-0.624	
PV1	70	6	3.765	4.000	1.000	5.000	0.933	0.000	-
PV2	71	5	3.392	4.000	1.000	5.000	0.967	-0.203	-
PV3	72	0	3.672	4.000	1.000	5.000	1.011	-0.043	-

The following sections presents the next step of checking missing values of the data quality process.

6.2.2. Check missing values

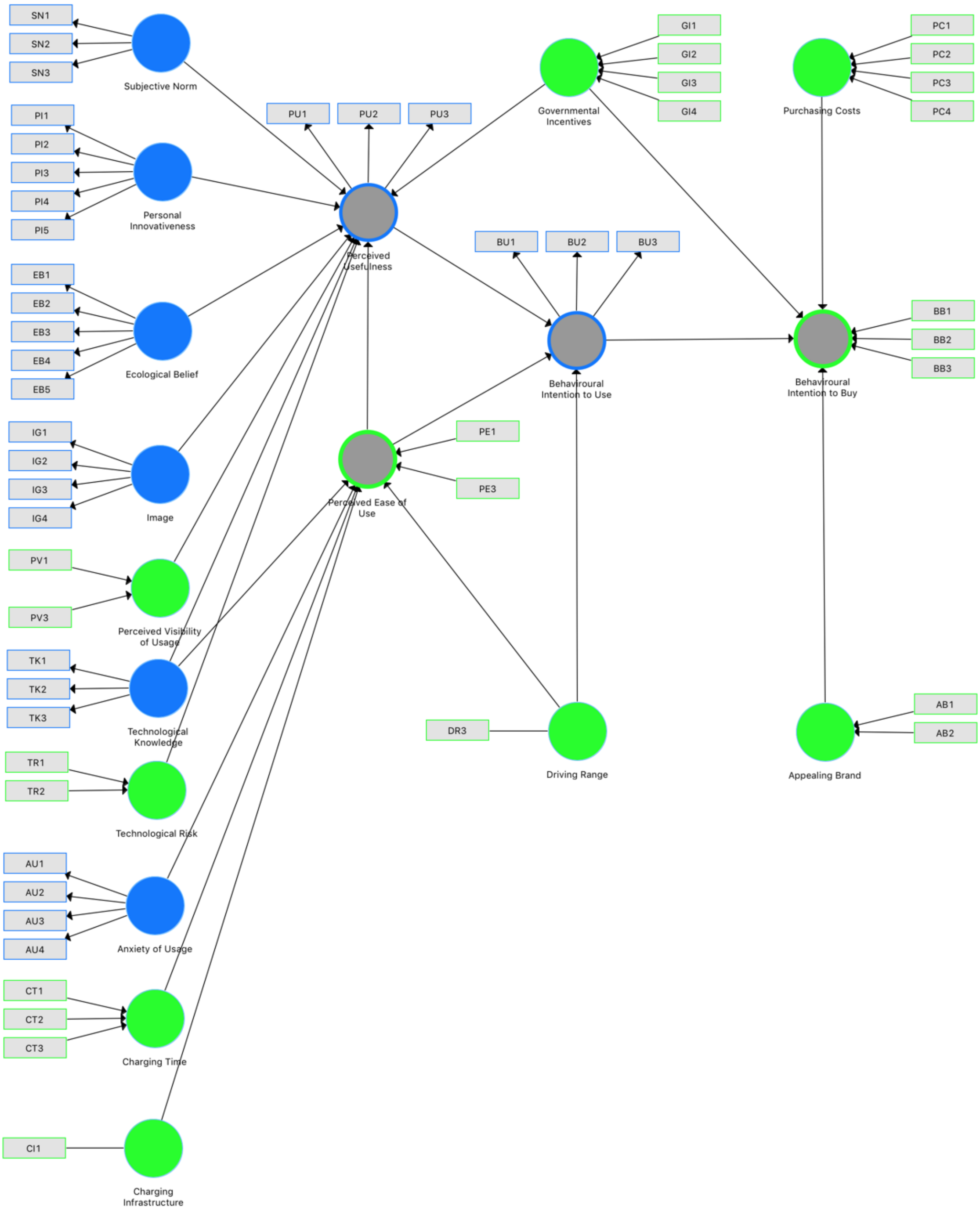
After uploading the data file, SmartPLS will automatically identify missing values in the data set. If an indicator has > 5% missing values, an exclusion needs to be discussed case by case. At <5% per indicator an averaging via SmartPLS will be performed. All the indicators of this thesis have less than 5% missing values and therefore no indicator is excluded. The last step of defining a weighting vector of the data quality process is presented in the following section.

6.2.3. Definition of a weighting vector

A weighting vector needs to be defined in order to weight the observations in the data set so that the structure of the data matches the structure of the population better. The participants in this filed trial are divided into 21% female and 79% male; however, the current gender ration of the total Indian population is 48% of female inhabitants and 52% of male inhabitants (StatisticTimes, 2021). That was the reason why a respective weighting vector was applied.

6.3. Creation of model in Smart PLS – Step 2

The next step is to create the developed Technology Acceptance model via the SmartPLS software. Figure 28 shows the research model with all constructs, latent variables, path connections and indicators. The colour blue indicates the formative measurement models, the colour green indicates the reflective ones.



Legend

SN: Subjective Norm
PI: Personal Innovativeness
EB: Ecological Belief
IMG: Image
PVoU: Perceived Visibility of Usage
TR: Technological Risk
TK: Technological Knowledge
AoU: Anxiety of Usage
CT: Charging Time
CI: Charging Infrastructure
PU: Perceived Usefulness
PEoU: Perceived Ease of Usage
BIU: Behavioural Intention to Use
GI: Governmental Incentives
PC: Purchasing Costs
DR: Driving Range
AB: Appealing Brand
BIB: Behavioural Intention to Buy

Figure 28 Research Technology Acceptance Model in SmartPLS

Source: own figure

The next chapter presents the parameter settings for the SmartPLS algorithm.

6.4. Smart PLS algorithm – Step 3

The following section will explain the parameter settings of SmartPLS. Within the scope of this research, three different types of calculations were carried out with the variance analysis software SmartPLS: PLS algorithm, Bootstrapping and Blindfolding procedure as shown in table 17.

The PLS algorithm calculation determines the magnitude of the model parameters (loadings, weights, and path coefficients) of the structural equation model. In addition, the PLS algorithm is used to calculate the goodness-of-fit value (R^2 value) of the internal consistency (factor reliability), the average recorded variance (AVE) and the Fornell-Larcker criterion. By means of the so-called bootstrapping procedure is used to test the significance of the path connections of the structural model by iterative sampling of a fixed size.

In bootstrapping, random samples or sub-samples are drawn from the original dataset (with backfilling). Each subsample is then used to estimate the model. This process is repeated until a large number of subsamples have been randomly drawn, typically about 5,000. The parameters estimated from the subsamples (in this case, the HTMT statistic) are then used to determine the standard errors of the estimates (Hair *et al.*, 2017).

The Blindfolding procedure allows the investigation of the predictive validity of the measurement instruments and is done stepwise suppression of a part of the data matrix and simultaneous reconstruction of the suppressed data using the estimated parameters. By comparing the estimated data with the actual data, the predictive validity can be determined.

Table 17 Selected parameter settings of the variance analysis software SmartPLS

Source: own table

	PARAMETER	SETTING	SOURCE
PLS-ALGORITHM	Weighting Scheme	Path weighting scheme (default)	(Henseler, Ringle Christian and Sinkovics Rudolf, 2009)
	Maximum Iterations	300 iterations (default)	(SmartPLS, 2020)
	Stop Criterion	As small as possible ($<10^{-5}$) The algorithm stops when the change in the other weights between two iterations is smaller than the stop criterion value or the maximum number of iterations is reached.	(SmartPLS, 2020)
BOOTSTRAPPING	Sign change option	Use individual sign changes	(Henseler, Ringle Christian and Sinkovics Rudolf, 2009)
	Number of bootstrap samples	5,000 samples	(Hair, Ringle and Sarstedt, 2011)
	Number of bootstrap cases	Equal to the number of valid observations	(Hair, Ringle and Sarstedt, 2011)
BLINDFOLDING	Use cross-validated redundancy		(Chin and Marcoulides, 1998)
	Omission distance d	Number of valid observations divided by d must not be an integer; choose $5 \leq d \leq 10$	(Chin and Marcoulides, 1998)

The PLS-SEM algorithm requires three basic algorithm settings to run (centroid, factor and path weighting scheme), from which the path weighting scheme is the most recommended one. Because the researchers aim the highest R^2 for endogenous latent variables and could be used for nearly all kinds of PLS path models.

The path weighting scheme is present for the estimation of the starting weights. The PLS-SEM algorithm ends when the maximum number of 300 iterations or the stopping criterion, which is by default 10^{-7} (i.e. 0.0000001), is reached (SmartPLS, 2020).

Table 18 demonstrates the results for the stop criterion changes of the PLS algorithm for this thesis. The results are 19 iterations, which are far below the maximum number of 300 iterations and therefore the data is evaluable.

Table 18 Results of Stop Criterion Changes in SmartPLS

Source: own table, screenshot out of SmartPLS software

Stop Criterion Changes

Matrix — Copy to Clipboard: Excel Format | R Format

	AB1	AB2	AB3	AU1	AU2	AU3	AU4	BB1	BB2
Iteration 2	0.528	0.683	0.585	0.472	0.310	0.077	0.477	0.824	0.171
Iteration 3	0.542	0.695	0.542	0.470	0.289	0.057	0.522	0.838	0.164
Iteration 4	0.560	0.676	0.556	0.472	0.310	0.077	0.477	0.840	0.163
Iteration 5	0.563	0.673	0.558	0.472	0.309	0.076	0.479	0.841	0.163
Iteration 6	0.564	0.671	0.560	0.472	0.312	0.079	0.473	0.842	0.163
Iteration 7	0.565	0.670	0.561	0.472	0.312	0.079	0.472	0.842	0.163
Iteration 8	0.565	0.670	0.561	0.472	0.312	0.079	0.471	0.842	0.163
Iteration 9	0.565	0.670	0.561	0.472	0.312	0.079	0.471	0.842	0.163
Iteration 10	0.565	0.670	0.561	0.472	0.312	0.079	0.471	0.842	0.163
Iteration 11	0.565	0.670	0.561	0.472	0.312	0.079	0.471	0.842	0.163
Iteration 12	0.565	0.670	0.561	0.472	0.312	0.079	0.471	0.842	0.163
Iteration 13	0.565	0.670	0.561	0.472	0.312	0.079	0.471	0.842	0.163
Iteration 14	0.565	0.670	0.561	0.472	0.312	0.079	0.471	0.842	0.163
Iteration 15	0.565	0.670	0.562	0.472	0.312	0.079	0.471	0.842	0.163
Iteration 16	0.565	0.670	0.562	0.472	0.312	0.079	0.471	0.842	0.163
Iteration 17	0.565	0.670	0.562	0.472	0.312	0.079	0.471	0.842	0.163
Iteration 18	0.565	0.670	0.562	0.472	0.312	0.079	0.471	0.842	0.163
Iteration 19	0.565	0.670	0.562	0.472	0.312	0.079	0.471	0.842	0.163

The main focus of the next empirical evaluation step is to check whether measurement models have sufficient quality to see whether the constructs are correctly represented; prerequisite that the relationships in the structural model make sense.

The estimation results of the structural model are not tested until the reliability and validity of the measurement models are ensured. First the reflective constructs will be tested and afterwards the formative ones. This is to see if the quality of the operationalization of the constructs is satisfactory before moving into testing the structural model in step 5. As part of the quality assessment of the structural model in the PLS-SEM context, it will be examined to see the extent to which the model is able to explain or predict the variance in the dependent variables. The primary quality criteria for PLS-SEM results are the relevance and significance of the path coefficients and the coefficients of determination (R^2 values). The f^2 effect strengths and the forecast relevance (Q^2) also allow the generation of further insights about the quality of the estimates in the PLS path model. The next chapter will explain the quality assessment of reflective measurement models.

6.5. Quality Assessment of reflective measurement models – Step 4a

The following chapter will explain in detail the approach how to assess the reflective specified measuring models of this thesis; according to step 4a as presented in figure 27.

6.5.1. Indicator reliability

6.5.1.1. Indicator outer loadings

Indicator outer loadings should be ≥ 0.7; values below 0.4 should be removed from the construct. In the present research, also due to the new development of individual constructs in the scope of the developed Technology Acceptance Model, a limit value of 0.6 can be considered acceptable according to (Huber *et al.*, 2008; Hair *et al.*, 2017).

6.5.1.2. T-statistics

Statistical significance describes the probability that differences in the values of measured variables are not due to chance. If statistical significance exists, it is assumed that a "super random" correlation exists (Hair *et al.*, 2017). The higher the significance level of a measurement, the higher the causal relationship of the relationship under investigation (Hair *et al.*, 2017). A $t \geq 1.65$ (5% significance level) should be the minimum value and a 10% level could be accepted in exploratory studies depending on new developed constructs (Hair *et al.*, 2017). The formula is as follows:

Equation 1 T-statistics[12]

Source: adapted from (Jain, 2023)

$$t = \frac{m - \mu}{s/\sqrt{n}}$$

6.5.2. Construct reliability and validity

The construct reliability (also called factor reliability) expresses the suitability of a construct to explain the variance of the manifest variables (indicators) assigned to it. This requires a strong relationship (correlation) of the indicators between each other, since otherwise indicators with low correlation would lead to a large total variance, which the construct would not be able to cover (Hair *et al.*, 2017).

6.5.2.1. Cronbach's Alpha

A popular criterion for checking the construct reliability is the so-called Cronbach's Alpha. It measures the average correlation between a group of indicators of a certain latent variable, adjusted by the number of indicators with a target value of $\alpha > 0.7$ (Hair *et al.*, 2017; Cronbach, 1951). The formula is as follows:

Equation 2 Cronbachs´s Alpha[13]

Source: adapted from (Hair et al., 2017)

$$\alpha = \left(\frac{M}{M-1}\right) \cdot \left(1 - \frac{\sum_{t=1}^{M} s_i^2}{s_t^2}\right)$$

[12] Legend formula: *m = mean; μ = theoretical value; s = standard deviation; n =variable set size*

[13] Legend formula: *M = represents the indicators (i = 1, ..., M);* $s^{2=}$ *represents the variance of the indicator variables i of a specific construct;* s_t^2 *= total variance of all M indicators of the construct*

6.5.2.2. Composite Reliability

Evaluates the extent to which the results obtained with different items of a test are consistent with a target value of > 0.7; values above 0.95 are considered highly redundant (Hair *et al.*, 2017; Bagozzi, 1994). The formula is as follows:

Equation 3 Composite Reliability[14]

Source: adapted from (Hair et al., 2017)

$$p_c = \frac{(\sum_{i=1}^{M} I_i)^2}{(\sum_{i=1}^{M} I_i)^2 + \sum_{i=1}^{M} var(e_i)}$$

6.5.2.3. Average Variance Extracted (AVE)

This criterion is defined as the mean value of the squared loadings of all construct related indicators (i.e., the sum of squared loadings divided by the number of indicators). Thus, the AVE corresponds to the commonality of a construct (Bagozzi, 1994). The target value is AVE > 0.5 (Hair *et al.*, 2017). The formula is as follows:

Equation 4 Average Variance Extracted[15]

Source: adapted from (Hair et al., 2017)

$$AVE = \frac{(\sum_{i=1}^{M} I_i)^2}{M}$$

6.5.3. Discriminant validity

Discriminant validity describes the extent to which a construct actually differs from other constructs along empirical standards. Discriminant validity analysis is thus concerned with ensuring, that a construct is empirically independent and thus measures

[14] Legend formula: *M = represents the indicators (i = 1, ..., M; I_i = standardized loadings of the indicator variables i of a specific construct; e_i = is the measurement error of the indicator variable i $var(e_i)$ = denotes the variance of the measurement error*

[15] Legend formula: *M = represents the indicators (i = 1, ..., M); I_i = standardized loadings of the indicator variables i of a specific construct*

a single concept (Hair *et al.*, 2017). The following criterion will be used in the scope of discriminant validity.

6.5.3.1. Heterotrait-Monotrait Ratio of Correlations (HTMT)

The Heterotrait-Monotrait Ratio of Correlations (HTMT) criterion describes the relationship between two types of correlations: the correlations between indicators measuring different constructs (between-trait correlation) and (between-trait correlation), and the correlations between indicators, each measuring its own construct (within-trait correlation). HTMT is the mean of all indicator correlations that each measure different constructs (Henseler, Ringle and Sarstedt, 2015). The target value is that 95% confidence interval of the HTMT statistic should not contain 1 for any of the construct combinations (Henseler, Ringle and Sarstedt, 2015). The formula is as follows:

Equation 5 HTMT[16]

Source: adapted from (Henseler, Ringle and Sarstedt, 2015)

$$HTMT_{ij} = \frac{1}{K_i K_j} \sum_{g=1}^{K_i} \sum_{h=1}^{K_j} r_{ig,jh} \div \left(\frac{2}{K_i(K_i-1)} \sum_{g=1}^{K_i-1} \sum_{h=g+1}^{K_i} r_{ig,ih} \frac{2}{K_j(K_j-1)} \sum_{g=1}^{K_j-1} \sum_{h=g+1}^{K_j} r_{jg,jh} \right)^{1/2}$$

6.5.3.2. Fornell Lacker Criterion

The Fornell Lacker Criterion describes that each construct´s AVE should be higher than its squared correlation with any other construct (Fornell and Larcker, 1981).

Equation 6 Fornell Lacker Criterion[17]

Source: adapted from (Fornell and Larcker, 1981)

$$AVE\ (\xi_j) \geq \varphi_{jl}^2$$

[16] Legend formula: K_j and K_j = is the number of indicators of construct ξ_i and ξ_j; k = indicator (k=1, ….K_j); r_{ij} = correlation coefficient between the construct scores of constructs ξ_i and ξ_j

[17] Legend formula: $AVE(\xi_j)$ *=average variance extracted of a latent variable* ξ_j*;* φ_{jl}^2 *= squared correlation between construct* ξ_j *and construct* ξ_l

The next section will present the empirical results for the quality assessment criteria of the indicator reliability, the construct reliability and validity and of the discriminant validity of the of the reflective measurement models.

6.6. Empirical results indicator reliability

Table 19 demonstrates the calculation for investigating the indicator reliability, the indicator loadings and t-statistics. Out of the 66 indicators, 12 have to be removed because the indicator loadings are below 0.4. Those which are close to the limit value of 0.6 have been kept in the model because of the corresponding minimum statistical significance of at least 10%; resulting in 54 remaining indicators.

Table 19 Results of Indicator Reliability *(continued on p. 120 ff.)*

Source: own table

Legend significance level:

*10% (t= 1- 1.65), ** 5% (t>1.65); *** 1% (t>2.33), **** 0.5% (t>2.58); ***** 0.01% (t>3.29); n.a.

Indicator	Indicator Loading	t statistics	Significance level
AB1- Appealing Brand	0.536	1.133	10% *
AB2- Appealing Brand	0.742	1.558	10% *
AB3- Appealing Brand	0.357	0.671	n.a.
AU1- Anxiety of Usage	0.836	2.159	**
AU2- Anxiety of Usage	0.772	2.039	**
AU3- Anxiety of Usage	0.672	1.981	**
AU4- Anxiety of Usage	0.661	1.800	**
BB1- Behavioural Intention to Buy	0.960	40.439	*****
BB2- Behavioural Intention to Buy	0.506	6.888	*****
BB3- Behavioural Intention to Buy	0.522	5.002	*****
BU1- Behavioural Intention to Use	0.882	56.047	*****

BU2- Behavioural Intention to Use	0.760	14.018	*****
BU3- Behavioural Intention to Use	0.826	29.794	*****
CI1- Charging Infrastructure	0.938	5.223	*****
CI2- Charging Infrastructure	0.016	0.065	n.a.
CI3- Charging Infrastructure	0.097	0.352	n.a.
CI4- Charging Infrastructure	0.203	0.719	n.a.
CI5- Charging Infrastructure	0.245	1.093	n.a.
CT1- Charging Time	0.878	6.755	*****
CT2- Charging Time	0.433	1.812	**
CT3- Charging Time	0.449	1.987	**
DR1- Driving Range	0.174	0.505	n.a.
DR2- Driving Range	0.137	0.537	n.a.
DR3- Driving Range	0.433	1.116	10% *
DR4- Driving Range	-0.261	0.828	n.a.
DR5- Driving Range	-0.879	1.205	n.a.
EB1- Ecological Belief	0.801	24.991	*****
EB2- Ecological Belief	0.703	9.163	*****
EB3- Ecological Belief	0.817	31.917	*****
EB4- Ecological Belief	0.650	11.414	*****
EB5- Ecological Belief	0.785	19.657	*****
GI1- Governmental Incentives	0.494	2.633	****
GI2- Governmental Incentives	0.904	9.051	*****
GI3- Governmental Incentives	0.420	2.425	***
GI4- Governmental Incentives	0.697	4.052	*****
IG1- Image	0.864	30.182	*****
IG2- Image	0.820	22.351	*****
IG3- Image	0.825	20.056	*****
IG4- Image	0.694	9.480	*****
PC1- Purchasing Costs	0.962	22.890	*****
PC2- Purchasing Costs	0.842	10.780	*****

PC3- Purchasing Costs	0.661	6.010	*****
PC4- Purchasing Costs	-0.456	3.152	****
PE1- Perceived Ease of Use	0.685	5.301	*****
PE2- Perceived Ease of Use	0.241	1.110	n.a.
PE3- Perceived Ease of Use	0.831	7.016	*****
PI1- Personal Innovativeness	0.791	19.413	*****
PI2- Personal Innovativeness	0.891	37.784	*****
PI3- Personal Innovativeness	0.868	28.440	*****
PI4- Personal Innovativeness	0.884	43.952	*****
PI5- Personal Innovativeness	0.730	15.596	*****
PU1- Perceived Usefulness	0.875	46.551	*****
PU2- Perceived Usefulness	0.658	8.918	*****
PU3- Perceived Usefulness	0.833	24.749	*****
PV1- Perceived Visibility of Usage	0.835	2.655	****
PV2- Perceived Visibility of Usage	0.094	0.285	n.a.
PV3- Perceived Visibility of Usage	0.518	1.794	**
SN1- Subjective Norm	0.899	43.461	*****
SN2- Subjective Norm	0.902	47.902	*****
SN3- Subjective Norm	0.586	7.236	*****
TK1- Technological Knowledge_	0.799	10.997	*****
TK2- Technological Knowledge_	0.770	10.262	*****
TK3- Technological Knowledge_	0.848	15.565	*****
TR1- Technological Risk	0.655	3.110	****
TR2- Technological Risk	0.942	8.439	*****
TR3- Technological Risk	0.322	1.417	n.a.

The removed indicators are:

- AB3- Appealing Brand
- CI2 - Charging Infrastructure
- CI3 - Charging Infrastructure

- CI4 - Charging Infrastructure
- CI5 - Charging Infrastructure
- DR1- Driving Range
- DR2 - Driving Range
- DR4 - Driving Range
- DR5 - Driving Range
- PE2 - Perceived Ease of Use
- PV3 - Perceived Visibility of Usage
- TR3 - Technological Risk

6.7. Empirical results construct reliability and validity

Table 20 shows the results of construct reliability and validity; meaning the values for Cronbach´s Alpha, the Composite Reliability and the Average Variance Extracted. All the values of Cronbach´s Alpha and of Composite Reliability are > 0.7 and therefore the target is fulfilled. Moreover, all the values of the Average Variance Extracted are > 0.5 and therefore the quality criteria are met. Afterwards the discriminant validity will be explained in the next section.

Table 20 SmartPLS Results of construct reliability and validity

Source: own table, screenshot out of SmartPLS software

Construct Reliability and Validity

Matrix | Cronbach's Alpha | rho_A | Composite Reliability | Average Variance Extracted (AVE)

	Cronbach's Alpha	rho_A	Composite Reliabil	Average Variance I
Anxiety of Usage_	0.748	0.706	0.826	0.546
Appealing Brand		1.000		
Behaviroural Int...		1.000		
Behaviroural Int...	0.765	0.795	0.863	0.679
Charging Infrast...		1.000		
Charging Time_		1.000		
Driving Range		1.000		
Ecological Belief	0.810	0.833	0.867	0.568
Governmental In...		1.000		
Image_	0.816	0.834	0.878	0.645
Perceived Ease...		1.000		
Perceived Usefu...	0.709	0.769	0.835	0.631
Perceived Visibil...		1.000		
Personal Innova...	0.890	0.899	0.920	0.698
Purchasing Costs		1.000		
Subjective Norm	0.730	0.815	0.846	0.655
Technological K...	0.734	0.756	0.848	0.650
Technological Risk		1.000		

6.8. Empirical results discriminant validity

Table 21 manifests the results for the discriminant validity. All the HTMT values are not containing a 1 for any of the construct combinations; hence the criterion is met.

Table 21 HTMT values for reflective specified constructs

Source: own table, screenshot out of SmartPLS software

Heterotrait-Monotrait Ratio (HTMT)

Confidence Intervals | Confidence Intervals Bias Corrected | Samples

	Original Sample (C	Sample Mean (M)	2.5%	97.5%
Personal Innova...	0.150	0.182	0.106	0.274
Personal Innova...	0.438	0.444	0.305	0.592
Personal Innova...	0.448	0.453	0.325	0.578
Personal Innova...	0.243	0.253	0.123	0.404
Personal Innova...	0.306	0.315	0.158	0.478
Subjective Nor...	0.237	0.251	0.135	0.399
Subjective Nor...	0.638	0.636	0.482	0.775
Subjective Nor...	0.453	0.457	0.276	0.617
Subjective Nor...	0.577	0.573	0.378	0.750
Subjective Nor...	0.629	0.630	0.485	0.768
Subjective Nor...	0.404	0.407	0.257	0.564
Technological K...	0.156	0.203	0.119	0.313
Technological K...	0.325	0.334	0.155	0.505
Technological K...	0.403	0.410	0.252	0.566
Technological K...	0.121	0.178	0.087	0.320
Technological K...	0.269	0.289	0.139	0.454
Technological K...	0.638	0.641	0.518	0.757
Technological K...	0.414	0.421	0.221	0.603

Table 22 demonstrates the results for the Fornell Larcker Criterion of reflective specified measured models, where all values are fulfilling the quality criterion. The following sections presents the indicator reliability.

Table 22 Fornell-Larcker Criterion – values for reflective specified measured constructs

Source: own table, screenshot out of SmartPLS software

Discriminant Validity

Fornell-Larcker Criterion | Cross Loadings | Heterotrait-Monotrait Rati... | Heterotrait-Monotrait Rati... | Copy to Clipboard: | Excel Format

	Anxiety of Usage_	Behaviroural Inten	Ecological Belief	Image_	Perceived Usefuln	Personal Innovativ	Subjective Norm	Technological Kno
Anxiety of Usage_								
Behaviroural Int...	0.163							
Ecological Belief	0.184	0.482						
Image_	0.251	0.285	0.324					
Perceived Usefu...	0.176	0.734	0.512	0.355				
Personal Innova...	0.150	0.438	0.448	0.243	0.306			
Subjective Norm	0.237	0.638	0.453	0.577	0.629	0.404		
Technological K...	0.156	0.325	0.403	0.121	0.269	0.638	0.414	

In the following chapter the quality assessment of formative measurement models will be provided and the empirical results for the quality criteria.

6.9. Quality Assessment of formative measurement models – Step 4b

Researchers should ensure the content validity of their constructs before starting the empirical evaluation of formatively specified constructs. The formative indicators should cover all (or at least the essential) facets of the construct and should be based on a thorough qualitative approach (e.g., expert interviews, thorough literature and theory analysis, qualitative preliminary studies) and they do not necessarily highly correlate with one another (unlike reflectively specified measurement models) (Hair *et al.*, 2017). The next sections will present the quality assessment criteria of formative measurement models.

6.9.1. Collinearity between indicators (variance inflation factor= VIF)

The VIF value of each indicator should be below 5 to avoid collinearity problems; because that means that 80% of its variance can be also explained by the remaining formative indicators of the same construct (Hair, Ringle and Sarstedt, 2011). Therefore, the researcher should consider eliminating the indicator in question.

The formula is as follows with the target value of VIF < 5 (Hair, Ringle and Sarstedt, 2011, p. 131).

Equation 7 Variance inflation factor[18]

Source: adapted from (Hair, Ringle and Sarstedt, 2011)

$$VIF = \frac{1}{1 - R_i^2}$$

Indicators' relative contribution to the construct

In case of a significant indicator weight, the indicator is seen as relatively relevant and therefore should be kept in the formatively specified measuring model. If the indicator weight is not significant, but with a relatively high (i.e., ≥ 0.50) or statistically significant loading, the indicator is absolutely relevant. In this case the indicator should generally be retained. If both the weight as well as the loading are not significant, there is no empirical reason for retaining the indicator and it should be removed from the model (Hair *et al.*, 2017).

The next section will present the empirical results for the quality assessment criteria of the collinearity between indicators and the indicators 'relative contribution to the construct of the formative measurement models.

6.10. Empirical results of collinearity between indicators

Table 23 illustrates the VIF values, which are all below the target value of 5 and therefore there are no collinearity problems. SmartPLS also provides the VIF values for the reflective indicators (called inner VIF values within SmartPLS report). However, since high correlations between the reflective indicators are expected, there is no

[18] Legend formula: R_i^2 =*represents the unadjusted coefficient of determination for regressing the i*th *independent variable on the remaining ones.*

interpretation of these results and the focus is not to interpret these results and focus is on VIF values of the formative indicators (outer VIF values).

Table 23 VIF values for formative specified measured model

Source: own table, screenshot out of SmartPLS software

Collinearity Statistics (VIF)

Outer VIF Values | Inner VIF Values

	VIF
AB1	1.125
AB2	1.039
AB3	1.087
AU1	2.051
AU2	2.079
AU3	1.750
AU4	1.095
BB1	1.183
BB2	1.190
BB3	1.175
BU1	1.732
BU2	1.462
BU3	1.568
CI1	1.174
CI2	1.271
CI3	1.401
CI4	1.308
CI5	1.374

Outer VIF Values | Inner VIF Values

	VIF
CT1	1.044
CT2	1.114
CT3	1.071
DR1	1.645
DR2	1.981
DR3	1.376
DR4	1.253
DR5	1.167
EB1	1.735
EB2	1.529
EB3	1.715
EB4	1.395
EB5	1.761
GI1	1.729
GI2	1.754
GI3	1.142
GI4	1.249
IG1	2.164

Outer VIF Values | Inner VIF Values

	VIF
IG1	2.164
IG2	1.778
IG3	1.750
IG4	1.448
PC1	2.091
PC2	3.251
PC3	1.905
PC4	1.309
PE1	1.093
PE2	1.068
PE3	1.030
PI1	1.981
PI2	3.807
PI3	3.455
PI4	2.833
PI5	1.656
PU1	1.558
PU2	1.228

Outer VIF Values | Inner VIF Values

	VIF
PI3	3.455
PI4	2.833
PI5	1.656
PU1	1.558
PU2	1.228
PU3	1.617
PV1	1.106
PV2	1.288
PV3	1.182
SN1	2.066
SN2	2.080
SN3	1.174
TK1	1.441
TK2	1.457
TK3	1.453
TR1	1.161
TR2	1.290
TR3	1.157

6.11. Empirical results of indicators' relative contribution to the construct

Table 24 and 25 demonstrate the results of the formative indicators` relative contribution to the construct: the indicator weight and the outer loading. The results show that all indicators are relevant due to their weight and loading value and are therefore kept in the research model.

Table 24 Indicator weight of formative constructs

Source: own table, screenshot out of SmartPLS software

	AoU	AB	BIB	BIU	CI	CT	DR	EB	GI	IMG	PEoU	PU	PVoU	PI	PC	SN	TK	TR
AB1		0.483																
AB2		0.787																
AU1	0.473																	
AU2	0.324																	
AU3	0.091																	
AU4	0.444																	
BB1			0.842															
BB2			0.163															
BB3			0.209															
BU1				0.479														
BU2				0.322														
BU3				0.403														
CI1					1.000													
CT1						0.848												
CT2						0.172												
CT3						0.402												
DR3							1.000											
EB1								0.309										
EB2								0.200										
EB3								0.331										
EB4								0.213										
EB5								0.258										
GI1									-0.219									
GI2									0.840									
GI3									0.213									
GI4									0.372									
IG1										0.320								
IG2										0.321								
IG3										0.361								
IG4										0.234								
PC1															0.753			
PC2															0.159			
PC3															0.215			
PC4															0.000			
PE1											0.543							
PE3											0.753							
PI1														0.225				
PI2														0.256				
PI3														0.218				
PI4														0.278				
PI5														0.219				
PU1												0.530						
PU2												0.309						
PU3												0.400						
PV1													0.839					
PV3													0.452					
SN1																0.472		
SN2																0.477		
SN3																0.248		
TK1																	0.402	
TK2																	0.336	
TK3																	0.495	
TR1																		0.359
TR2																		0.811

Table 25 Outer loadings of formative indicators

Source: own table, screenshot out of SmartPLS software

	AoU	AB	BIB	BIU	CI	CT	DR	EB	GI	IMG	PEoU	PU	PVoU	PI	PC	SN	TK	TR
AB1		0.636																
AB2		0.881																
AU1	0.845																	
AU2	0.786																	
AU3	0.683																	
AU4	0.640																	
BB1			0.960															
BB2			0.506															
BB3			0.522															
BU1				0.882														
BU2				0.760														
BU3				0.825														
CI1					1.000													
CT1						0.881												
CT2						0.441												
CT3						0.441												
DR3							1.000											
EB1								0.801										
EB2								0.703										
EB3								0.816										
EB4								0.650										
EB5								0.785										
GI1									0.493									
GI2									0.904									
GI3									0.420									
GI4									0.697									
IG1										0.864								
IG2										0.820								
IG3										0.825								
IG4										0.694								
PC1															0.962			
PC2															0.842			
PC3															0.661			
PC4															-0.456			
PE1											0.669							
PE3											0.844							
PI1														0.791				
PI2														0.891				
PI3														0.868				
PI4														0.884				
PI5														0.730				
PU1												0.874						
PU2												0.660						
PU3												0.833						
PV1													0.894					
PV3													0.554					
SN1																0.899		
SN2																0.902		
SN3																0.586		
TK1																	0.798	
TK2																	0.768	
TK3																	0.849	
TR1																		0.657
TR2																		0.943

The previous chapters demonstrated the quality assessment of all formative and reflective constructs of the Technology Acceptance Model of this present research. The result was that all quality criteria have been met and that the data is evaluable for the further analysis and interpretation. The next chapter shows the validation step of the structural equation model.

6.12. Validation of structural equation model – Step 5

After the quality assessment of the formative and reflective constructs, the following chapter will validate the quality and the results of the structural equation model. Global quality criteria have been used to assess the overall model. The aim is to examine the 24 established research hypotheses.

For this purpose, the collinearity test for the structural model will be applied; the same procedure that has been used to evaluate the formative specified constructs. Afterwards the path coefficients of the structural model (sign, magnitude and significance of the path coefficients) will be analysed, before the structural equation model is tested for the goodness effect of fit factor and the effect size, which is the substantial explanatory contribution of all latent exogenous variables. Finally, all constructs will be checked for their predictive power (Stone-Geisser criterion). Table 26 provides an overview of quality criteria for the assessment of the structural model, followed by the next section which presents the collinearity test.

Table 26 Quality criteria for the assessment of the structural model

Source: own table

Definition	Quality measure	Definition	Set point	Source
1) Collinearity test	Collinearity	VIF	< 5	Hair *et al.*, 2017)
2) Sign, magnitude and significance of the path coefficients	Sign	Positive/negative	> 0.1	(Hair *et al.*, 2017)
	t-test significancy level	t	>1.65	(Hair *et al.*, 2017)
3) Goodness of fit factor	Coefficient of determination	R^2	>0.33	(Chin and Marcoulides, 1998)
4) Substantial explanatory contribution of all latent exogenous variables	Effect size	f^2	>0.02	(Chin and Marcoulides, 1998)
5) Predictive validity	Stone-Geisser-Criterion	Q^2	>0	(Geisser, 1974; Stone, 1974)

6.12.1. Collinearity test

Table 27 illustrates the VIF values, which are all below the target value of 5 and therefore there are no collinearity problems of the structural equation model; the quality criteria is therefore fully met. The following section presents the significance test of the empirical evaluation.

Table 27 VIF values for evaluating the structural equation model

Source: own table

Inner VIF values	Behavioural Intention to Buy	Behavioural Intention to Use	Perceived Ease of Use	Perceived Usefulness
Anxiety of usage			1.037	
Appealing brand	1.006			
Behavioural intention to use	1.309			
Charging infrastructure			1.031	
Charging time			1.064	
Driving range		1.010	1.030	
Ecological belief				1.315
Governmental incentives	1.100			1.193
Image				1.440
Perceived ease of use		1.085		1.172
Perceived usefulness		1.078		
Perceived visibility of usage				1.293
Personal innovativeness				1.608
Purchasing costs	1.236			
Subjective norm				1.565
Technological knowledge			1.029	1.502
Technological risk				1.145

6.12.2. Sign, magnitude and significance of the path coefficients

Furthermore, a significance test must be conducted to validate the statistical relevance of the path coefficients of the inner model. Significance refers to the fact that a relationship between two variables with a predefined probability is not by a random distribution of data, but by an actual difference in the underlying distribution of the database. A distinction is made between two types of hypotheses. The so-called null hypothesis (H0) states that the latent exogenous variable has no significant influence on the latent endogenous variable, whereas the alternative hypothesis (H1) assumes exactly this. Before conducting a significance test, it is important to define the so-called significance level or alpha (α). This value needs to be set in advance as the threshold for statistical significance. This error of the 1st kind describes the probability of error and relates to the fact that the null hypothesis H0 = is wrongly rejected in favour of the alternative hypothesis H1 (Hair *et al.*, 2017). In many areas of application, a significance level of 5 % ($t > 1.65$) is usually assumed, as in this present research (Hair *et al.*, 2017). The larger the magnitude of t, the stronger the argument against the null hypothesis. This means that there is stronger evidence for a significant difference. The closer t is to 0, the more likely it is that there is no significant difference.

A t-value > 3.29 is highly significant and therefore this path connection is empirically validated and confirmed, such as the path connection of "Anxiety of usage → Perceived ease of use" with $t = 3.087$. If a t-value is < 1, there is no significance and therefore this path connection, such as "Image → Perceived Usefulness" is not confirmed. The significance-level were clustered into the following categories according to (Hair *et al.*, 2017, p. 168 f.) as presented in table 28 and table 29 summarizes the results for significance level of each path connection.

Table 28 Significance level of path connection

Source: own table, adapted from (Hair et al., 2017)

n.a.	* 10%	** 5%	*** 1%	****0,5%	**** 0,01%
<1	(t=1-1.65)	(t>1.65)	(t>2.33)	(t>2.58)	(t>3.29)

Table 29 Sign, magnitude and significance of path coefficients

Source: own table

Path connection	**Path coefficient**	**t Statistics**	**Significance level**
Anxiety of Usage → Perceived Ease of Use	-0.167	3.87	*****
Appealing Brand → Behavioural Intention to Buy	0.005	0.083	n.a.
Behavioural Intention to Use → Behavioural Intention to Buy	0.638	12.017	*****
Charging Infrastructure → Perceived Ease of Use	0.175	2.614	****
Charging Time → Perceived Ease of Use	0.190	3.239	****
Driving Range → Behavioural Intention to Use	0.002	0.038	n.a.
Driving Range → Perceived Ease of Use	0.047	0.740	n.a.
Ecological Belief → Perceived Usefulness	0.273	3.815	*****
Governmental Incentives → Behavioural Intention to Buy	0.099	1.921	**
Governmental Incentives → Perceived Usefulness	0.185	2.915	****
Image → Perceived Usefulness	-0.004	0.052	n.a.
Perceived Ease of Use → Behavioural Intention to Use	0.251	4.892	*****
Perceived Ease of Use → Perceived Usefulness	0.086	1.651	**
Perceived Usefulness → Behavioural Intention to Use	0.512	9.327	*****
Perceived Visibility of Usage → Perceived Usefulness	-0.091	1.326	*
Personal Innovativeness → Perceived Usefulness	0.008	0.116	n.a.
Purchasing Costs → Behavioural Intention to Buy	0.198	3.005	****
Subjective Norm → Perceived Usefulness	0.305	4.175	*****
Technological Knowledge → Perceived Ease of Use	0.190	2.692	****
Technological Knowledge → Perceived Usefulness	-0.005	0.077	n.a.
Technological Risk → Perceived Usefulness	-0.106	1.659	**

The next section of this chapter shows the coefficient of determination.

6.12.3. Coefficient of determination (R^2 value) or goodness of fit factor

The most widely used quality criterion for the evaluation of the structural model is the coefficient of determination (R^2 value). This coefficient is a measure of the prediction performance of the model and is calculated by the squared correlation between the actual and the predicted values for a specific endogenous construct. R^2 value thus represents the combined influences of all exogenous latent variables on the endogenous latent variable. The R^2 value is defined in the value range between 0 and 1, with higher values indicate better forecasting performance.

The interpretation of R^2 value is dependent on the measurement model and its complexity and the field of research; there is no real rule of thumb for the coefficient, but rather empirical data. While R^2 values of 0.20 are generally considered to be high in studies of consumer behaviour, there are higher values of 0.75 in success factor research (e.g., in studies explaining customer satisfaction or studies explaining customer satisfaction or loyalty). For scientific research in marketing, for example it is recommended to use values of 0.75 (substantial), 0.50 (moderate) and 0.25 (weak) for the endogenous latent variables (Hair *et al.*, 2017; Henseler, Ringle Christian and Sinkovics Rudolf, 2009). Table 30 shows the R^2 values of the endogenous variables of behavioural intention to buy, behavioural intention to use, perceived ease of use and perceived usefulness. Those values are all between 0 and 1 and thus are meeting the criterion of the prediction performance of the model. The next section presents the effect size of latent exogenous variables.

Table 30 Coefficient of determination of endogenous variables of the research model

Source: own table

Latent endogenous variable	R^2 values
Behavioural Intention to Buy	0.609
Behavioural Intention to Use	0.394
Perceived Ease of Use	0.175
Perceived Usefulness	0.350

6.12.4. Effect size (f2)

The effect size is the substantial explanatory contribution of all latent exogenous variables; it is calculated based on the coefficient of determination R^2 as follows as presented in equation 8.

Equation 8 Effect size

Source: (Chin and Marcoulides, 1998, p. 316)

$$f^2 = \frac{R^2_{incl.latent\ exogenous\ variable} - R^2_{excl.latent\ exogenous\ variable}}{1 - R^2_{incl.latent\ exogenous\ variable}}$$

The effect size indicates how much the explanatory power of the overall model would deteriorate if the corresponding construct would not be considered in the research model (Chin and Marcoulides, 1998). The following guidelines will be applied for the evaluation of the f^2 values: 0.02, 0.15, and 0.35 represent small, medium, and large effects of the exogenous latent variables. There is no effect at all, if the effect size is smaller than 0.02 (Cohen, 1988). Table 31 presents the results of the effect size analysis.

Table 31 Effect size of the latent exogenous variables of the research model

Source: own table

Latent endogenous variable	→ latent exogenous variable	f^2 values
Anxiety of Usage	→ Perceived Ease of Use	0.033
Appealing Brand	→ Behavioural Intention to Buy	0.000
Behavioural Intention to Use	→ Behavioural Intention to Buy	0.793
Charging Infrastructure	→ Perceived Ease of Use	0.036
Charging Time	→ Perceived Ease of Use	0.041
Driving Range	→ Behavioural Intention to Use	0.000
Driving Range	→ Perceived Ease of Use	0.003
Ecological Belief	→ Perceived Usefulness	0.087
Governmental Incentives	→ Behavioural Intention to Buy	0.023
Governmental Incentives	→ Perceived Usefulness	0.044
Image	→ Perceived Usefulness	0.000
Perceived Ease of Use	→ Behavioural Intention to Use	0.096
Perceived Ease of Use	→ Perceived Usefulness	0.010
Perceived Usefulness	→ Behavioural Intention to Use	0.401
Perceived Visibility of Usage	→ Perceived Usefulness	0.010
Personal Innovativeness	→ Perceived Usefulness	0.000
Purchasing Costs	→ Behavioural Intention to Buy	0.081
Subjective Norm	→ Perceived Usefulness	0.092
Technological Knowledge	→ Perceived Ease of Use	0.042
Technological Knowledge	→ Perceived Usefulness	0.000
Technological Risk	→ Perceived Usefulness	0.015

The path connections of the constructs of technological knowledge, technological risk and perceived ease of use do show slightly positive, but extremely weak effect size < 0.01 on the construct perceived usefulness.

On top of that, the constructs of perceived visibility of usage, personal innovativeness and image do as well show no effect size on the construct of perceived usefulness.

Moreover, the construct of driving range has no significant influence on the construct of behavioural intention to use and on the construct of perceived ease of use; this has been also analysed by the effect size and through the significance level.

Last but not least, the construct of appealing brand does not have an effect size on the construct of behavioural intention to buy, which was also confirmed by the significance level.

The remaining latent endogenous variables do show a small until medium effect size. It stands out, that the effect size of the construct behavioural intention to use do have a very large effect on the construct of behavioural intention to buy; as well as the large effect size of the construct perceived usefulness on the construct of behavioural intention to use. Those large effects have been also confirmed by the significance level and underline the statistical significance. The following section explains the predictive validity.

6.12.5. Blind folding and testing of forecast relevance (Q^2 value)

A further quality criterion for the validation of the structural model is the predictive validity (predictive relevance), which is determined with the aid of the Stone-Geisser Q^2 criterion (Stone, 1974; Geisser, 1974). This indicates how well the model is able to predict the value of the data matrix on the basis of the model parameters.

The Q^2 value is generated via the so-called blind folding procedure for a specified omission distance D generated. The blind folding is a procedure that takes every d-th data point in the data matrix of the indicators of the endogenous constructs and estimates the parameters (i.e., the path coefficients and the construct values) with the remaining data points (Chin and Marcoulides, 1998; Henseler, Ringle Christian and Sinkovics Rudolf, 2009). In a structural model, Q^2 values above 0 indicate the predictive relevance of the path model for a specific (reflectively measured) endogenous construct. The corresponding Stone-Geisser criterion is calculated according to the following formula as shown in equation 9.

Equation 9 Stone-Geisser criterion

Source: adapted from (Stone, 1974)

$$Q^2 = 1 - \frac{\sum_k E_{jk}}{\sum_{kk} O_{jk}}$$

$\sum_k E_{jk}$ represents the sum of the squares of the forecast errors, i.e., the squared deviations between the collected data base and the respective omitted and consequently estimated data points based on the model as well as the model parameters.

$\sum_{kk} O_{jk}$ describes the sum of squares of the difference between estimated value and mean value of the remaining data from the blind folding procedure (Krafft, Götz and Liehr-Gobbers, 2005). Q^2 values can be calculated based on two different approaches. The cross-validated redundancy approach and the approach of cross-validated communalities. The literature recommends the application of the cross-validated redundancy approach for the determination of the forecast relevance Q^2, as it includes the core element of the path model to predict the omitted data points (Hair *et al.*, 2017). The results of the analysis can be seen in the table below.

Table 32 Results of Q2 (Stone-Geisser-Criterion)

Source: own table

Latent endogenous variables	**$Q^2 > 0$ (Construct Cross validated Redundancy)**
Behavioural intention to buy	0.278
Behavioural intention to use	0.247
Perceived ease of use	0.077
Perceived usefulness	0.198

The results show that all the predictive validities of the latent endogenous variables are clearly greater than 0, the quality criterion of the prediction validity can therefore be considered to be fully met. The next section presents the moderation variable gender.

6.12.6. Moderation variable gender

If a moderation variable is present, the strength or even direction of the relationship between two constructs depends on a third variable: meaning that the nature of the relationship changes depending on the values of the moderation variable. For example, the relationship between two constructs in a customer survey may depend on the education of the customers and thus not be the same for all customers. In this case, moderation can and should serve as a way to capture heterogeneity in the data.
In this present research the moderation variable gender was used; in this case it served as a grouping variable in order to divide the data in two groups and in order to investigate if there are differences in the data set and therefore if there are differences in the acceptance of e-mobility in India. This thesis focused on the investigation of the following three hypotheses, as demonstrated in table 33.

Table 33 Extract research hypotheses

Source: own table

H21	Gender moderates the influence of subjective norm on the perceived usefulness of electric passenger cars (stronger influence for women).
H22	Gender moderates the influence of ecological belief on the perceived usefulness of electric passenger cars (stronger influence for women).
H23	Gender moderates the influence of purchasing costs on the general behavioural intention to buy electric passenger cars (stronger influencer for women).

The analysis in SmartPLS demonstrated the difference of the significance level of the path connections between the female and the male customer group, as presented in table 34 and 35. The next section present the moderation variable car-ownership.

Table 34 Sign, magnitude and significance of path coefficients of the female customer group

Source: own table

*10% (t=1-1.65) ** 5% (t>1.65) *** 1% (t>2.33). **** 0.5%(t>2.58); ***** 0.01% (t>3.29); n.a. <1

Path connection	Path coefficient	t Statistics	Significance level
Ecological Belief → Perceived Usefulness	0.392	2.490	***
Purchasing Costs → Behavioural Intention to Buy	0.183	1.325	*
Subjective Norm → Perceived Usefulness	0.182	1.062	*

Table 35 Sign. magnitude and significance of path coefficients of the male customer group

Source: own table

*10% (t=1-1.65) ** 5% (t>1.65) *** 1% (t>2.33). **** 0.5%(t>2.58) ***** 0.01% (t>3.29); n.a. <1

Path connection	Path coefficient	t Statistics	Significance level
Ecological Belief → Perceived Usefulness	0.171	2.081	**
Purchasing Costs → Behavioural Intention to Buy	0.217	3.229	****
Subjective Norm → Perceived Usefulness	0.342	4.345	*****

6.12.7. Moderation variable car ownership

This thesis also used car ownership as moderation variable in order to analyse if there is a different acceptance behaviour between the surveyed customers who own already a vehicle comparing the acceptance behaviour of the total surveyed participants in this field research. Table 36 presents the results of the surveyed group owning already a vehicle. Path connections with a different significance level compared to the total surveyed group were highlighted in blue. The next chapter summarizes the empirical results.

Table 36 Sign, magnitude and significance of path coefficients of the car-owning customer group

Source: own table

*10% (t=1-1.65) ** 5% (t>1.65) *** 1% (t>2.33) **** 0.5%(t>2.58); ***** 0.01% (t>3.29); n.a. <1

Path connection	**Path coefficient**	**t Statistic**	**Significance level**
Anxiety of Usage → Perceived Ease of Use	-0.194	1.732	**
Appealing Brand → Behavioural Intention to Buy	0.015	0.210	n.a.
Behavioural Intention to Use → Behavioural Intention to Buy	0.697	10.500	*****
Charging Infrastructure → Perceived Ease of Use	0.164	1.922	**
Charging Time → Perceived Ease of Use	0.160	1.007	*
Driving Range → Behavioural Intention to Use	-0.015	0.150	n.a.
Driving Range →Perceived Ease of Use	0.015	0.167	n.a.
Ecological Belief → Perceived Usefulness	0.369	3.799	*****
Governmental Incentives → Behavioural Intention to Buy	0.046	0.554	n.a.
Governmental Incentives → Perceived Usefulness	0.215	2.153	**
Image → Perceived Usefulness	-0.072	0.718	n.a.
Perceived Ease of Use → Behavioural Intention to Use	0.272	2.915	****
Perceived Ease of Use -> Perceived Usefulness	0.178	2.077	**
Perceived Usefulness → Behavioural Intention to Use	0.444	4.419	*****
Perceived Visibility of Usage → Perceived Usefulness	0.084	0.825	n.a.
Personal Innovativeness → Perceived Usefulness	-0.037	0.313	n.a.
Purchasing Costs → Behavioural Intention to Buy	0.199	2.220	**
Subjective Norm → Perceived Usefulness	0.121	1.094	**
Technological Knowledge → Perceived Ease of Use	0.242	2.283	**
Technological Knowledge → Perceived Usefulness	-0.021	0.191	n.a.
Technological Risk → Perceived Usefulness	-0.101	1.032	*

6.13. Summary of empirical research results

The following chapter will summarize the empirical research results: the confirmation or falsification of the 24 research hypotheses, as well as the results considering the moderation variable gender and car ownership. The confirmation or falsification of the research hypotheses are based on the results out of the t-values and the significance level of each path connection, as explained in chapter 6.12.2., 6.12.6. and 6.12.7. using the significance-level categories according to (Hair *et al.*, 2017) as presented in table 37.

Table 37 Significance level of path connection

Source: adapted from (Hair et al., 2017)

n.a.	*10%	** 5%	*** 1%	****0.5%	**** 0.01%
<1	(t=1-1.65).	(t>1.65);	(t>2.33).	(t>2.58)	(t>3.29)

The perceived usefulness does have a very strong positive influence on the usage of electric passenger cars (t=9.3), as well as the effect of perceived ease of use on the usage of electric passenger cars (t=4.9); thus hypothesis 1 and 2 have been confirmed. Furthermore, the perceived ease of use positively influences the perceived usefulness of electric passenger cars (t=1.7).

On top of that the behavioural intention to use is strongly impacting the behavioural intention to buy an electric passenger car (t=12.0).

Furthermore, the subjective norm (t=4.2) and the ecological belief (t=3.8) do have a strong positive effect on the usefulness of electric passenger cars. The influence of personal innovativeness (t=0.1), as well as image (t=0.1) on the usefulness of an electric passenger car, as assumed in the research model, could not be verified as significant. Perceived visibility of EV usage does have a low effect on the perceived usefulness (t=1.3).

In general, driving range is a very important influencing factor in various countries in terms of accepting electric passenger cars as stated in chapter 4. The automotive industry is dealing a lot with this topic and discusses this with potential customers. This research model investigated also the impact of driving range on the perceived ease of use (t=0.7) and on the general behavioural intention to use electric passenger cars (t=0.0). However, in India both impacts turned out to have no effect at all, neither positive nor negative.

Moreover, the perceived offer of Indian electric passenger car brands, consequently the appealing of Indian brands does not influence the behavioural intention to buy electric passenger cars (t=0.1). Additionally, the perceived technological knowledge about electric passenger cars does not positively influence the perceived usefulness (t=0.1), however there is a strong significant positive effect on the ease of use (t=2.7). Nevertheless, the negative influence of the perceived technological risk on the usefulness of electric passenger cars was confirmed as significant (t=1.7).

This might be also the same reason why the hypothesis about the anxiety of electric passenger car usage has been confirmed: anxiety of electric passenger car usage effects negatively the perceived ease of use (t=3.9). Furthermore, the hypotheses about the charging time (t=3.2) and charging infrastructure (t=2.6) have been verified and confirmed as very significant. The lower the charging time, the higher the perceived ease of use and the higher the available charging infrastructure, the higher the perceived ease of use.

The purchasing costs of an electric passenger car are quite important among the surveyed group. It has been clearly approved that the higher the purchasing costs, the lower is the general behavioural intention to buy electric passenger cars (t=3.0).

Another important influencing factor are the governmental incentives. The higher the perceived governmental incentives, the higher the perceived usefulness of electric passenger cars (t=2.9) and the higher the planned behaviour to buy an electric passenger car (t=1.9). Those hypotheses have been firmly approved as significant.

The influence of purchasing costs, subjective norm and ecological belief has been also analysed from the gender point of view.
This research investigated those indicators through the moderation variable gender. How do the results distinguish between the male and female participants of this research? As confirmed in the previous hypotheses, purchasing costs do influence the general behavioural intention to buy electric passenger cars. However no stronger influence of women (t=1.3), as assumed in this research, but a slightly higher influence of male participants (t=3.2).
The same result turned out by the indicator subjective norm. There is a significant stronger influence of the male surveyed group (t=4.3 vs. t=1.1 of female group) meaning that the acceptance of electromobility depends to a certain extent on external perceptions, which can be influenced by media reports, experts' opinions and the social environment.
The last difference between those two possible consumer groups is the factor ecological belief. As previous confirmed the ecological belief does positively influence the perceived usefulness of electric passenger cars. In this context, the influence on the female survey group is higher (t=2.5) than the male group (t=2.0). If they have the choice between two products, women will more often choose the more environmentally friendly one, purchase products which are made out of recyclable material and would consider themselves to act sustainable in their daily life. Moreover, the male surveyed group tend to be more price-consciousness. The path connection of purchasing costs on

the behavioural intention to buy an electric passenger car is more significant (t=3.2) compared to the female surveyed group (t=2.5).

On top of that this thesis investigated the acceptance behaviour among the surveyed customer group by dividing the group in those who are owning a vehicle with the following outcome: The significance level of the path connection anxiety of usage on perceived ease of use is significant lower compared to the total surveyed group (t=1.7 vs. t=3.9); meaning the customer who already own a vehicle do have less anxiety while imaging driving an electric passenger car.
The influence of charging infrastructure and charging time on perceived ease of use is also lower compared to the total surveyed group (t=1.9 vs. t=2.6 & t=1.0 vs. t=3.2). Additionally, the effect of governmental incentives on behavioural intention to buy, as well as on perceived usefulness is lower, or even do not exist within the car ownership group (t=0.6 vs. t=1.9 & t=2.1 vs. t=2.9). Moreover, the influence of perceived visibility on perceived usefulness does not exist (t=0.8 vs. t=1.3).
The path connection of purchasing costs on behavioural intention to buy is also much lower compared to the total surveyed group (t=2.2 vs. t=3.0), as well as the path connection of subjective norm on perceived usefulness (t=1.1 vs. t=4.2). Last but not least is the influence of technological knowledge on perceived ease of use and the impact of technological risk on perceived usefulness is smaller comparing to the total surveyed group (t=2.3 vs. t=2.7 & t=1.0 vs. t=1.7).

Summarized, the following influencing factors are having the highest significant level and therefore having a very strong positive effect on the acceptance behaviour of electric passenger cars in India among the total surveyed group (t-values above 0.01%; t>3.29).

- Behavioural Intention to Use → Behavioural Intention to Buy: t=12.0

- Perceived Usefulness → Behavioural Intention to Use: t=9.3

- Perceived Ease of use → Behavioural Intention to Use: t=4.9

- Subjective Norm → Perceived Usefulness: t=4.2

This path connection had also a high significant level in the male surveyed group (t=4.3).

- Anxiety of Usage → Perceived Ease of Use: t=3.9

- Ecological Belief → Perceived Usefulness: t=3.8

This path connection was also strong significant in the female surveyed group (t=2.5).

The following path connections are having a medium significant level on the acceptance behaviour of electric passenger cars in India among the total surveyed group (t-values between 5% and 0.5%; t>1.65 and t>2.58).

- Charging Time → Perceived Ease of Use: t=3.2

- Purchasing Costs → Behavioural Intention to Buy: t=3.0

This path connection had also a medium significant level in the male (t=2.0)

- Governmental Incentives → Perceived Usefulness: t=2.9

- Technological Knowledge → Perceived Ease of Use: t=2.7

- Charging Infrastructure → Perceived Ease of Use: t=2.6

- Governmental Incentives → Behavioural Intention to Buy: t=1.9

- Technological Risk → Perceived Usefulness: t=1.7

- Perceived Ease of Use → Perceived Usefulness: t=1.7

The following path connection are having a low significant level on the acceptance behaviour of electric passenger cars in India among the total surveyed group (t-values above 10%; t=1-1.65):

- Perceived Visibility of Usage → Perceived Usefulness: t=1.3

In the female surveyed group the following two path connections are also having a low significant level:

- Purchasing Costs → Behavioural Intention to Buy: t=1.3

- Subjective Norm → Perceived Usefulness: t=1.1

In the car-owning group the following two path connections are further having a low significant level:

- Charging Time → Perceived Ease of Use: t=1.0

- Technological Risk → Perceived Usefulness: t=1.0

Finally, the below presented path connections are having no impact and significant level on the acceptance behaviour of electric passenger cars in India among the total surveyed group (t-values <1):

- Appealing brand → Behavioural Intention to Buy: t=0.1

- Driving Range → Behavioural Intention to Use: t=0.0

- Driving Range → Perceived Ease of Use: t=0.7

- Image → Perceived Usefulness: t=0.0

- Technological Knowledge → Perceived Usefulness: t=0.1

In the car-owning surveyed group it was further shown that the following path connection is also having no significant level on the acceptance behaviour of electric passenger cars in India:

- Perceived Visibility of Usage → Perceived Usefulness: (t=0.8)

Table 38 & table 39 summarize all research hypotheses and if those have been either confirmed (green hook) or falsified (red cross) among the total surveyed group, among the surveyed potential customers who are owning a vehicle already and the research hypotheses among the male and female group of the participants.

Table 38 Summary confirmation/rejection of research hypotheses (continued on p. 150 ff.)

Source: own table

	Research hypotheses	**confirmed/falsified by the total surveyed group**	**confirmed/falsified by the car-owning surveyed group**
1	The higher the perceived usefulness, the higher the general behavioural intention to use electric passenger cars.	☑	☑
2	The higher the perceived ease of use, the higher the general behavioural intention to use electric passenger cars.	☑	☑
3	The higher the perceived ease of use, the higher the perceived usefulness of electric passenger cars.	☑	☑
4	The higher the general behavioural intention to use electric passenger cars, the higher the behavioural intention to buy electric passenger cars.	☑	☑
5	Subjective norm does have a positive influence on the perceived usefulness of electric passenger cars.	☑	☑ Lower significance level
6	The higher the personal innovativeness level, the higher the perceived usefulness of electric passenger cars.	☒	☒
7	The higher the ecological belief, the higher the perceived usefulness of electric passenger cars.	☑	☑
8	Image supports the perceived usefulness of electric passenger cars.	☒	☒

9	The higher the perceived visibility of electric passenger car usage, the higher the perceived usefulness of electric passenger cars.	☑	☒ No significance level
10	The higher the perceived technological risk, the lower the perceived usefulness of electric passenger cars.	☑	☑ Lower significance level
11	The higher the perceived technological knowledge about electric passenger cars, the higher the perceived usefulness.	☒	☒
12	The higher the perceived technological knowledge about electric passenger cars, the higher the perceived ease of use.	☑	☑ Lower significance level
13	The higher the anxiety of electric passenger car usage, the lower the perceived ease of use.	☑	☑ Lower significance level
14	The quicker the charging time, the higher the perceived ease of use.	☑	☑ Lower significance level
15	The higher the availability of charging infrastructure, the higher the perceived ease of use.	☑	☑ Lower significance level
16	The higher the perceived electric driving range, the higher the perceived ease of use.	☒	☒
17	The higher the perceived electric driving range, the higher the general behavioural intention to use electric passenger cars.	☒	☒
18	The higher the perceived offer of electric passenger cars by Indian brands, the higher the behavioural intention to buy electric passenger cars.	☒	☒

19	The higher the perceived governmental incentives, the higher the perceived usefulness of electric passenger cars.	☑	☑ Lower significance level
20	The higher the perceived governmental incentives, the higher the planned behaviour to buy an electric passenger car.	☑	☒ No significance level
21	The higher the perceived purchasing costs, the lower is the general behavioural intention to buy electric passenger cars.	☑	☑ Lower significance level

Table 39 Summary confirmation/rejection of research hypotheses with the moderation variable gender

Source: own table

	Research hypotheses	**confirmed/falsified**
22	Gender moderates the influence of subjective norm on the perceived usefulness of electric passenger cars (stronger influence for women).	☑ Stronger influence of men
23	Gender moderates the influence of ecological belief on the perceived usefulness of electric passenger cars (stronger influence for women).	☑
24	Gender moderates the influence of purchasing costs on the general behavioural intention to buy electric passenger cars (stronger influencer for women).	☑ Stronger influence of men

The last section of this chapter ends with the conclusion.

6.14. Conclusion

This chapter explained step by step the empirical evaluation process and the quality assessment of the developed Technology Acceptance Model towards the acceptance behaviour in India using the variance-based structural equation modelling software SmartPLS. Thereby it was possible to validate and fully confirm the quality of the research model. Out of the initial 66 indicators in the model, 12 indicators have been excluded due to the low quality of the indicator reliability. The remaining 54 indicators have been validated and therefore kept in the measurement model. Through the subsequent examination of the construct reliability, the content validity, the construct validity of the operationalisation of the constructs and their sufficient delimitation from other constructs of the model were verified.

Finally, the empirical results were presented, the confirmation or falsification of the 24 research hypotheses considering also the moderation variable gender and car ownership. The next chapter will provide the outcomes of this research.

7. Outcomes

7.1. Introduction

This chapter summarises the research conducted for this thesis and presents its findings and implications for the Indian automotive industry to promote electric passenger cars, but also for the Indian government to achieve their ambitious climate targets.
Moreover, this chapter presents the limitations of the research: Research boundaries, focus only on electric passenger cars (4-wheelers), limitations of systematic literature review generic definition of identified influencing factors, choice of sampling method and choice of theoretical field research. Finally, the researchers propose 7 issues for further research.

7.2. Concluding remarks

India signed in 2015 the historic Paris climate agreement to fight against global warming and to reduce CO_2-emissions in order to control global warming caused by greenhouse effect and claimed at the Glasgow Climate Change Conference in 2021 to become climate-neutral in 2070 (Nandi, 2021). Moreover, the government of India established the National Electric Mobility Mission Plan 2020 to improve national energy security, decrease adverse environmental impacts from road transportation sector and to push domestic manufacturing capabilities for electric passenger cars (Patnaik *et al.*, 2021). The target is to achieve 30% share of sold electric passenger cars in 2030.
India is holding a huge potential for the Indian automotive industry to increase the sales of electric passenger cars. Because India´s young population will continue to grow and will become the most populated country in the world in 2030 (United Nations, 2023). Furthermore, among the compared countries India is having the strongest GDP growth

rate with +6.2% until 2027 and the passenger car market will grow until 2030 with a CAGR of +4.8% (International Monetary Fund, 2023; Statista, 2023b). On top of that India is holding a low car-ownership of 1.7% and 41% of India´s new passenger car buyers are between 25 and 34 years old, which fits to latest studies where millennials tend to be more eager to go for electric passenger cars (Statistisches Bundesamt, 2023c; Statista, 2023b). India also has great leverage by selling more electric passenger cars to support the government´s climate target and to reduce India´s CO_2-emissions being the third biggest CO_2-emitter worldwide. In 2021 the transportation sector was responsible for 9% of India´s greenhouse gas emissions of which passenger cars were the biggest polluter of CO_2 with 41% (Statista, 2022c; Statista, 2021a).

Thus, Increasing the acceptance behaviour of Indian car users of electric passenger cars in India will support the plans of the NEMMP and will contribute to decrease the share of India´s CO_2 emissions. However, there is a gap between today´s electric passenger car share of 1.4% and the ambitious goal of the Indian government to achieve 30% share until 2030.

This research addressed the research problem and research aims, as presented in chapter 1.4. and 1.6. in order to answer the research question of which are the key influencing factors regarding the acceptance behaviour of electric passenger cars in India from the customers` point of view. The conducted systematic literature review in chapter 4 identified and defined 14 influencing factors through a comprehensive systematic literature review, which have been afterwards validated through conducted expert interviews. The factors are the following: *Subjective Norm, Personal Innovativeness*, *Charging Infrastructure*, *Charging Time*, *Image*, *Ecological Belief*, *Anxiety of Usage*, *Technological Risk*, *Technological Knowledge*, *Governmental Incentives*, *Purchasing Costs*, *Driving Range*, *Perceived Visibility of Usage* and *Appealing Brand.* Moreover chapter 4 identified research gaps and limitations of the reviewed studies. In present literature the focus of the acceptance behaviour towards electric passenger cars are on markets like the USA, China or UK and not on India. Furthermore, the Technology Acceptance Model was not applied as research methodology, but for instance qualitative studies based on questionnaires, case studies or literature review. Moreover, insights about which are the key influencing factors towards electric passenger cars were mostly gained through expert or stakeholder interviews and not through surveying potential customer groups. To answer the research question and to close the gaps in the state of the art, the researcher applied the following research methodology as stated in chapter 5. A structural equation modelling was applied using the variance-based method to operationalize the complex Technology Acceptance Model of this research. The developed Technology Acceptance Model consists in total of 18 constructs (whereof 10 are reflective and 8 constructs are formative ones), 2 moderation variables (gender and car-ownership) and 66 latent variables. Moreover, 24 research hypotheses have been outlined by the researcher on which the TAM of this research is based.

For the field research an online questionnaire was conducted with 232 participants. The researcher selected Indian young professionals with a higher level of education as addressees for the questionnaire. Explanations and shortcomings were given towards the selected sampling method and sampling process.

Chapter 6 presented the empirical evaluation of this research and the quality assessment of the developed Technology Acceptance model, as well as the empirical result using the variance-based structural equation modelling software SmartPLS. Overall, the research model has met all quality criteria. Finally, the empirical results were presented in chapter 6.13. in terms of the confirmation or falsification of the 24 research hypotheses and also in terms of the significance level of the path connections considering also the moderation variable gender and car ownership.

Summarized, the research question of which are the key influencing factors towards the acceptance behaviour of electric passenger cars in India out of a customer´s point of view can be answered as follows:

Besides the three factors (*Perceived Usefulness, Perceived Ease of Use* and *Behavioural Intention to Use*) from the original TAM by Davis et al. (1989) which are all having high significant levels both in the total surveyed group and in the car-owning group as stated in 6.12.2. and 6.12.7., this research identified the following influencing factors having an impact on the acceptance behaviour of electric passenger cars in India among the total surveyed group in a descending order. *Subjective Norm, Anxiety of Usage* and *Ecological Belief* are having the highest significance level and therefore the highest impact on the acceptance behaviour. *Charging Time, Purchasing Costs, Governmental Incentives, Technological Knowledge, Charging Infrastructure, Technological Risk* and *Perceived Visibility of Usage* are having a medium significance level on the acceptance behaviour towards electric passenger cars in India and *Perceived Visibility of Usage* only have a low influence. No influence on the acceptance behaviour are having the following factors: *Appealing Brand, Image, Driving Range* and *Personal Innovativeness.*

The results in the car-owning surveyed group were the following: *Ecological Belief* is having the highest significant level. *Charging Infrastructure, Governmental Incentives, Purchasing Costs, Anxiety of Usage, Technological Knowledge* and *Subjective Norm* are having a medium significance level on the acceptance behaviour and *Charging Time*, as well as *Technological Risk* only a low impact on the acceptance behaviour towards electric passenger cars. No influence on the acceptance behaviour among the car-owning surveyed group are the same ones as identified in the total surveyed group, *Appealing Brand, Image, Driving Range* and *Personal Innovativeness* and additionally *Perceived Visibility of Usage*.

Moreover, this research investigated the influence of *Ecological Belief, Purchasing Costs* and *Subjective Norm* between the male and female surveyed group with the following outcome: *Subjective Norm* and *Purchasing costs* are having a strong impact on the acceptance behaviour towards electric passenger cars among the male surveyed group compared to a low level in the female one. However *Ecological Belief* is having the strongest significance level in the female surveyed group.

Thus, the key findings of the research results were the following comparing those findings also to the latest customer survey as stated in chapter 4.1.

It is unexpected that *Driving Range* is not important in India (neither in the total nor in the car-owning surveyed group), however *Driving Range* is among the top 3 purchasing reasons in the USA to not buy electric passenger cars.

Driving range not having an impact on the acceptance behaviour towards electric passenger cars in India could be explained by the author due to the fact that the daily one-way commuting distance by 70% of urban inhabitants in India is below 10 km and therefore less than the compared countries and less than in the USA with 66 km (Statista, 2019a; Flynn, 2023). Comparing those findings to the latest classic customer surveys about the purchasing reasons for buying electric passenger cars in Germany, USA or China, as presented in chapter 4.1., it is interesting to see that especially the influencing factor *Ecological Belief* occur in all compared countries among the top 3 purchasing reasons for electric passenger cars. This research confirms therefore that *Ecological Belief* is also very important in India among the surveyed group and especially also among the female one due to the fact that *Ecological Belief* is among the factors with the highest significant level in this research. Furthermore, *Governmental Incentives* were mentioned in China and Germany as stated in chapter 4.1. among the top purchasing reasons. This research also confirmed that *Governmental Incentives* influence the acceptance behaviour towards electric passenger cars in India. Moreover,

Purchasing Costs are very important in India towards the acceptance behaviour of electric passenger car. This could be explained by the author due to the fact that the average car price of a new passenger car in India is relative to the average income much higher compared to China, USA or Germany, as stated in chapter 2. *Purchasing Costs* were also mentioned as major influencing factor in latest customer surveys in Germany and in the USA, s. chapter 4.1.; even though that the purchase of an electric passenger car seems to be more affordable in those markets by looking on the average passenger car price relative to the average income in those countries.
Finally, the findings of this study will assist all stakeholders in the Indian automotive industry for promoting electric passenger cars more successful and to better understand the customer´s perceptions towards their acceptance behaviour of electric passenger cars, but also to support the Indian government to achieve their ambitious climate targets and to fight against greenhouse gases. The next chapter will explain the research limitations.

7.3. Limitations of the research

This chapter presents the limitations of this research as follows:

- Research boundaries: Focus only on electric passenger cars (4-wheelers)
- Limitations of systematic literature review
- Generic definition of identified influencing factors
- Choice of sampling method
- Choice of theoretical field research

Chapter 2 presented the research boundaries of this thesis and that the research focused to identify the influencing factors towards the adoption of electric passenger cars in India (4-wheelers) and not on trucks, two- or three-wheelers in India. The definition of the influencing factors, but more the impact on the acceptance behaviour of the customers helps car manufacturers, but also the Indian government to address the right topics to promote the share of electric passenger cars and to support India´s ambitious climate targets being the third biggest CO_2-emitter worldwide. However, the transportation sector is responsible for 9% of India´s greenhouse gas emissions, whereof the road transportation accounts 90% of the transportation sector´s final energy consumption (Statista, 2022c; NewClimate Institute and Climate Analytics, 2020). If the major goal would be to reduce India´s CO_2-emissions, then of course the focus needs to be on the electricity sector being responsible with 37% for India´s greenhouse gas emissions (Statista, 2022c). However, this was not the scope of this thesis.
The researcher defined the influencing factors towards the acceptance behaviour for electric passenger cars in India through conducting a systematic literature review. 14 influencing factors have been identified using two peer-reviewed and well-known databases Web of Science and Scopus, and Base-search as grey-literature.

Of course, more or other influencing factors could have been occurred, if the researcher would have chosen other databases or other grey literature. Additionally, other influencing factors could have been identified by focusing for example only on niche markets which are also at an early stage of electric passenger car market penetration such as India. Since customer behaviour could differ significantly in bigger markets of electric passenger cars compared to smaller ones.

Moreover, the 14 identified influencing factors were each combined into a generic definition term, e.g., governmental incentives. However, the term governmental incentives for instance includes many individual aspects such as free parking for electric passenger cars, exemption of vehicle registration tax, exemption of value added tax, special reserved electric passenger cars number plates and many more.

Also, the term ecological belief is a very broad term with many aspects. This research has proven that the ecological belief influences the perceived usefulness of electric passenger cars. But of course, it would be interesting to know if the person is also caring not only about the technology itself of electric passenger cars, but also about the whole product development and lifecycle of electric passenger cars. Also, the question of where the energy for the electric passenger cars is coming from would be interesting to investigate. Because customers might believe that they act environmentally friendly by driving electric passenger cars without polluting the environment through emissions, but in fact by considering that emissions are produced through generating power for electric vehicles, it is not sustainable either.

There are also limitations in this research due to the choice of sampling method and process by the researcher. Indian young professionals with a higher level of education do not represent of course the Indian population in all respects, but only with respect to those characteristics that are relevant for this research question. Moreover, the defined characteristics of an average electric passenger car driver or of a possible electric passenger car driver could differ in India; but since data was not available for an average Indian electric passenger car driver, the researcher derived the assumed characteristics from available data such as from the USA.

On top of that, the surveyed group answered the online questionnaire towards their acceptance behaviour of electric passenger cars in India on their own without a field trial of real driving experience of electric passenger cars. With 45% car ownership, those participants do have experience in driving vehicles, but of course might not in driving electric passenger cars. If the surveyed group would have had the chance to participate in a field trial of driving electric passenger cars, the conditions of participation were the same for all and the empirical results could of course differ to the ones in this research.

In conclusion, some of the described limitations of this research could be further investigated and deepened. Those that could be further investigated are proposed by the researcher for further research in the next chapter 7.4.

7.4. Recommendation for further research

With the answers to the research question of this study, new research gaps opened up on several issues. A summary of these issues is provided in the following chapter.

1. Deep dive male and female customers of electric passenger cars
2. Further surveys with experience of electric passenger car usage
3. Further survey at a later stage of market penetration with higher electric passenger car offer and a higher share of electric passenger cars
4. Deep dive green energy supply for electric passenger cars
5. Deep dive possible governmental incentives
6. Further analysis in total costs of ownership (TCO)
7. Market research for two- and three-wheelers

7.4.1. Deep dive male and female customers of electric passenger cars

This research analysed if there is a difference between the awareness of price sensitivity, ecological belief and subjective norm when it comes to the question of acceptance of electric passenger cars. The surveyed female customer group does have a stronger ecological awareness and would consider purchasing an electric passenger car rather than a conventional one. Male consumers are more influenced by external factors and price-sensitivity compared to the female participants in this research.

In parallel it was found out that the female consumer group showed a noticeable higher anxiety by the question of electric passenger car usage. They answered more often with agree / strongly agree to the question if they feel uncomfortable, nervous or even anxious by driving electric passenger cars. This demonstrates a clear need for action and further research in this very important and sensitive topic. The author of this thesis proposes that further researches could explicitly focus on possible female customers, their individual needs and wishes.

7.4.2. Further surveys with experience of electric passenger car usage

This survey asked the participants if they are already owning a vehicle to get to know if they are familiar with driving vehicles. Furthermore, they were asked about their attitude towards electric passenger cars. What they think about driving range, charging infrastructure etc. However, the answers were based on their subjective opinion about electric passenger cars and not based on a driving experience during this research. Therefore, it would be recommended to conduct a pilot project of driving experience for future studies. This would help the participants to gain personal experience in driving electric passenger cars. This ensures that all test participants have the same level of experience, which avoid any measurement variations that may arise. On top of that, for future investigations an extended study would be recommended that allows the participants to use electric passenger cars over a longer period of time.

7.4.3. Further survey at a later stage of market penetration with higher electric passenger car offer and a higher share of electric passenger cars

It is recommended by the researcher to re-validate a second time this research model at a later stage of the electric passenger car market penetration in India in order to analyse if there might be changes in the characteristics of the influencing factors. As electromobility is currently still in a very early phase of diffusion, it is primarily people with an affinity for technology who benefit from the use of an electric passenger car and not the mass-market buyer.

7.4.4. Deep dive green energy supply for electric passenger cars

A sustainable and green shift to electric passenger cars should be primarily driven by renewable power generation to meet the additional electricity demand in order to reduce the overall level of CO_2 in the atmosphere, whereby electric passenger cars are a way to contribute to this goal. “As per India’s Nationally Determined Contribution (NDC) for Climate change submitted to the United Nations Framework Convention for Climate change, India has committed to increase its generation capacity from non-fossil resources to 40% of the total generation capacity and reduce the carbon intensity of its GDP by 33-35% by the year 2030 as compared to that in 2005” (Mohan, 2022).

The current energy mix in India is the following: The biggest electricity generation is from burning coal for about 50% of India's total electricity generation. Other fossil sources are lignite with 1.6% and gas with 6.1%. Due to the low installed capacity, nuclear power plants only count with 1.7% and diesel power plants with 0.1%. Renewable energy sources contribute already with 40.5% to the national energy mix. Electricity generation by large hydropower plants accounts for 11.5% of total electricity generation in India and wind and solar with 29% (Government of India Ministry of Power, 2022).

Although India already achieved the goal to increase non-fossil resources to 40.5%, India is still considered as the third largest emitter of CO_2 emissions. Thus, in order to reduce further the carbon intensity, more expansion of renewable energies is needed, which also benefits to the strategy of promoting e-mobility in India.

7.4.5. Deep dive possible governmental incentives

Another important factor regarding the acceptance of electric passenger cars are governmental incentives, as confirmed in this research model. The National Electric Mobility Mission Plan by the Indian government offers incentives for electric two-, three and four-wheelers based on the battery capacity and based on a cap of the cost of the vehicle.

However, the amount of eligible electric four-wheelers is lower compared to the two- and three-wheelers. The reason behind this is that firstly the batteries of electric passenger cars are noticeable larger and hence not covered by a "per kWh of battery capacity" basis; secondly the total number of electric passenger cars is mostly capped and thirdly the monetary benefit is only valid until a market vehicle price of currently 1,5 Mio Rs (approx. 18,750 US$[19]). With the latest electric passenger car offer in India this would only apply on the electric Tata Nexon and Tata Tiger.

Therefore, the author of this thesis recommends to further investigate different options of governmental incentives in India. It would make sense to also conduct a best practice analysis with other countries since governmental incentives are a broadly elastic term in terms of different motivations.

A best practice analysis with Norway could be one idea since they started quite early as one of the first countries to install numerous incentives regarding electric passenger cars. Those could be exemption of vehicle registration tax, exemption of value added tax, exemption of the annual vehicle tax, free road/highway toll fees, exemption of parking fees in municipal boundaries, special reserved electric passenger cars number plates, tax reduction for company owned cars, monetary incentives by purchasing an electric vehicle (such in Germany), financial support of fast charging stations and many

[19] Exchange rate INR/US$= 0.0125; data from Oanda. Available at: https://www.oanda.com/currency-converter/de/?from=INR&to=USD&amount=1; (Accessed at: 22.08.22)

more. However, it is difficult to compare India with Norway, since Norway is sparsely populated and very rich (oil and gas) even on a European scale and has also a lot of hydropower (electricity from renewable sources).

Thailand could be a good role model on the Asian continent, since it is quite densely populated as India and the streets in the big cities, such as in Bangkok are mostly crowded with jammed traffic. The government of Thailand established the "Eco-Car Program" in 2007 to attract production of efficient small cars to the country. The Eco-Car program has supported sales and production of small-engine and low-emission cars. Buyers of Eco-Cars currently pay a reduced excise tax on the sales price. The program has been successful in the domestic market. Eco-Cars "Made in Thailand" are also exported on a large scale. The program will expire in 2025 (Hundt, 2021). As a result, the benefits of electric passenger cars are crucial in terms of being an accessible option for mass-market buyers and therefore requires further research and best practice analysis.

7.4.6. Further analysis in total costs of ownership (TCO)

On top of that further analysis is needed in terms of costs since India is a price-sensitive market. This research only asked the survey group about the purchasing costs and which price premium versus a conventional vehicle would be still acceptable. However, there is not only the purchasing price of an electric passenger car which is influencing the acceptance of e-mobility, but also the total costs of ownership (TCO). TCOs are including cost of ownership, usage cost, maintenance costs, energy and fuel costs, acquisition cost, disposal costs and non-quality costs.

Hence, further research is required focusing specifically on the total costs of ownership in order to decide which qualitative and quantitative measurement is needed to further push the electric passenger car-penetration in India. In addition to the total costs of ownership, it could be helpful to analyse the acceptance of electric passenger cars through different acquisition forms; meaning if the acceptance would change if the electric passenger cars are either bought, leased, financed or just shared. Especially carsharing is an important factor since Indian customers are used to share their rides since decades in a three-wheeler or six-seater van. Carsharing together with electric passenger cars would be a new concept in India and could be an accelerator to further push the electric passenger car-penetration in this country.

7.4.7. Market research for two- and three-wheelers

The current subsidies will be mostly applied on the two- and three-wheeler market, since those vehicles are below a certain market price for the monetary benefit and do have a smaller battery capacity. Together with this fact and the fact that the market of two- and three-wheelers is huge compared to the passenger car market, this holds great potential to further push the acceptance of e-mobility within the country. In 2022 the split of the two-, three- and four-wheeler market was as follows, presented in figure 29.

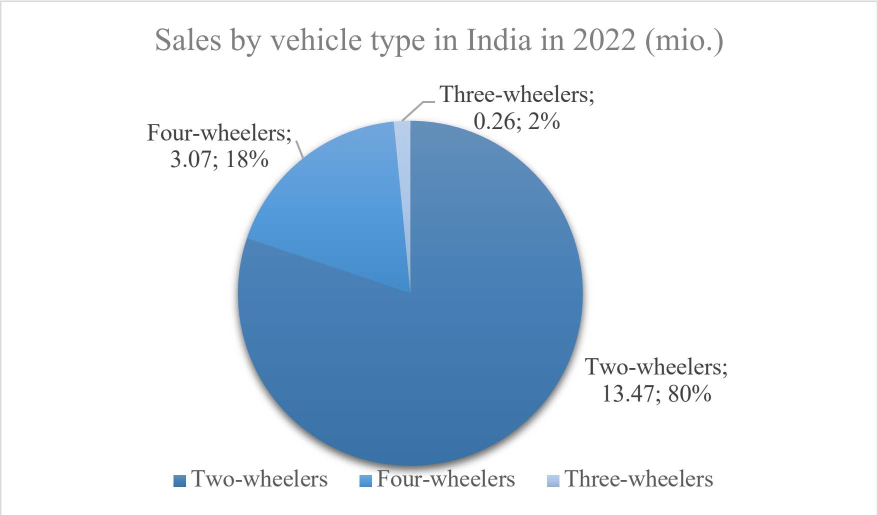


Figure 29 Sales by vehicle type in India in 2022 (mio.)

Source: own figure, adapted from (Statista, 2022a)

Electrifying this huge amount of two- and three wheelers would leap forwards to a faster reduction of CO_2 emission and would contribute to fight against air pollution and against increasing greenhouse gases. Therefore, the author of this thesis proposes to conduct a similar market research also for the two- and three-wheelers market in order to fulfil the ambitious target of the Indian government to become climate neutral in the year 2070. This chapter concluded with the following section.

7.5. Conclusion

The last chapter of this thesis provides a summary of the research conducted for this thesis, the definition of influencing factors and their impact towards the acceptance behaviour of electric passenger cars in India out of a customer´s perspective. A Technology Acceptance Model was developed based on structural equation modelling and empirically validated and tested. Moreover, the limitations of this research have been outlined and used as a basis for proposing ideas for future research to improve the behavioural research towards the customer acceptance behaviour for electric passenger cars in India.

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Appendix

Appendix 1 Questionnaire for expert interview

E-mobility in India

My name is Ms. Anja Barucha, I am 30 years old and I am a German PhD student who is fascinated about India.
I fell in love with this country in 2012 after living 6 months in Nashik for writing my Master thesis at a German automotive supplier; since then I visit India every year to explore more about this great country an its dynamic economy.

You are now invited to participate in a study on the acceptance of electric vehicles in India. You are asked for your opinion, because you belong to expert groups of successful business people and because you are open minded towards new technologies that can help to reduce pollution and CO2 emissions.
This study is part of my PhD in Business with Management at the University in Plymouth, UK.

The study will investigate the factors in India that are crucial in the light of the acceptance of electric vehicles and to what extent these factors are appealing to an Indian customer.
Before answering the questionnaire, please read carefully the information sheet attached in the e-mail; if you are having any questions feel free to contact me directly (anja.barucha@plymouth.ac.uk).

Answering the questionnaire will take approx. 10 minutes.

You can withdraw either immediately during answering the questionnaire or within two weeks after answering/completing the questionnaire; if this is the case you can use the link below for a withdrawal request:

Link: withdrawal.study.emobility.india@gmail.com

Warm regards,

Anja Barucha
* Required

UNIVERSITY OF PLYMOUTH

General data

1. Full name

____

2. Occupation

____

3. Age

____

4. Gender

Mark only one oval.

- Male
- Female
- Prefer not to say

Expert Questionnaire

5. 1. How long are you working in India or with the focus on the Indian market of passenger cars or in administration or legislation of passenger traffic in India?

Mark only one oval.

- 1 - 2 years
- 3 - 4 years
- 5 - 10 years
- > 10 years

6. 2a) The worldwide biggest trends within the automotive industry are Connectivity, Autonomous Drivin; Shared services and e-mobility. What is in your opinion the major challenge for the Indian market ?

Check all that apply.

- Connectivity
- Autonomous Driving
- Shared services
- E-mobility

Other:

7. 2b) Why is your selected trend the major challenge for the Indian market?

8. 3. Are you aware of the National Electric Mobility Mission Plan (NEMMP) 2020 by the Indian governme

Mark only one oval.

- Yes
- No
- Do not know

9. 4. With NEMMP Indian government has the goal to become a 100% electric vehicle nation by 2030. Do y think this is achieveable?

Mark only one oval.

- Yes
- No
- Do not know

10. 4a) If you answered "yes" in question 4, why is this goal achieveable?

11. 4b) If you answered "no" in question 4, what needs to be done?

12. 5. Do you have personal experience with electric vehicles and other alternative fueled vehicles?

Check all that apply.

- [ ] Battery-electric vehicle (BEV)
- [ ] Plug-in electric vehicle (PHEV)
- [ ] Hybrid electric vehicle
- [ ] Fuel cell vehicle (FCV)
- [ ] Natural gas vehicle (NGV)
- [ ] none

Other: [ ] ____________

13. 6. What is in your opinion the most suitable alternative fuel-type vehicle for the Indian market?

Check all that apply.

- [ ] Battery-electric vehicle (BEV)
- [ ] Plug-in electric vehicle (PHEV)
- [ ] Hybrid electric vehicle
- [ ] Fuel cell vehicle (FCV)
- [ ] Natural gas vehicle (NGV)
- [ ] none

Other: [ ] ____________

14. 7. What is in your opinion the most appealing brand out of the perspective of a Indian car customer wl it comes to electric vehicles?

15. 8a) Trend E-mobility: Which segment needs to be "elctrified" first in India? *

Check all that apply.

- [ ] 4-wheeler
- [ ] 2-wheeler
- [ ] 3-wheeler
- [ ] Truck
- [ ] Bus
- [ ] Van

Other: [ ] ____________________

16. 8b) Trend E-mobility: Which vehicle type needs to be "elctrified" first in India? *

Check all that apply.

- [ ] Hatback
- [ ] Sedan
- [ ] Crossover
- [ ] SUV
- [ ] SUC
- [ ] MPV

17. 9. Which stakeholders should be leading the promotion of electric vehicles in India?

Check all that apply.

- [ ] Government
- [ ] OEMs
- [ ] Energy Network
- [ ] Automotive suppliers

Other: [ ] ____________________

18. 10a) Which are in your opinion the biggest positive attributes linked to electric vehicles in regards to situational factors? (please choose 5) *

Check all that apply.

- [ ] Car of the future
- [ ] Governmental incentives
- [ ] Road tax exemption
- [ ] Air quality
- [ ] Climate change
- [ ] Low noise
- [ ] Performance
- [ ] Sustainability
- [ ] Fuel economy

Other: [ ] ____________________

19. 10b) Which are in your opinion the biggest positive attributes linked to electric vehicles in regards to psychological factors? (please choose 5) *

Check all that apply.

- [ ] Technology-oriented
- [ ] Emotions
- [ ] Social status
- [ ] Pro-environmental lifestyle
- [ ] Prestige
- [ ] Social influence
- [ ] Attitude
- [ ] Pioneering-ecological spirit
- [ ] Symbol of success
- [ ] Self-image

Other: [ ] ____________________

20. 11a) Which are in your opinion the biggest concerns about electric vehicles (please choose 5) *

Check all that apply.

- [ ] Purchasing costs
- [ ] Driving range
- [ ] Battery capacity
- [ ] Performance
- [ ] Charging infrastructure
- [ ] Charing time
- [ ] Safety
- [ ] Total cost of ownership
- [ ] Low noise
- [ ] Stable power grid

Other: [ ] ______________________

21. 11b) What needs to be done in your opinion to overcome those 5 biggest concerns in the perspective of customer?

____
____
____
____
____

22. 12. How important would you rank pyschological aspects in the buying decision process of a car customer? (1: least important - 5: most important)

Mark only one oval.

1	2	3	4	5
◯	◯	◯	◯	◯

23. 13a) In which regions should be invested to promote electric vehicles?

Mark only one oval.

- Urban
- Suburban
- Rural
- Other: ____________________

24. 13b) In which state(s) should be invested to promote electric vehicles?

25. 13c) In which city/cities should be invested to promote electric vehicles and why?

26. 14. Should electric vehicles only be implemented in the public infrastructure system (taxi etc.)

Mark only one oval.

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

27. 15. Do you have any other comments regarding the acceptance of electric vehicles in India which you would like to add?

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Google Forms

Appendix 2 Online questionnaire for field research

Acceptance of e-mobility in India

You are now invited to participate in a study on the acceptance of electric passenger cars (4-wheelers) in India.

My name is Ms. Anja Barucha, I am a business engineer and I am a German PhD student who is fascinated about India. I fell in love with this country in 2012 after living 6 months in Nashik for writing my Master thesis at a German automotive supplier; since then I visit every year India to explore more about this great country.

This study is part of my PhD in Business with Management at the University in Plymouth, UK.

You are kindly asked for your opinion, because you belong to the current and future generation of successful business people who are open minded towards new technologies and who are able to contribute to a more sustainable and CO2-neutral India.

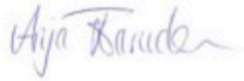
This study will investigate the key factors that are crucial in the light of the acceptance of electric vehicles and to what extent these factors are appealing to an Indian car customer.

Answering the questionnaire will take approx. 15 minutes.

As a thank you, 4x Amazon Coupons á 1.000 INR will be raffled among all participants.

Warm regards,

Anja Barucha, Master of Engineering



There are 73 questions in this survey.

General Data

Gender *

Please choose **only one** of the following:

- ◯ Female
- ◯ Male

How old are you? *

❶ Only numbers may be entered in this field.
Please write your answer here:

From which state/union territories in India are you from? *

❶ Choose one of the following answers
Please choose **only one** of the following:

- ◯ Andhra Pradesh
- ◯ Arunachal Pradesh
- ◯ Assam
- ◯ Bihar
- ◯ Chhattisgarh
- ◯ Goa
- ◯ Gujarat
- ◯ Haryana
- ◯ Himachal Pradesh
- ◯ Jharkhand
- ◯ Karnataka
- ◯ Madhya Pradesh
- ◯ Maharashtra
- ◯ Manipur

- Meghalaya
- Mizoram
- Nagaland
- Odisha
- Punjab
- Rajasthan
- Sikkim
- Tamil Nadu
- Telangana
- Tripura
- Uttarakhand
- Uttar Pradesh
- West Bengal
- Andaman & Nicobar Islands
- Chandigarh
- Dadra and Nagar Haveli
- Daman and Diu
- Government of NCT of Delhi
- Jammu & Kashmir
- Ladakh
- Lakshadweep
- Puducherry

In case of a missed state, please select the state where you residing in.

What is your occupation?

Choose one of the following answers
Please choose **only one** of the following:

- Student
- Research associate
- Faculty member
- Professor

Make a comment on your choice here:

Please indicate your highest level of education (include degree you are currently working on)? *

Choose one of the following answers
Please choose **only one** of the following:

- ◯ Elementary
- ◯ High school/GED
- ◯ Some college/associates
- ◯ Masters
- ◯ PhD
- ◯ Post doctorate

What is your annual family income from all sources before taxes? *

Choose one of the following answers
Please choose **only one** of the following:

- ◯ < 299.000 INR
- ◯ 300.000 INR - 499.000 INR
- ◯ 500.000 INR - 799.000 INR
- ◯ 800.000 INR - 1.199.999 INR
- ◯ 1.200.000 INR - 1.999.000 INR
- ◯ > 2.000.000 INR
- ◯ prefer not to say

Do you own a car?

❶ Choose one of the following answers
Please choose **only one** of the following:

- ◯ Yes
- ◯ No
- ◯ not yet, but plan to buy one

Perceived Usefulness of Electric Vehicles (EVs)

It would be a reasonable decision to use EVs.

❶ Choose one of the following answers
Please choose **only one** of the following:

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

EVs are a good innovation.

❗ Choose one of the following answers
Please choose **only one** of the following:

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

Electric vehicles are useful.

❗ Choose one of the following answers
Please choose **only one** of the following:

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

Perceived Ease of Use of EVs

Handling an EV is the same as handling a conventional vehicle.

❶ Choose one of the following answers
Please choose **only one** of the following:

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

Contentional vehicle = internal combustion engine (diesel or petrol)

I do not see big showstoppers in handling an EV.

❶ Choose one of the following answers
Please choose **only one** of the following:

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

Learning to operate an EV is easy for me.

❶ Choose one of the following answers
Please choose **only one** of the following:

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

Behavioural Intention to Use EVs

I plan to use an EV in the future.

❶ Choose one of the following answers
Please choose **only one** of the following:

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

I can imagine using an EV in addition to the conventional vehicle(s) in my/family household.

❶ Choose one of the following answers

Please choose **only one** of the following:

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

I can imagine using an EV spontaneously.

❶ Choose one of the following answers

Please choose **only one** of the following:

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

Behavioural Intention to Buy EVs

I can imagine buying an EV.

❶ Choose one of the following answers
Please choose **only one** of the following:

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

I can imagine leasing an EV.

❶ Choose one of the following answers
Please choose **only one** of the following:

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

I can imagine paying an additional charge for an EV.

❶ Choose one of the following answers
Please choose **only one** of the following:

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

Subjective Norm

People around me (family/friends), who influence my behaviour, would like if I drive an EV.

❶ Choose one of the following answers
Please choose **only one** of the following:

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

People, who are important to me, would like if I drive an EV.

❶ Choose one of the following answers
Please choose **only one** of the following:

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

Social media do support the usage of EVs.

❶ Choose one of the following answers
Please choose **only one** of the following:

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

Personal Innovativeness

Among my friends/family members, I am usually the first to try out new technologies.

❶ Choose one of the following answers
Please choose **only one** of the following:

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

I always look for new, innovative products.

❶ Choose one of the following answers
Please choose **only one** of the following:

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

I enjoy experimenting with new products.

❶ Choose one of the following answers
Please choose **only one** of the following:

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

When I hear about new products I am interested in, I try to test them.

❶ Choose one of the following answers
Please choose **only one** of the following:

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

I would rather prefer to test new products personally than reading tests/customer feedbacks.

❗ Choose one of the following answers

Please choose **only one** of the following:

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

Ecological Belief

If I have the choice between two similar products, I always choose the more environmentally friendly one.

❗ Choose one of the following answers

Please choose **only one** of the following:

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

I do prefer purchasing products which are made out of recyclable material.

❗ Choose one of the following answers
Please choose **only one** of the following:

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

I try to act environmentally sustainable in my daily life.

❗ Choose one of the following answers
Please choose **only one** of the following:

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

I often accept to pay a higher price in order to buy environmentally friendly products.

❗ Choose one of the following answers

Please choose **only one** of the following:

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

I did convince some of my friends/family members to avoid buying non-environmentally friendly products.

❗ Choose one of the following answers

Please choose **only one** of the following:

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

Purchasing Costs

I would accept to pay an additional price of <5% for EVs vs. comparable conventional vehicles .

❗ Choose one of the following answers

Please choose **only one** of the following:

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

I would accept to pay an additional price of 5 - 10% for EVs vs. comparable conventional vehicles .

❗ Choose one of the following answers

Please choose **only one** of the following:

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

I would accept to pay an additional price of 11 - 20% for EVs vs. comparable conventional vehicles .

❶ Choose one of the following answers

Please choose **only one** of the following:

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

I don´t accept a higher price for EVs. vs. comparable conventional vehicles.

❶ Choose one of the following answers

Please choose **only one** of the following:

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

Technological Knowledge

I do know a lot about e-mobility.

❶ Choose one of the following answers
Please choose **only one** of the following:

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

I do know more about e-mobility compared to my friends/family members.

❶ Choose one of the following answers
Please choose **only one** of the following:

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

I follow news in the field of e-mobility.

❗ Choose one of the following answers
Please choose **only one** of the following:

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

Technological Risk

I do not belief that e-mobility is a matured innovation.

❗ Choose one of the following answers
Please choose **only one** of the following:

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

I do not believe that EVs have the same reliability as conventional vehicles.

❶ Choose one of the following answers
Please choose **only one** of the following:

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

There are still a lot of open and unanswered questions when it comes up to e-mobility.

❶ Choose one of the following answers
Please choose **only one** of the following:

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

Anxiety of Usage

I am nervous while driving vehicles.

❶ Choose one of the following answers
Please choose **only one** of the following:

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

I am anxious while driving vehicles.

❶ Choose one of the following answers
Please choose **only one** of the following:

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

I feel uncomfortable while driving vehicles.

❶ Choose one of the following answers
Please choose **only one** of the following:

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

I feel uncomfortable while charging electric vehicles.

❶ Choose one of the following answers
Please choose **only one** of the following:

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

Driving Range

I accept a total driving range of EVs of minimum 70 – 100km.

❶ Choose one of the following answers
Please choose **only one** of the following:

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

I accept a total driving range of EVs of minimum 150km.

❶ Choose one of the following answers
Please choose **only one** of the following:

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

I accept a total driving range of EVs of minimum 300km.

❶ Choose one of the following answers
Please choose **only one** of the following:

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

I only accept a total driving range of EVs of minimum 600km

❶ Choose one of the following answers
Please choose **only one** of the following:

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

I cannot accept losses regarding the total driving range of EVs compared to conventional vehicles.

❶ Choose one of the following answers

Please choose **only one** of the following:

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

Charging Infrastructure

It is easier for me to use an EV if a comprehensive and appropriate charging infrastructure is available.

❶ Choose one of the following answers

Please choose **only one** of the following:

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

Currently there is a lack of appropriate public charging infrastructure.

❶ Choose one of the following answers
Please choose **only one** of the following:

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

The current lack of home charging infrastructure prevents me to buy an EV.

❶ Choose one of the following answers
Please choose **only one** of the following:

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

The fear of an insufficient and instable national power grid prevents me to buy an EV.

❗ Choose one of the following answers

Please choose **only one** of the following:

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

I fear not having access to a public charging station when I need it.

❗ Choose one of the following answers

Please choose **only one** of the following:

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

Charging Time

I accept a full charging time of approx. 1 hour with a super charger.

❶ Choose one of the following answers
Please choose **only one** of the following:

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

I accept a full charging time of approx. 8 hours by charging at a ususal home power outlet.

❶ Choose one of the following answers
Please choose **only one** of the following:

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

Since I would charge my EV either at home over night or during work, I do not care about the charging time.

❶ Choose one of the following answers

Please choose **only one** of the following:

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

Governmental Incentives

In my point of view the government should reduce the purchasing costs of EVs through cash incentives.

❶ Choose one of the following answers

Please choose **only one** of the following:

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

In my point of view the government should reduce the purchasing costs of EVs through tax incentives.

❶ Choose one of the following answers

Please choose **only one** of the following:

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

I would purchase an EV if the government would establish a malus system for conventional vehicles (higher taxes, higher costs, fines when buying a conventional vehicle).

❶ Choose one of the following answers

Please choose **only one** of the following:

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

I would consider buying an EV if I would receive non-monetary incentives such as road tax exceptions, free parking, extra EV road lanes within the city etc.

❗ Choose one of the following answers

Please choose **only one** of the following:

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

Appealing Brand

I prefer a dedicated EV brand like Tesla if I would buy an EV.

❗ Choose one of the following answers

Please choose **only one** of the following:

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

I would prefer an Indian brand if I would buy an EV.

❶ Choose one of the following answers
Please choose **only one** of the following:

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

I do not care about the brand origin of EVs.

❶ Choose one of the following answers
Please choose **only one** of the following:

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

Image

Using an EV would lead to a higher positive social reputation.

❗ Choose one of the following answers
Please choose **only one** of the following:

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

I would draw attention on me by using an EV.

❗ Choose one of the following answers
Please choose **only one** of the following:

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

My social environment would think that I do care about environment protection if I use an EV.

❗ Choose one of the following answers
Please choose **only one** of the following:

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

An EV is a status symbol.

❗ Choose one of the following answers
Please choose **only one** of the following:

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

Visibility of Usage

I prefer “purpose” design of EVs rather than the design of conventional vehicles.

❗ Choose one of the following answers

Please choose **only one** of the following:

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

Purpose design means in this context a dedicated developed vehicle for an electric motor without compromises (in functions, size, width and weight).

Current EVs which are based on already existing conventional vehicles, should be differentiated through special paints/trims/nomenclature.

❗ Choose one of the following answers

Please choose **only one** of the following:

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

For me it is important that the look-and-feel of an EV is special.

❗ Choose one of the following answers

Please choose **only one** of the following:

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

👍 **Thanks a lot for participating!**

Your valuable opinion is crucial for this research in order to contribute to a CO_2-neutral, eco-friendly and sustainable India - now and in the future.

Once the data of the study have been anonymised and analysed, you will have the opportunity to receive a brief summary of the results of the study.

If so, you are more than welcome to contact me via:
anja.barucha@googlemail.com

02.05.2020 – 18:00

Submit your survey.
Thank you for completing this survey.