Not up for electric? Empirical study to identify barriers to acceptance of electromobility

Ableitung eines erweiterten Kaufverhaltensmodells bei technisch komplexeren Produkten – Elektrofahrzeuge

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***Abstract* —** Pollution and particulate matter caused by traffic are increasing year by year. This puts both people and the environment at risk. As a result, more and more people are concerned about their environment (Cf. Finger 2015: 10; Attenborough and Lagarde 2019: 5; Continental 2021: 7). In this context, the classic internal combustion engines are at the center of discussions about drive technology. Electrification of powertrains is expected to result in the use of gentler technologies. This offers the opportunity to reduce dependence on oil in the long term and to minimize emissions (Cf. Proff and Szybisty 2016: 2; Karle 2021: 2; Appel 2021, n.p.; Delhaes 2021: n.p.). As environmental friendliness has been perceived as an important purchase criterion by customers in recent years, manufacturers' portfolios have evolved and changed in the direction of electromobility. Thus, electric cars have now been available on the market as a series product for just over a decade (Cf. Karle 2021: 3; Dudenhöffer 2014: 315; Deutsches CleanTech Institut, 2010: 26). Since sales figures of electric vehicles in Germany did not account for a larger share of total vehicle sales for a long time, the market penetration potential of this innovative drive technology was accordingly critically questioned (Cf. Schmidt 2009: 27-28; Kampker et al. 2018: 13).

The reasons for the lower registration numbers were manifold. The main points of criticism of electric vehicles were and are the significantly higher purchase price, the insufficient range, a lack of comprehensive charging infrastructure, long charging times, and doubts about technical safety and reliability (Cf. Proff et al. 2022: 7; Bennet and Vijaygopal 2017: 501). Only in 2020 and 2021 did the sales figures of electric vehicles increase noticeably. When considering this changed situation, the question thus arises whether the growth in registered electric vehicles results solely from the political support measures. Or whether further/other technical, socio-economic or psychological factors have influenced consumers in their purchase decisions (Cf. Kampker et al. 2018: 14; Kraftfahrt-Bundesamt 2021: n.p.; CAM 2021: n.p.; Bandelow and Kundolf 2018: 172). Despite rising registration figures, the aforementioned criticisms of electromobility still cannot be dismissed out of hand. Accordingly, in addition to technical shortcomings, a lack of consumer acceptance for electromobility can also be assumed (Cf. Sanguesa 2021: 391; Fazel 2014: 303-306; Dudenhöffer 2015: 321). Acceptance is understood as the willingness to use a product. The formation of positive attitudes and intentions to use the product are also necessary to gain acceptance for the same (Cf. Dethloff 2004: 18).

Thus, acceptance can be understood as a central criterion for the extent to which potential consumers view electromobility as a valid alternative to conventionally powered vehicles. Since Germany has missed the target of 1 million registered electric vehicles in 2020, this raises the question, against the background of the above, of the influencing factors that inhibit the acceptance of electric vehicles and the measures that can be taken to help accelerate the spread of these innovative drive technologies (Cf. Fazel 2013: 1 ff.; BMWI 2022: n.p.; Kraftfahrt- Bundesamt 2020: p. 10). This research project is intended to provide an answer as to how consumer acceptance can be increased and through which measures the willingness of potential consumers to buy can be achieved (Cf. Lippold 2015: 3-4). The aim is to provide recommendations for the targeted marketing of electric vehicles.

Based on the current development and further expansion of electromobility, it is also important to determine the potentials and influencing factors for hydrogen-powered vehicles (Cf. Karle 2021: 211; h2.live 2021: 5; Rudschies 2019: 10-15). In the long term, hydrogen-powered vehicles offer the potential to mature as an alternative to conventional internal combustion engine vehicles. Against this background, hydrogen vehicles could be a sustainable substitute for future mobility alongside electric vehicles, as they can be moved autonomously over longer distances (e.g., vacation trips) with short refueling stops (Cf. Rosen 2018: 11; Kaindl 2019: n.p.; h2.live 2021: 18-21).

I. Technology Acceptance

Three authoritative models are cited in the literature to explain technology and user acceptance. The Theory of Reasoned Action (TRA) forms the basis and has been extended by the Theory of Planned Behavior (TPB) and the Technology Acceptance Model (TAM) (Cf. Dudenhöffer 2015: 77). In the literature, the aforementioned three models are considered robust and useful models for explaining technology acceptance (Cf. Fazel 2014: 103).

In the following, the present research project focuses in particular on a modified version of the TAM. The TAM is characterized by its simplicity and multiple applications. Moreover, it is widely used and has been frequently extended by appropriate modifications (Cf. Dillon and Morris 1996: 13; Lin and Chang 2011: 425; Luarn and Lin 2005: 875; McFarland and Hamilton 2006: 429; Nysveen et al. 2005: 247; Mathieson 1991: 187).

As can be seen from the previous knowledge development, the acceptance of electromobility (BEV and FCV) is influenced by criteria such as range and charging time. For example, low maintenance costs cannot outweigh the disadvantages by rational consideration (Cf. Beggs et al. 1981: 2). The test persons compare the innovative electromobility of vehicles to which a personal experience is present, these are predominantly vehicles with internal combustion engine. Sincemost of the test persons have no or hardly any personal experience with electric vehicles, features that could trigger enthusiasm for electromobility - such as stepless acceleration - remain unconsidered (Cf. Dudenhöffer 2015: 45). Thus, it remains to be noted that the use of technological innovations isnot a given, which is why many theoretical models in acceptance research are based on behavioral models (Cf. Dillonand Morris 1996: 8). Accordingly, in the following, various theories and studies will be presented that deal with cognitive areas of behavior on the consumer side and the acceptance of technologies on the other side. Subsequently, these will be elicited with regard to their transferability to the acceptance of electromobility (BEV and FCV). Davis, F.D. et al. (1989), for example, identified variables influencing acceptance in order toderive interventions from them. They also address the questionof why people reject or accept technological innovations.

II. Research Gap

The identified research gap can be broken down into three areas:

- First, the assumed influence of interest as an additional influencing factor in the technology acceptance model.
- Second, the influence of external factors such as trends, market and government policies, which are assumed to have an indirect influence on technology acceptance through political instruments.
- Lastly, the expected indirect influence, which is caused by cultural, social and personal factors that have an influence on technology acceptance.

A closer look reveals various points of reference between the Munich Interest Theory and the Technology Acceptance Model.

First of all, it can be seen that both theories refer to motivational aspects. Following Dewey, Krapp refers to these aspects within the interest construct: Interest can be described as a special form of motivation. A person can become completely absorbed in a thing and devote himself to it wholeheartedly because it is personally important and meaningful to him (Cf. Krapp 2010a: 16). In the Theory of Planned Behavior, Ajzen again assumes that behavioral intention involves motivational factors that influence behavior. Accordingly, intention as an indicator can provide information about how strongly a person is determined to perform a certain behavior (Cf. Ajzen 1991: 181). This view of Ajzen is also adopted by Davis et al. 1989 in the context of his Technology Acceptance Model: it is assumed that usage intention/intent significantly influences usage (Cf. Dudenhöffer 2015: 111). However, neither the Theory of Planned Behavior nor the Technology Acceptance Model can answer where the motivation within an intention comes from.

Likewise, the aspect of competence can be identified as a point of reference to the TAM. According to the Munich Interest Theory, the need to experience competence refers to a person's feeling of being able to make a difference with one's own behavior and of being able to meet given or self-imposed requirements (Cf. Krapp 1998: 194; Krapp and Ryan 2002: 72). This, in turn, can be related to the perceived ease of using the TAM. Should a person feel that he or she can make a difference with his or her own behavior and cope with the demands that come with it, execution is perceived as easier andthus control is perceived as higher (Cf. Davis et al 1989:). A similar relationship can be seen with the TPB construct of perceived behavioral control (Cf. Ajzen 2005: 111).

Also between the need for social inclusion, which goes back to the Munich Interest Theory, a connection can be made to the Technology Acceptance Model, in this case "TAM 2" by Venkatesh and Davis from the year 2000. This is because the TAM 2 includes the Subjective Norm, which has already been recognized by Ajzen and Fishbein in the context of the TRA as an influencing factor of behavioral intention. The Subjective Norm is based on the perceived social pressure of a person to perform or refrain from performing a certain behavior, depending on the perception of whether relevant reference persons approve or disapprove of the performance of a certain behavior (Cf. Ajzen and Fishbein 1980: 7). This subjective norm can also be explained by the need for social inclusion, in which a person strives to be connected with other important (reference) persons and to be accepted and recognized by them (Cf. Krapp 1998: 195; Krapp and Ryan 2002: 72).

Another point of contact between the Technology Acceptance Model and the Munich Interest Theory can be identified within the aspect of identity (Cf. Krapp 2010a: 16; Krapp 1999: 399). Thus, a relationship was identified between the acceptance of hydrogen-powered vehicles and its perception of use (Perceived Usefulness). Perception in this case means the holistic perception of an object (Cf. Dinse 2001: 165 ff.). This perception can be regarded as a person's central interest in an object. The interest in turn produces an individual personality structure and can be called an individualself, which has a unique structure of attitudes (Cf. Krapp 2010a: 16; Krapp 1999: 399).

In summary, between the Munich Interest Theory reference points to different aspects of the Technology Acceptance Model can be identified and both theories partly include or consider similar constructs (motivation, autonomy, social connection and identity).

Two conclusions can be drawn from this:

Interests are related to intentions and these influence a person's behavior. This could be explained by the assumption that the intention as well as the interest has a motivational character. Accordingly, the intrinsic motivation contained in the interest construct reinforces the motivation underlying the intention to actually perform a certain behavior.

The value-related component should also play a central role, because according to Krapp, the object of interest should be temporarily or permanently integrated into the central regions of a person's self-concept. The related goals of action are compatible with individual attitudes, expectations, and values and are called self-intentionality (Cf. Krapp 1999: 400).

Second, it can be concluded that although interest has points of contact with various aspects of TAM and thus plays arole in this theory, it is an extension of TAM due to various construct features that are not addressed in TAM.

In this regard, reference should be made to research conducted by Mohiyeddini and Bauer in 2007, who extended the TPB model to include the variable emotion. However, the emotion variable was not used as a further determinant of behavioral intention, but as a mediator variable between intention and behavior. Transferred to the Technology Acceptance Model, such an extension could also be used in the TAM, so that a mediating relationship arises between behavioral intention and actual use (Cf. Mohiyeddini and Bauer 2007: 10).

Moreover, in their gender-segregated study of mobile communication service provider adoption, Nysveen et al. 2005 demonstrated a positive influence of intrinsic motivation on the construct of attitude as well as on the construct of intention to use for both men and women. Since there is an intrinsic motivational aspect to interest, it should be possible to transfer this accordingly, so that interest could have an influence on intention to use (Cf. Nysveen et al 2005: 252).

Likewise, Venkatesh and Bala 2008 found a significant influence of the construct Perceived Pleasure on Perceived Ease of Use. In doing so, the construct of intrinsic motivation was included in the construct of Perceived Pleasure, which in turn means for this research that an effect of interest on Perceived Ease of Use can be assumed (Cf. Venkatsh and Bala2008: 291).

Based on these findings, the construct of interest is included in the research model, assuming a positive impact on the constructs of Perceived Usefulness, Subjective Norm, Perceived Ease of Use, and Behavioral Intention on the one hand, and a mediating impact on Actual Use on the other.

Thus, by adding the construct of interest to the TAM, the aspects of motivation and identity, as well as those of the emotional experiential qualities associated with the behavior, and the aspect of knowledge enhancement with respect to the subject matter domain of the behavior and the related value reference are taken into account. It is possible that it is precisely these aspects that lead people to buy an electric car instead of a conventional vehicle with an internal combustion engine. It may also be possible to explain the personal value they attach to this subject area. Possibly it is the interest that prompts people to move from a behavioral intention to an energetic behavior.

III. The influence of political instruments on the acceptance of electromobility

As has been made clear by the previous explanations in the previous chapters, there is currently a broad and diversified range of electric vehicles, which is continuously expanding and developing (Cf. Karle 2021: 195-210; Kraftfahrt-Bundesamt 2020: 10; shocking-solutions 2021: n.p.; Mehta and Senn-Kalb 2021: 18).

In addition to pure battery electric vehicles (BEVs), a rapidly growing range of plug-in hybrid vehicles has been particularly evident on the market since 2014. Hybrid vehicles were and are understood by industry as well as research and early consumers (innovators) as the first step towards an electrified vehicle fleet (Cf. Faraz et al. 2020: 153-155; Kraftfahrt-Bundesamt 2020: 10; Kuhnert et al. 2021: 6-7; EV-Volumes 2022: n.p.).

In this respect, fuel cell vehicles are currently the exception rather than the rule. Despite this, their further development is being driven forward by some manufacturers, above all Hyundai and Toyota, as positive synergy effects can certainly be foreseen in connection with the use and storage of renewable energies. The research focus is currently more on long-distance freight transport than on passenger car transport.If this proves to be true, the hydrogen infrastructure would be further expanded and freight transport in particular would have a positive influence on the future development of hydrogen-powered passenger cars (Cf. Rudschies 2019: 10-15; Karle 2021: 211-212; Doppelbauer 2020: 175-177; h2.live 2021: 18-21).

Vehicle prices that rely on electromobility in the powertrain are generally significantly more expensive than conventional internal combustion engine vehicles and thus still represent a barrier to entry for a large proportion of consumers. Increasingly diversified and constantly evolving battery technologies are expected to drive prices down in the future as competition strengthens (Cf. Doppelbauer 2020: 144-159; Larminie and Lowry 2012: 36-53; Kampker et al 2018: 48-50). From the international comparison, it is also possible to derive the hypothesis that direct government support for vehicle purchase has a positive effect on registration figures. In this regard, our European neighbors Norway and the Netherlands can be cited as positive examples. In an international comparison, such as with the USA or Japan, direct subsidies were also introduced comparatively late in Germany. The initial introduction of direct subsidies in 2016 did not bring thehoped-for consumer response. This was only achieved by a significant increase in the subsidy in 2020. Thereafter, registration figures developed slightly positively, but recognizably in the direction of increased sales of electrified vehicles (Cf. BMWI 2016: n.p.; BMWI 2022: n.p.; Karle 2021:214-215; Mehta and Senn-Kalb 2021: 182-184, 186, 202 ff.). In contrast to Germany, the charging infrastructure in our European neighbors was already much better developed when the first electric vehicles came onto the market. It is assumed here that this additionally contributed to increased sales. The fact that our neighboring countries invested more in the charging infrastructure and in direct purchase premiumsubsidies ultimately paid off, whereas Germany's initial subsidy measures mainly went into electromobility research (Cf. BMWI 2022: n.p.; Karle 2021: 213-214; Virta 2022: n.p.;
Kuhnert et al. 2021: 6-7).

Germany has also provided an additional incentive for consumers to invest in an electrified vehicle with the increased purchase premium in 2020. The initial question here is whether this is the decisive factor in the purchase of an electrified vehicle. Or are other, also politically initiated influences such as the expansion in the charging infrastructure or tax benefits responsible for an improved acceptance and ultimately for the willingness to buy electric vehicles (Cf. BMWI 2022: n.p.; EV-Volumes 2022: n.p.; Kuhnert et al. 2021: 12).

However, it should also be noted that the expansion of the charging infrastructure, the expansion of which is also being pushed by the German government, is only being advanced at a slow pace. In addition to the basic expansion, further sub-goals are also planned, such as adequate coverage in the various regions of Germany with charging options and a uniform system. A uniform system can be seen in terms of the different charging plugs used or in terms of the respective preferred payment options of the various charging point operators, which the federal government is striving to standardize (Cf.

Doppelbauer 2020: 295; Sanguesa et al. 2021: 373-374; Silberg et al. 2021: 5; BMWI 2022: n.p.; Amendment Ordinance to the Charging Point Ordinance II 2017: n.p.).

Lastly, it should be noted that a large part of the value creation is related to the accumulators or the vehicle batteries. In addition to this aspect and against the backdrop of current supply chain problems, especially with regard to the significantly increased prices and limited availability of freight space on container ships, a localization/regionalization of a cell production is seen as an important aspect by both the automotive industry and research funding. This regionalization would create jobs in Europe in the medium to long term. In addition to an assured availability of batteries for the expected demand from the automotive market, the domestic economy also benefits from this new technology sector (Cf. Karle 2021: 97-105 & 216; Silberg et al. 2021: 21-23; Kampker et al. 2018: 27; Cf. BMWI 2022: n.p; Mehta and Senn-Kalb 2021: 41).

By extending the TAM to include the indirect influence of political instruments on the acceptance of electromobility, both direct and indirect promotion are thus examined. Here, it is important to consider that the political instruments emergefrom (mega-) trends, which have been recognized by the industry as new/additional revenue opportunities and develop these products for the market. A mega-trend such as electromobility can also be brought about favorably by politicaldecisions (e.g., achieving CO^2 targets). Initially, indirect political instruments were used in Germany to promote research and development. However, the use of these instruments changed, so that today a mix of indirect and direct support measures has been adopted by the German government to counter the stagnating or slowly rising sales figures for electrified vehicles. In the meantime, the increase in sales figures mentioned above suggests that the measures are supporting the desired shift to an electrified vehicle fleet. Accordingly, this use of policy instruments is assumed to induce consumers to purchase an electric car instead of a conventional internal combustion engine vehicle. More generally, it will be investigated whether the use of policy instruments has an impact on the acceptance of electromobility. Furthermore, it will be investigated whether direct political measures are understood differently by the population or consumers than indirect measures to promote electromobility.

IV. The influence of cultural, social and personal factors on the acceptance of electromobility

This chapter will first show that consumers from different countries prefer vehicles with different drive systems for individual transportation. It will also be determined whether there are similarities and differences in the main selection criteria and considered whether these can be explained by cultural, social or personal factors. For the country comparisons, China, the USA and Germany will be used in the following, as these show the greatest differences in terms of their purchasing preferences according to the literature (Cf. Dudenhöffer 2015: 236 ff.).

Figure 2 below, which refers to a study by Deloitte, shows that consumer preferences of passenger cars from different countries differ with regard to the drive type of their purchased vehicle. First, it can be seen that conventional vehicles with an internal combustion engine still account for the largest share in the three regions of comparison. For example, vehicles with an internal combustion engine accounted for 69% of the preferred drive systems in the U.S., 58% in China and 49% in Germany. If the various drive systems of hybrid vehicles, i.e. PHEV + HEV, are considered as a whole, hybrid vehicles would account for 30% of new registrations in Germany, 23% in China and 22% in the USA. Only a 5% share of consumers in the U.S. preferred pure battery electric drive for their next vehicle, compared to 17% and 15% in China and Germany, respectively. In conclusion, it can be said that consumers are following the market offer, so that in Germany just under 50%of respondents would opt for at least a partially electrified vehicle drive. In China, this is still around 40% and in the USA, reservations regarding electromobility are apparently stillgreatest, as only just under 1/3 of respondents here would opt for a (partially) electrified vehicle (Cf. Proff et al. 2022: 7).

Figure 1: Consumers' powertrain preferences for their next vehicle as of October 2021, by key country

If consumer preferences are compared with those of 10 years ago, the picture is clearly different. One of the reasons for this is that electromobility was only just gaining in importance as a future vehicle drive system, or consumers were beginning to gain an understanding of this "innovative" technology. Furthermore, the 3rd wave of electromobility has just been heralded as a green alternative to conventional combustion engines (Cf. Deutsches CleanTech Institut 2010: 17; Schwedes 2018: 205-206). Accordingly, consumers of vehicles with (partially) electric drive can be described as (Cf. Rogers 2003: 281; Chapter 2.2; Chapter 2.3 Karnowski 2017: 21). It should be emphasized at this point that the study deals with the consumer perspective and not the company perspective (Cf. Dudenhöffer 2015: 96 ff.).

Figure 3 below shows that Deloitte already conducted a study on the adaptation of electromobility in various countries in 2011. However, a completely different picture of the expected diffusion of electromobility emerged in the country comparison. It can be seen, for example, that consumers in the U.S. and Germany, as domesticated automotive nations, are rather skeptical about this innovative drive technology,whereas consumers in China were much more open to it (Cf. Giffi et al. 2011: 1-3). One possible explanation for this high level of approval may be that many Chinese consumers have never owned a vehicle of their own and therefore have no or only limited experience and thus no preferences regarding the drive system (Cf. Dudenhöffer 2015: 60-62, 296-298).

In addition to the consumer declarations of intent regarding the adaptation of electromobility in 2011 and 2021 examined above, the main requirements for electric vehicles were examined through further surveys of various institutions. It became apparent that lower emissions/environmental friendliness, subsidies or tax breaks for electromobility, lower costs by means of TCO consideration over the vehicle life cycle, and the need to keep up with technological progress canbe the influencing factors that lead to purchase. However, the studies/surveys differ from each other, so it is not possible to compare and evaluate these three countries in a comparable way (Cf. BDEW 2020: n.p.; Deloitte 2018: 12; Rakuten Insight2019: n.p.).

By extending the TAM to include indirect factors based on cultural, social and personal characteristics, the aim is to investigate whether this can explain the acceptance of a technology in an improved way. It is worth mentioning here that it is assumed that personal factors in particular play a significant role in the acceptance and purchase decision of the individual (Cf. Cf. Dudenhöffer 2015: 321). Furthermore, a connection is seen between the study results, which are mainlybased on the personal factors of an individual, and a local studyarea (e.g. Germany). The latter should thus allow conclusions to be drawn about social and/ or cultural characteristics of the local study area and allow consumers to be clustered. In particular, the country-specific comparison of purchase intentions between

2011 and 2021 suggests that the framework conditions for electromobility have changed significantly, making the need to identify findings for TAM research only logical (Cf. Dudenhöffer 2015: 322).

V. Research focus and research questions

For a heterogeneous product, a correspondingly versatile theoretical model must be used so that the complexity can be captured and resolved in the best possible way. Since a number of recent studies have shown that the Technology Acceptance Model can be used not only to explain the acceptance of information systems, but can also be applied to other areas of technology through appropriate adaptation and adjustment, the TAM provides the theoretical basis for this investigation (Cf. Fazel 2014: 103).

The actual usage behavior of the subjects will not be investigated here. A relationship between intention and behavior is assumed (Cf. Dudenhöffer 2015: 111). Therefore, intention is used as dependent variable instead of actual usage (Cf. Ajzen and Fishbein 1980: 41 and 90). Moreover, it has already been confirmed that intention to use almost fully mediates the influence of the other TAM variables. It remains to be noted that intentions do not necessarily result in behavior (Cf. Ajzen and Fishbein 1980: 188 f.).

As can be seen from Dudenhöffer's work and the current diffusion level of electric vehicles with 1.42% (Cf. Appendix 1), so far no mutliplier effect of the sales volume of electric vehicles could be caused due to a lack of acceptance among consumers (Cf. Dudenhöffer 2015: 318). However, the consumers' declarations of intent as well as the increased market supply suggest that a trend reversal in the field of electromobility can be expected in the medium term (Cf. Proff et al. 2022: 7; Mehta and Senn-Kalb 2021: 18).

Based on these considerations, we will use the example of electromobility to investigate whether the construct of interest as an independent variable increases the proportion of variance in technology acceptance that has been elucidated and can thus function as a determinant of intention to use.

Research Question 1: Does extending the TAM with the addition of the variable interest better predict intention than the non-extended model?

Hypothesis 1: Adding the variable interest as a determinant of intention to use can significantly increase the predictive power of the TAM.

Furthermore, we want to examine whether political and personal factors have an indirect influence on the intention to use and the associated variance of technology acceptance and can thus serve as an extension of the TAM model.

Research Question 2: Does adding indirectly influencing political variables to the TAM better predict intention than the non-extended model?

Hypothesis 2: Adding indirectly influencing political variables will better predict technology acceptance usage intention.

Research Question 3: Does adding indirectly influencing personal factors to the TAM better predict intention to use than the non-extended model?

Hypothesis 3: Adding indirectly influencing personal variables will better predict technology acceptance usage intention.

Other questions to be answered in this research are:

- Why do many consumers in established markets persist in their views and are slow to adopt new technologies?
- What barriers prevent a higher acceptance rate of electric vehicles?
- Does the acceptance of electric mobility correlate with the willingness to take risks and try something new?
- Are cultural differences responsible for varying levels of interest and thus acceptance?
- Do political systems influence the adaptation of electromobility?
- Do age differences / generational differences have an influence on the acceptance of electromobility?
- Are there gender-specific adaptation differences related to electromobility?
- Does income have an influence on the acceptance of electromobility?

A further research direction, which is also not considered in Fazel's model, could investigate the inertia of different societies towards the socialized standard of locomotion. In thisregard, the acceptance of electric vehicles / hydrogen vehicles in the USA, Germany and China could be investigated. Furthermore, implications for the further diffusion or serial introduction of vehicles with new propulsion technologies (BEV's, FCV's) in different markets could be derived from the findings of this investigation (Cf. Continental AG 2021: p. 4; Dudenhöffer 2015; Meffert et al. 2019: 214 ff.).

An alternative research direction would be to investigate whether different levels of acceptance of electric vehicles / hydrogen vehicles exist within a country depending on cluster affiliation. GfK panels could be used for this purpose, for example. Furthermore, implications for segmentation, targeting and positioning as well as different advertising measures for different consumer types could be determined (Cf. Aral 2020: 20; Kothe 2002: 738; Böhler 1977: 10 ff.).

VI. Research model and Methodology

The empirical investigation will be conducted within the framework of a sample study (Cf. Kromrey et al. 2016: 47). The questionnaire to be developed with associated data collection as well as the modified TAM will result in an original empirical study (Cf. Schnapp et al. 2006: 21). Since anonline survey using an online questionnaire is planned, complete randomization cannot be guaranteed and possibleconfounding factors[1] cannot be controlled (Cf. Aronson et al. 2004: 43; Stein 2014: 141). For this reason, the planned study can be described as an experimental field study (Cf. Tausendpfund, 2017: 195; Taffertshofer et al. 2009: 13 ff.). Since the present study is a cross-sectional study, measurementrepetition should be avoided (Cf. Stein 2014: 142).

The idea is that, in addition to scientific relevance, a statement for practice can also be derived. In contrast to the TRA, the assumption is pursued that the inclusion of further influencing factors increases the explanatory power of the acceptance.[2] Voluntary use is assumed, so that a distinction

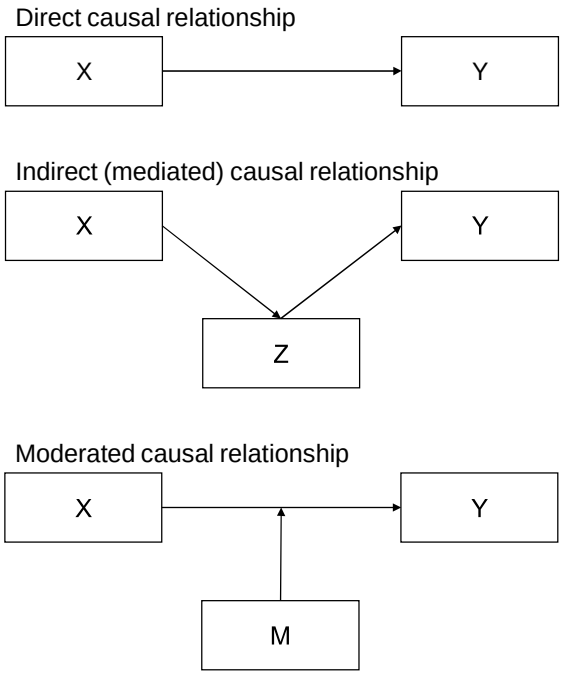
[1] During the survey, already known confounding factorscannot be eliminated. However, these can be taken into account and worked out during the interpretation ofthe results.

[2] The TRA assumes that all external variables arealready included in the "Attitudes".

between voluntary and obstructed use can be dispensed with (Cf. Dudenhöffer 2015: 109).

Three main relationships can be identified in the relations of the constructs (see the following Figure 4): direct effects, indirect effects (mediators), and moderators (influences on the relationship between two variables) (Cf. Henseler and Fassot 2010: 715):

Figure 1 Relationships between the variables



Source: Own illustration based on Henseler and Fassot 2010: 715

This model is based in part on Fazel's research model. However, it was supplemented by the construct interest. Furthermore, it differs in the derived extension of intention and its influence on the behavioral intention to purchase a BEV/HPEV, the behavioral intention to purchase an FCV or the behavioral intention to use car sharing offers. In addition, based on Kotler and Keller 2016, a clustering of the influencing factors of the TAM into motivation, perception, learning, and memory was performed (Kotler and Keller 2016:187-194). In addition, above the center of the model, the influence from trends, the market supply, and governmental requirements is examined (Kotler and Keller 2016: 31-32, 95, 105 ff.). Below the center of the model, the investigation into the influence of culture, the social environment and personal factors takes place (Kotler and Keller 2016: 179-187).

The constructs and determinants, which have not been mentioned and explained in detail so far, are taken from Fazel's research. The constructs and determinants are based on either the Theory of Reasoned Action, the Theory of Planned Behavior, or the Technology Acceptance Model, as well as Fazel's definitions (Cf. Blatter et al. 2018: 34 ff.).

As can be seen from the research model, it is assumed that ultimately all constructs have an influence on the intention to use. Constructs with a direct influence are indicated by a solid line. Whereas constructs with an indirect influence are shown with a dashed line. In addition, the variables in the oval orange-shaded boxes in the center of the model are assumed to have a moderating influence.

It can be seen that the construct of interest has a direct as well as moderating influence within the model. Furthermore, in the dark gray rectangular boxes, the basis functions of the TAM can be seen (Cf. Schnell et al. 2013: 146; Fazel 2014: 178).

For the investigation of the presented research model, the procedure of causal analysis, or structural equation modeling, will be used. Structural equation modeling provides empirical verification and validation of empirical data. For this purpose, a statement about the presumed effect relationships between several variables is derived in advance. Structural equation models belong to the multivariate analysis methods and can examine several statistical variables in parallel and structural equation models have a theory-testing (confirmatory) character (Cf. Hair 2006: 711; Backhaus et al. 2008: 334; Chin 1998: 297; Kornmeier 2009: 167). The developed model and the datato be collected can be analyzed, for example, with the statistical programs SPSS or Smart PLS (Cf. Dudenhöffer 2015: 212 ff.; Fazel 2014: 282-283).

The data basis should be an online questionnaire. This can be constructed, for example, using the program SoSci Survey and sent via a link (Cf. Schnell et al. 2013: 314). The SoSci Survey program is specifically designed for scientific surveys (Cf. Leiner 2019: n.p.). To ensure the comprehensibility of the questionnaire, a pretest with different test persons should be conducted in advance of the actual data collection and then possible improvements should be incorporated into the questionnaire (Cf. Weichbold 2014: 299 ff.). In order to achieve a high reach, the internet link should be disseminated via various social media channels such as Facebook, Twitter, Instagram, Xing, LinkedIn, as well as via e-mail and various online forums. This provides a non-probabilistic opportunity sample (Cf. Döring and Bortz 2016: 465-469). The relevant groups of people are reached by this distribution. The irrelevant usually do not use the media through which the questionnaire is to be distributed. In order to ensure that the questions are answered with a certain basic level of experience, only returns from persons aged 18 or older are to be considered for the survey. Accordingly, the sample composition in the survey period to be defined can be defined as follows (Cf. Lamnek 2010: 80):

- Survey area: Federal Republic of Germany
- Citizens
- Voluntary use
- From the age of 18
- The minimum sample size should be n>250 to achieve sufficient testing of the population (Cf. Przyborski and Wohlrab-Sahr 2014: 127).

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