Choice design as key to technology adoption

- A research agenda in the domain of electric cars -

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Abstract

Whether an innovation is adopted or rejected by a consumer depends not only on technological, economic or social factors but also on psychological attributes of the decision maker (Kleijnen et al., 2009). Furthermore, according to studies from the domain of behavioral economics, there is evidence that the design of the decision situation itself has a significant impact on the final decision as well (Thaler et al., 2013). The goal of the research proposed in this paper is to apply insights from innovation resistance theory and behavioral economics to the case of technology adoption, that is (1) to consider psychological aspects in the design of technology adoption settings and (2) to evaluate the effect such consciously designed choices have on real adoption decisions. As part of the study, several experiments will be conducted to test the influence of different choice designs on the perception and adoption of electric vehicles and to identify potential strategies for the design of decision settings that are supportive to their adoption.

Keywords: choice architecture, experimental studies, nudging, innovation resistance, sustainable technology

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1. Motivation

Electric cars are important means to mitigate climate change problems, increasing global resource shortages and reduce pollution especially in urban areas (Jochem et al. (2015), Kley et al. (2011)). In 2010, the German government announced the target of reaching one million electric cars in 2020 in Germany (Abdelkafi et al., 2013). The establishment of electric cars is of particular interest for several interest groups. First, general public whose health and life quality could be enhanced by reduced noise and air pollution in growing urban areas. The European Union captured the goal of reduced air pollution in their climate targets for 2030 (Jochem et al., 2015). To meet the targets, Germany has to reduce GHG (green house gas) emissions of passenger cars by 60 % between 1990 and 2050 which can hardly be achieved without the use of electric cars (EC (European Commission) (2011), Jochem et al. (2015)). Besides social and environmental consequences, lagging behind at electric car diffusion could undermine Germany's position as one of the most influential automotive industry nations in the world and thus lead to losing industrial power (Handelsblatt, 2016). Due to contradicting interests of reaching short-term profit targets with traditional gasoline cars Germany's car manufacturers and suppliers are trapped in striving to maintain the status quo (Sorge, 2014) while in the meantime international car manufacturers and new players from the IT sector establish their global production facilities (Geiger, 2015). As a result, the global rise of electric cars may lead to dramatic shifts in industrial power structures and drives risk for national automakers and suppliers to face the threat of falling back because of missing innovative alternatives for their core businesses (Schipper, 2015). The more it is important to get consumers interested and demand the technology to provide an intrinsic motivation for automakers to invest in the technology of electric cars.

The remainder of the paper proceeds as follows: Section 2 provides related work from relevant domains. Section 3 introduces the research problem and the hypothesis of the study. Section 4 explains the underlying research questions and methodology. Section 5 completes the paper with a conclusion and discussion of the topic.

2. Related Work

The question of what determines the adoption of an innovation has a long history in research (Venkatesh et al., 2007). Also the adoption of electric cars in particular and considerations how it could be enhanced and predicted has been subject of many scientific and corporate research studies since the early 80s of the last century (e.g. Calfee (1985), Beggs et al. (1981)). Since then a lot of research has been done to understand which premises have to be fulfilled that individuals use or buy electric cars and how fast markets would develop as a consequence. The following section gives a short insight into the state of knowledge relevant for the planned research.

2.1. Adoption of electric cars

The majority of research on this topic bases its results on empirical findings made in surveys or interviews (Rezvani et al., 2015). Most of these studies focus on the identification of adoption factors and barriers in order to derive strategies how these requirements could be addressed best (e.g. Fazel (2013), Egbue and Long (2012), Lane and Potter (2007)). According to Rezvani et al. (2015) there are four groups of adoption factors identified in existing literature: (1) technical factors, (2) contextual factors, (3) cost factors and (4) individual and social factors. **Technical factors** are all issues concerning the vehicle like e.g. its driving range, emissions and environmental impacts, performance, safety but also its ease of use (e.g Moons and De Pelsmacker (2012), Lane and Potter (2007)).**Contextual factors** comprise all external (governmental, industrial) aspects whose availability is relevant for the willingness to purchase and use electric cars, that is e.g. the availability of (public) charging infrastructure, governmental incentives like tax reliefs or buyers premium (e.g. Egbue and Long (2012), Lane and Potter (2007)). In Germany, governmental incentives like a buyers premium are still hypothetical means and their actual effects thus remain unclear. Several studies try to analyze and predict the (long-term) effects of fiscal incentive mechanisms (e.g. Lieven (2015), Sierzchula et al. (2014), Shepherd et al. (2012)). Fiscal incentives are not planned to be part of this research as the study focus lies on the question of how the setting of the (experimental) adoption decision should be designed and what effect is caused hereby and not how governmental incentives itself should be designed to be most effective. That is why theory on this topic is not elaborated in further detail in this paper. In

Rezvani et al. (2015) purchase cost, running cost and (saving) fuel cost are considered as **cost factors** (based on e.g. Schuitema et al. (2013), Egbue and Long (2012), Lane and Potter (2007)). Aspects concerning the adopting person and societal influencers as a whole are considered in the fourth group as **individual and social factors**. Studies on these aspects are of particular interest for this study since they comprise valuable investigations on the personality of early electric car adopter or the role of emotions and psychological barriers for the adoption of electric cars (e.g. Steinhilber et al. (2013), Moons and De Pelsmacker (2012), Franke et al. (2012)). Furthermore, several of these works already use established adoption models like the Theory of planned behavior (TPB) (Fazel (2013), Moons and De Pelsmacker (2012), Egbue and Long (2012), Lane and Potter (2007)) or theoretical constructs from economic decision theory like the Rational choice theory (Lane and Potter, 2007) as theoretical foundation. Most promising studies for this research are (Franke et al., 2012) and (Moons and De Pelsmacker, 2012). In their study, Franke et al. (2012) focus on driving range as major psychological barrier for the acceptance of electric cars. Based on an empirical study they examine the individual perception of a comfortable driving range and its antecedents (e.g. personality traits, coping skills). In contrast, Moons and De Pelsmacker (2012) integrate emotions towards car driving and electric cars into the Theory of Planned Behavior (TPB). Theoretical contribution is the investigation of emotions in the usage intention decision process of new and more sustainable consumer products and differences in motivations to use these new products. Result is that emotions and attitude are the strongest predictors of usage intention, followed by subjective norm. Reflective emotions towards car driving and perceived behavioural control factors are also important antecedents.

2.2. Innovation resistance theory

As innovations, new technologies usually impose some form of change for the consumer (Kleijnen et al. (2009), Bagozzi and Lee (1999), Ram (1987), Sheth (1981)). However, *"the typical human tendency is to strive for consistency and status quo rather than to continuously search for, and embrace new behaviors"* (Sheth (1981), p.275). Because of this tendency, consumers usually seek for psychological equilibrium (Osgood and Tannenbaum, 1955) and anything which endangers the status quo is likely to evoke initial resistance (Ram and Sheth (1989), Rogers (1976)). The stronger the habit which

is challenged by the innovation, the stronger the resistance of the consumer (Sheth, 1981). As such, resistance is a natural part of the adoption process: only when the initial resistance of the consumer has been overcome, adoption takes place (Sheth, 1981). However, according to Rogers (1976), traditional innovation and adoption research suffers from a so-called "pro-change bias", i.e. assumes customers to be always open to change and eager to instantly use innovations. The theory of innovation resistance strives to close this gap by studying antecedents and barriers to the adoption of innovations with the goal of being able to understand the psychological processes behind consumer resistance (Kleijnen et al. (2009), Bagozzi and Lee (1999)). So far, there is evidence to suggest that resistance is a product of internal processes and external innovation-related barriers. Internal processes comprise the individual inclination to resist changes, i.e. the attitude towards change in general (Heidenreich and Handrich (2014), Kleijnen et al. (2009)) and the inherent human tendency to maintain the status quo, i.e. to misperceive expected changes due to loss aversion (Kahneman and Tversky, 1979). Innovation-related barriers comprise functional concerns about usage, value and risk issues while psychological barriers reflect concerns regarding the image of the innovation and its compliance with existing traditions of the consumer (Ram and Sheth, 1989). An understanding of the decision making of technology adoption therefore requires an understanding of the resistance provoked by the technology.

2.3. Choice architecture

The theory of choice architecture states that the way a choice is presented to the decision maker already influences the decision he takes (Johnson et al., 2012). Initially introduced by Leonard (2008) the term "choice architecture", also labelled as "nudging", has gained increasing and controversial interest in science and public (Selinger and Whyte, 2011). The concept of libertarian paternalism understands humans as mostly irrational decision makers who often vote for options which are, rationally considered, not the best choice for them. To help them to make better decisions, choices are designed in a way that decision makers are more likely to vote for options they would also chose when deciding on a completely rational basis (Thaler et al. (2013), Goldstein et al. (2008)). Especially in the context of environmental consciousness and sustainable behavior, choice architecture has been established as promising

tool to affect irrational decision making (Mont et al. (2014), Bothos et al. (2014)).

3. Research Problem

According to Steinhilber et al. (2013) the transition to low carbon transport requires a "new notion of mobility" (p.532) and thus challenges long established mobility routines and habits. This inevitably provokes consumer resistance. A widespread market success of electric cars is still absent although electric cars are in general honored by consumers (Bühler et al., 2014). Empirical studies identify three main concerns regarding the adoption of electric cars that explain the gap: these are (1) perceived limited range, (2) high costs and (3) limited charging infrastructure (Steinhilber et al. (2013),Egbue and Long (2012)). While high initial costs are still an actual problem for widespread electric car adoption, major barriers like perceived range anxiety and the associated fear of limited public charging infrastructure has been proven to be mainly a psychological concern (Franke et al., 2012). As a result, even in rental and carsharing settings where usage costs are almost equal compared to costs for using traditional gasoline cars consumers tend to back off from chosing electric cars in anticipation of perceived limitations in driving experience even if their desired driving range would be fully covered by the range of the car (Holzer, 2015). The resulting research problem can be formulated as followed:

> **Research Problem:**
> *The transition to electric cars leads to a significant change in mobility behaviour and thus provokes consumer resistance. One of the major barriers for electric car usage is their perception. Electric cars are perceived to fall short of consumer expectations in regard of range and convenience. Even in settings where costs correspond with gasoline cars it can be observed that customers back off from chosing electric cars due to range anxiety.*

A significant part of consumer resistance against electric cars is based on perceptual misconceptions. Electric cars are perceived as inferior choices in comparison to traditional gasoline and diesel drive cars. This perception changes with the usage of electric cars. As soon as consumers actually drive

and experience electric cars, their perception of range anxiety changes significantly towards a positive attitude (Bühler et al., 2014). This leads to the conclusion that in specific settings electric car adoption could be enhanced by supporting consumers to overcome their so far irrationally biased perception of electric cars.The resulting hypothesis for the study can then be formulated as followed:

> **Working Hypothesis:**
> *Electric car adoption can be enhanced by supporting consumers to overcome their biased perception of electric cars . Due to the nature of human decision making and based on insights from choice architecture theory it is assumed that such support can be realized through a conscious design of the adoption setting. Supportive electric car choice design may thus have a positive impact on the selection of electric cars over conventional car alternatives which will in turn enhance adoption probability.*

The adoption of electric cars has not been studied from the perspective of behavioral theory and economics so far and therefore lacks a deeper understanding of and ways to address psychological factors in adoption decisions. This study aims to bridge this gap.

4. Research Approach

In order to understand and control influencing variables in electric car adoption decisions, experimental studies are chosen because of their explanatory strength: nonexperimental research techniques such as interviews, case studies or surveys are "limited to statements about description and correlation" while "experiments permit statements about causation" (Kantowitz et al. (2005), p.52). During the experiments, individual choice behavior will be observed, e.g. by the use of eye tracking. An important part in experimental decision studies is the measurement of emotion since human decisions are strongly influenced by emotions (Coricelli et al., 2007). To understand and shape consumer perception, it is necessary to also measure cognitive and emotional arousals during the experimental selection process. According to Myers (2004), emotions manifest in behavior but also in psychophysiological data collected by biosensor technology. In this research it is planned to use biosensor technology like electrocardiograms and electrodermal measurement

in order to identify and understand unconscious and emotional factors such as anxiety, stress, effort or arousal in the adoption process. Based on this knowledge, choices can be designed in a way that e.g. negative emotions are better compensated and perceived biases towards the technology of electric cars can be alleviated.

5. Conclusion and Research Contribution

The research proposed in this paper aims to consider psychological aspects and insights from innovation resistance theory and behavioral economics in the design of technology adoption choices. This will be achieved by conducting experimental lab studies to test the influence of different choice designs on the perception and adoption of electric cars. The intended research contributes in several aspects to the body of knowledge. First, the study of experimental decision making allows a deeper and more realistic understanding of how technology adoption decisions are made by individuals. So far, theoretical contributions to this area are mainly built upon empirical studies which assess the intention or willingness to adopt a technology (in case of electric cars: e.g. Fazel (2013), Moons and De Pelsmacker (2012), Egbue and Long (2012)). Moons and De Pelsmacker (2012) themselves state the so-called "intention-behavior linkage" as main limitation of their work and emphasize that *"behavioural intentions do not evidently translate into objectively measured buying behaviour"* (p.220). Besides the intention shortcoming, one of the main weaknesses of existing technology adoption models such as TAM are the limited consideration of emotions (Bagozzi, 2007). The proposed research will address both issues by providing behavioral observations of actual adoption decisions and measurements of occurring emotions in this context and thus contributes to the theory of technology adoption in multiple areas of interest. The second contribution will be made by studying the role of emotions and resistance behaviour during the experience of applied choice architecture ("nudging") which has been considered little in existing studies on this topic so far (Bothos et al., 2014). Insights on this issue may offer valuable starting points for further studies in innovation resistance theory, adoption of electric car research and applied behavioral economics.

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