Perception of Electric Vehicles Examined by User Experience and Marketing Concepts

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Abstract

The electrification of our streets can contribute to less greenhouse gas emissions as electric vehicles (EVs) are more efficient than traditional cars and electricity can be produced from renewable sources. Although EVs meet most drivers' mobility needs, their market share is small. By looking at EVs through the lens of psychological theories the user perception is analysed regarding utilitarian, hedonic and symbolic attributes as well as basic needs and user experience concepts. This helps to understand user perception and perceived problems with EVs as well as addressing perceived problems in vehicle design from a users perspective. While EVs meet user needs in theory by utilitarian aspects, there is a lack of hedonic and symbolic values for some drivers in many EVs. The Tesla Model S, representing a new generation of EVs, is discussed regarding these topics. The psychological perspective can help to contribute to the improvement of EVs and presumably to a better user perception. The literature on these topics is reviewed and it's up-to-dateness discussed.

Keywords: electric vehicles; utilitarian, hedonic and symbolic attributes; needs; user experience; Tesla Model S

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Cars play an important role in many people's daily lives as they are used to commute to work, run errands, drive around for pleasure and to travel. They also strongly contribute to greenhouse gas emission as they run almost entirely on fossil fuels such as petroleum or diesel. One way of reducing that impact is the transition to cars that use less to no non-renewable energy such as electric vehicles (EVs). "In terms of environmental impact, for the average EU electricity mix, BEVs [Battery Electric Vehicles] have less than a half of the emissions than an ICEV [Internal Combustion Engine Vehicle]." (Faria, Moura, Delgado, & De Almeida, 2012, p. 19). While the idea of propelling cars with electricity is, in principle, as old as the history of cars in general, ICEVs have dominated the market for over a decade now. During the last few years however, electric cars have become a more present topic again. Regarding the recent developmental advances in EVs and many car manufacturers having one or more EV models on the market or in development, this paper looks at the perception of EVs in general, perceived problems with electric cars and tries to make sense of them by examining in the light of psychological concepts on cars as well as providing potential approaches to enhance user perception. Starting with a brief review of the available literature on the general perception of EVs, the perceived advantages and especially disadvantages of EVs are then identified. Furthermore, user experience concepts as well as marketing concepts are introduced in the theoretical part of this paper. These include the focus on the users experience of the car in terms of satisfying basic needs and differentiating between experiences by driving versus experiences beyond driving and by categorizing the cars benefits as being of utilitarian, hedonic or symbolic value to the user and how these attributes have influence on the customers satisfaction and delight. Can these theories explain, why EVs often are not considered an attractive alternative? These perspectives provide the methodological basis upon which the further discussion of the specific problems

with EVs is build. Each problematic aspect of EVs is reviewed and discussed. What can these concepts provide to explain why certain aspects of EVs may be perceived as problematic and how could these explanations improve the ability of car manufacturers to address some of the main problems with the users perspective in mind? As an example for an electric vehicle that in many aspects is superior to other EVs on the market, including utilitarian as well as hedonic qualities, the Tesla Model S is discussed. The Model S has an answer to many of the problematic attributes typically seen in EVs. What distinguishes this model from others and which features are beneficial for the attractive package? These questions are discussed towards the end of this work and provide an example to further discuss the previously elaborated problems and possible solutions. This paper discusses what psychological perspectives could contribute to the electrification of the streets with a focus on the car itself. Government regulations, taxes, incentives and campaigns to change driving behaviour are beyond the scope of this thesis. Focusing on the car first, in the next section, the perception of EVs is evaluated and perceived problems with EVs are elaborated.

Perception of Electric Vehicles

This section provides an impression of the general acceptance of electric vehicles and their perception among potential EV drivers as well as pointing out some of the main perceived problems with EVs. Krause, Carley, Lane, and Graham (2013) carried out a survey among the general public in U.S. cities to compare the perception of electric vehicles and their advantages over other vehicles on the market and calculations of fuel and maintenance costs. They found that generally, people are underestimating electric vehicles' more favourable attributes such as fuel cost savings and savings in maintenance cost while somewhat underestimating less favourable attributes like purchase price premiums over similar ICEVs as well. In a European study carried out in the United Kingdom among a well educated sample, Skippon and Garwood (2011) found that consumers understand the

environmental benefits of BEVs and are aware of the higher purchase investment as well as the lower running costs.

When focusing on perceived problems with electric vehicles, some attributes are named quite persistently. Despite recent developmental advances in battery technology, batteries are still the main limiting technical factor in electric vehicles' attributes as they influence driving range, charging time, purchase cost, kerb weight and performance. However, driving ranges of modern electric vehicles meet most people's transportation needs and can therefore be seen as a technical and psychological challenge in perceiving EVs as a suitable option (Franke, Neumann, Bühler, Cocron, & Krems, 2012). This will be discussed in more detail in the following sections.

For a North American technical university population Egbue and Long (2012) found the main concerns about EVs to be battery range, cost and charging infrastructure. Further, they assessed ratings on EV attributes where looks/style and comfort were among the least appealing attributes of EVs. Hidrue, Parsons, Kempton, and Gardner (2011) similarly found that "range anxiety, long charging time, and high purchase price remain consumers' main concerns about electric vehicles." (p. 704) As these attributes are found persistently among the literature to be the main problems people perceive with EVs, this work will focus on driving range, charging and looks/style to further elaborate on by applying the concepts introduced in the following.

User Experience (UX) and Experience of Cars

"The term 'user experience' is associated with a wide variety of meanings (Forlizzi & Battarbee, 2004), ranging from traditional usability to beauty, hedonic, affective or experiential aspects of technology use." (Hassenzahl & Tractinsky, 2006, p. 91) In their paper 'User experience – a research agenda', Hassenzahl and Tractinsky (2006) discuss three major

threads in User Experience: ‘beyond the instrumental’, ‘emotions and affect’ and ‘the experiential’.

‘Beyond the instrumental’ refers to qualities beyond the task-goal related such as aesthetics, surprise, diversion, intimacy and hedonic aspects. In their section ‘Emotions and affect’ Hassenzahl and Tractinsky (2006) name research related to affective states as antecedents of product use, emotions during the interaction with a product and resulting emotions and affects after its use. Further, the authors divide ‘the experiential’ into a situational and a temporal component. A product, which is in a specific state, is used in a specific context for a specific period of time with a defined beginning and end. (Hassenzahl & Tractinsky, 2006) See also Figure 1. But, “none of these perspectives fully captures UX. UX is about technology that fulfils more than just instrumental needs in a way that acknowledges its use as a subjective, situated, complex and dynamic encounter. UX is a consequence of a user’s internal state (predispositions, expectations, needs, motivation, mood, etc.), the characteristics of the designed system (e.g. complexity, purpose, usability, functionality, etc.) and the context (or the environment) within which the interaction occurs (e.g. organisational/social setting, meaningfulness of the activity, voluntariness of use, etc.).” (Hassenzahl & Tractinsky, 2006, p. 95)

Bargas-Avila and Hornbæk (2011) reviewed a wide range of empirical studies on UX and describe the general topics discussed in empirical research on UX to include the following. First, it is stressed that UX is considered to take a holistic view on the user-product interaction by many studies. Second, the authors show that UX focuses on positive aspects of the user-product interaction particularly including hedonic, non-instrumental aspects that lead to a positive experience while interacting with a product. “For many researchers, the emphasis on positive aspects of UX leads to a focus on human values and needs (Hassenzahl, Diefenbach, & Göritz, 2010), because they ultimately determine why

something is positive to users." (Bargas-Avila & Hornbæk, 2011, p. 2690) The focus on needs also provides part of the guideline along which the following discussion of electric vehicles' attributes is formed.

Although not particularly broadly, user experience concepts have been previously used to look at cars from a user-product-interaction perspective (e.g. Eckoldt, Hassenzahl, Laschke, & Knobel, 2013; Knobel, 2013). A car's experience may include the experience by mere driving as well as experiences beyond driving, i.e. experiences from interactions with the car that do not serve the driving task. (Knobel, 2013) Traditionally, car manufacturers seem to primarily focus on the driving experience itself, however, "the act of driving itself need not be the only source for positive automotive experiences" (Knobel, 2013, p. 5). Arguably, as driver-supporting systems take over more and more driving-tasks and the development of autonomous driving has advanced to partially autonomous driving in production vehicles, expanding to new sources of positive experiences while driving should increasingly include experiences beyond driving (Knobel, 2013). In his work Knobel (2013) differentiates between 'experiences on group drives for pleasure' and 'experiences while commuting alone' and proposes several approaches to design experiences for these driving scenarios. Next, the application of UX on cars with a focus on needs is introduced.

Needs

Psychological needs can be seen as basic experiences that make people happy/satisfied (Sheldon, Elliot, Kim, & Kasser, 2001). According to Sheldon et al. (2001) autonomy, competence, relatedness and self-esteem, as well as in times of privation maybe security, can be identified as the most common needs. A definition for each term is given in Table 1. Eckoldt, Hassenzahl, Laschke, and Knobel (2013) have described examples of in-car experience design based on some of these needs. They primarily focus on in-car systems as they illustrate examples for interactive systems in the car specifically meant to serve one of

these basic needs. While the authors make their point by illustrating the idea of designing features specifically meant to promote a positive experience, these needs may also be used as a structure to look at a car's whole experience package, as it is done in this paper, rather than only serving as inspirations for specific in-car features.

Utilitarian, hedonic and symbolic values

Another perspective, both different and related to the user experience concept, is offered by marketing theories, which include the following classification of product values: benefits of a product can be classified as having utilitarian, hedonic or symbolic value. Utilitarian benefits include functional, instrumental and practical values. Hedonic benefits are a sum of aesthetic, experiential and joy-related benefits (Chitturi, Raghunathan, & Mahajan, 2007, 2008). While utilitarian values seem to be related to usability (they are useful to achieve the task), hedonic qualities are part of the user experience concept (they provide positive experiences). However, these values are not independent in their effect. This is, as Schuitema, Anable, Skippon, and Kinnear (2013) showed, relevant for EV-attributes. They found instrumental/utilitarian values to be important largely because of their effect on hedonic and symbolic values.

It could be shown that people choose an option/product that meets utilitarian needs over one that does not, the so-called principle of precedence (Berry, 1994, p. 199; Chitturi et al., 2007). If utilitarian and hedonic cut-offs are both met however, people tend to choose the hedonically superior product over the inferior one, this is referred to as the principle of hedonic dominance (Chitturi et al., 2007). Chitturi et al. (2008) evaluated the post-purchase effects of utilitarian and hedonic benefits on satisfaction, delight, word of mouth, and repurchase intentions to assess customer loyalty. They could show, that meeting or exceeding people's utilitarian goals leads to satisfaction while meeting or exceeding hedonic goals leads to customer delight. Finally, delighting customers, other than simply satisfying them, leads to

higher word of mouth and enhances repurchase intentions and therefore is associated with higher loyalty (Chitturi et al., 2008).

The multidimensional view of a product's qualities also includes aesthetic and symbolic values (Bargas-Avila & Hornbæk, 2011). Also, symbolic values are seen as an important type of value associated with material possessions and car use (Dittmar, 1992; Steg, 2005). "The symbolic values refer to the identity of a person. They are twofold: the expression of the self and a social–categorical expression indicating one's social position or group membership." (Steg, 2005, p. 149) In a study about car use, Steg (2005) could show that symbolic and affective motives are indeed relevant for car use, in some cases even more so than instrumental ones.

In this section, user experience as a concept, its previous applications to cars using basic needs as a structure as well as utilitarian, hedonic and symbolic values and their relevance for products were introduced. In the following section, the introduced theoretical constructs are used to analyse the perceived attributes and problems of EVs.

Theory applied

In this section, the effects of utilitarian, hedonic and symbolic attributes of EVs are elaborated and the perception of EVs and perceived problems with EVs are discussed by looking at what their impacts on the user experience are.

Utilitarian, hedonic and symbolic values

Perceived attributes of EVs and perceived disadvantages can be distinguished as being utilitarian, hedonic or symbolic attributes. Fuel cost savings, savings in maintenance cost, purchase price premiums, limited driving range, longer charging/refuelling time and different charging infrastructure can be classified as utilitarian attributes of EVs. Less attractive looks and style as well as lower levels of comfort may be seen as hedonic attributes of EVs as well as influencing attributes to symbolic values. Environmental benefits are, from

the individual's perspective, most likely to be seen as symbolic values of EVs. While this distinction makes sense, there is also an overlap or interplay between these attributes, see also Schuitema et al., (2013).

Utilitarian values

Although by looking at the literature concerning transportation habits one could conclude that current EVs offer sufficient capabilities of utilitarian nature, Schuitema et al. (2013) suggest that "instrumental attributes are important for the intention to adopt EVs because they influence emotional responses to EVs (hedonic function) and are used to form and express an identity (symbolic function)" (Schuitema et al., 2013, p. 47). Hence, utilitarian attributes have influence less in a direct manner but largely by promoting hedonic and symbolic values. (Schuitema et al., 2013) This may also to be taken into consideration when thinking about the individual EV attributes in the light of UX concepts as also in UX the functionality/usability of a product has its influence on positive experiences with it.

Hedonic values

According to the literature (e.g. Egbue & Long, 2012), EVs are not perceived to have high hedonic values. While the most obvious utilitarian goals of customers in terms of transportation are mostly met by EVs as well as by ICVs (Franke et al., 2012), EVs are not bought by most customers. Rather than hedonic values, EVs mostly have utilitarian values like no use of petroleum and therefore decreased running costs and reduced greenhouse gas emissions (which can also be seen as a symbolic value) in favour of them. However, since the principle of precedence (Berry, 1994) should no longer be of importance after utilitarian goals are met, the principle of hedonic dominance (Chitturi et al., 2007) suggests the hedonically superior product to be more attractive to the customer. If utilitarian benefits that

EVs offer compared to ICVs are not relevant to the customer, in this scenario, the hedonically superior ICVs have an advantage over EVs. Therefore, it seems be of great importance to maximise EVs' hedonic qualities and to market them accordingly in order to convince customers.

Symbolic values

Skippon and Garwood (2011) found that EVs signal the owner/driver to be high in conscientiousness, openness and agreeableness. This adds symbolic value to EVs that is likely to be attractive to some buyers but could as well be a drawback for others. Further, since a lot of EVs are small cars "they may be perceived by higher income drivers as not providing adequate signals of their wealth, status and social dominance" (Skippon & Garwood, 2011, p. 530).

User Experience and Needs

The perception of electrical vehicles is likely to be influenced by the user experience of the cars. There are surely opportunities to improve the user experience with electric cars and this could add significantly to a better perception of EVs and a reduction of problems being associated with them. Due to the technical differences between ICVs and EVs and the resulting differences in important aspects of their use, there may be new challenges for the EV experience designers regarding the user interface of the car as well as aspects like the charging-procedure and car-features that where not possible in ICVs. Experiences beyond driving might add an important contribution to EVs hedonic and symbolic qualities. For example "Easter eggs" (i.e. hidden games/features in an operating system or application) like in the Tesla Model S that change the vehicle presentation on the displays to a James Bond car or calling the fastest accelerating mode "ludicrous" instead of "sport" may add to hedonic experiences beyond driving.

When looking at the most common basic needs (Sheldon et al., 2001), some of the perceived disadvantages of electric vehicles can be assigned possible reasons. Further, with having the users needs in mind, these problems might be addressed more in a more goal-oriented fashion. In the following, the perceived attributes of EVs are discussed with a focus on their relevance for the user experience and especially basic needs fulfilment is used to reason about perceived problems.

Driving Range

Limited driving range, being one of the main concerns about EVs, may decrease the sensation of autonomy as well as maybe security and self-esteem. Conventional vehicles typically offer a range of 500 to 800 kilometres (or 300 to 500 miles) on one tank of fuel or a nearly unlimited range, as there is the possibility to fill up the tank quickly at a gas station. For conventional mid-price electric vehicles (e.g. Nissan Leaf, Volkswagen e-Golf), a NEDC (New European Driving Cycle) driving range of 150 to 250 km (or 90 to 150 miles) is more typical ("eGolf", 2016; "Nissan Leaf", 2015). High-end electric vehicles like the Tesla Model S 90D offer a NEDC range of up to 530 km (or 330 miles) on a single charge ("Model S", 2016). EVs are perceived to have a limited driving range based on the technical range that can be achieved on one charge but likely also because of the limitations in possibilities for recharging on the go. As for example Pearre, Kempton, Guensler, and Elango (2011) showed, most peoples driving needs are met by even the average mid-price EVs driving range on most days of the year. Only few people would have to make adoptions to their driving habits on more than a couple of days a year. Thus, like Franke et al. (2012) discussed, "range anxiety" (i.e. the "fear of becoming stranded"; Tate, Harpster, & Savagian, 2008, p. 158) seems to be mainly a psychological, rather than a technical, barrier to the adoption of electric vehicles. If EVs pose a source of uncertainty about mobility abilities and therefore decrease security and

autonomy, they conflict with established car-attributed qualities. This is an issue that should be, and partially already is, addressed by researchers and car manufacturers.

As Franke et al. (2012) found, the experience of range can vary across different drivers. However, it seems to be an omnipresent topic considering the interaction with electric vehicles. Since Franke et al. (2012) found the "comfortable range" (i.e. the portion of the remaining objective range that people are comfortable with using) to differ from the possible range that could be achieved with the energy stored in the battery, there could be use for an individualized car-driver communication to enable each driver to develop an optimal experience regarding this topic. As some manufacturers already do, it might be helpful to integrate the increasing number of charging points into the cars navigation software and trip planning to enhance the driving experience with EVs.

Charging

Refuelling or charging is arguably the most significant change in utilizing EVs compared to ICVs. While ICVs can be refuelled with petrol or diesel at any one of an omnipresent network of service stations, EVs can be charged of the grid. Most populated areas of the world are provided with electricity from the grid, however, intended opportunities to charge vehicles of it are rare compared to service stations for ICVs. In addition to limited charging opportunities, the process itself takes longer in EVs than in ICVs. Charging car batteries typically can take from half an hour up to 12 or more hours for one charge, depending on the charging infrastructure (amperage, voltage) and size and type of the battery. In most cases in the literature, charging the car overnight at home is assumed the only scenario (e.g. Pearre et al., 2011). This leads to the assumption of the daily driving range being limited to the distance that can be driven with the amount of electricity the battery can store. If this assumption where to be true, the feeling of autonomy could be

reduced not only by a limited driving range but also by the necessity to get back to the domestic charger every night. However, in recent years, companies like Tesla Motors have started to establish a network of charging facilities across the United States, Europe and the Asia-Pacific area that allow vehicles to be charged quickly ("Supercharger", 2016). In the case of Tesla Motors, their "Superchargers" offer customers to charge their Tesla vehicles at high speeds and free of charge allowing for a usable on the way refuelling. Charging point networks like the Tesla Superchargers could change the assumption of only being able to charge over night at home and therefore increase the autonomy of EV drivers. When different EV drivers meet at such charging-locations, they could also serve as a source of relatedness experiences. This development being quite new, it is not yet reflected in the literature and needs empirical attention in the future.

Looks/Style and Comfort

The perception of EVs having bad looks/style and offering low levels of comfort (Egbue & Long, 2012) can be seen as a UX problem. If EVs are perceived as having low style and bad looks, this might be linked to bad influences on self-esteem among people considering buying an EV and surely does not help promoting a positive experience by enhancing the hedonic value through aesthetics. Due to the development in recent years however, this aspect might need a re-evaluation. Regarding the looks/style of EVs there are some vehicles on the market now that do not differ from the same model with internal combustion engines (e.g. Volkswagen e-Golf), others are designed from ground up as EV-models like the Tesla Model S and Model X and offer mature looks. These models, arguably, can no longer be distinguished from ICVs in terms of looks and style. Although, also among the most recent EVs there are still some models with dissenting looks that might not attract customers in search of a stylish car. The perception of EVs' level of comfort not being a

particularly appealing attribute of EVs (Egbue & Long, 2012) could have multiple reasons. There could be a stereotypical image of EVs influenced by golf carts, electrified wheelchairs and the like that do not offer the comfort attributes of a conventional car. Further, since a lot of EVs where and some still are small cars, this may also influence the perception of EVs not being particularly comfortable. With new full-size luxury models on the market like the Tesla Model S however, this aspect might be perceived differently in 2016 and needs re-evaluation. Nevertheless, the stereotype could also stay persistent for a while despite new models. However, Tesla Motors for many has the role of a game changer regarding the electric vehicle marked and is discussed in the following with a special attention to the previously elaborated perceived problems with EVs.

How about Tesla Motors?

The company founded in 2003 in California introduced the Tesla Roadster to the market in 2008, a sports car based on a Lotus platform with a high capacity battery and fast acceleration. In 2012 the Model S was launched, a large sports-sedan developed by Tesla Motors as an electric vehicle from the ground up. In 2015, Tesla Motors started the production of the Model X, an SUV with similar battery and drivetrain as the Model S. Most recently, Tesla announced a 35’000 dollar mid-size sedan, which is planed to be on the road by the end of 2017, and to be produced in larger quantities. (“About”, 2016) Despite its price starting at just under CHF 80’000 (including taxes in Switzerland; “Design Model S”, 2016) the Model S was sold over 107’000 times worldwide by February 2016 (Tesla Motors Inc, 2016) and has attracted a lot of attention. It is Tesla Motors that, to the authors knowledge, first sold mass-produced electric vehicles in the high price segment with luxury car attributes such as high performance, panoramic sunroof, leather seats and air-suspension. The success of this car manufacturer could be linked to numerous aspects named in this paper; some examples are discussed in this section.

Tesla's combination of a driving range of up to over 500 km on one charge that the Model S provides and the Tesla network of "Supercharger" charging points with free and fast charging strongly addresses the range problem people perceive with EVs. Both the impressive range and the charging network are likely to promote the important satisfaction of the need for autonomy by allowing for long distance travelling. Further, these aspects might also have an influence on the feeling of security, self-esteem and competence by providing the driver with similar options for travelling as drivers of ICVs have. Apart from this rather utilitarian aspect that Tesla addressed, there are many hedonic and symbolic aspects in favour of for example the Model S.

The Model S is sold in specifications with over 500 horsepower and has, as is characteristical for EVs, a lot of torque at any speed. This instrumental attribute likely speaks for itself but is also linked to hedonic as well as symbolic values. (see Schuitema et al., 2013) With power of this magnitude, delighting experiences of acceleration are offered at the driver's tap on the accelerator. While many may enjoy it, hardly anyone needs a 0 to 100 km/h acceleration in 3 seconds. Besides this hedonic quality, it might also have symbolic value and promote the satisfaction of the need for competence as well as contribute to a good user experience by delighting the driver.

Premium car attributes like leather seats, air-suspension, a panoramic sunroof and a hi-fi sound system all add to the cars comfort and its hedonic value. Also the general styling of the car is comparable to other premium vehicles and offers high aesthetic values. The Model S being a full-sized sedan, besides offering a lot of interior space, is likely to offer different symbolic values compared to the typical small EV. One can assume that it offers sufficient demonstration of status, wealth and social dominance to higher income drivers (see also Skippon & Garwood, 2011) while still offering the values associated with a "green" car

and with EVs signalling the owner to be high in conscientiousness, openness and agreeableness (Skippon & Garwood, 2011).

The Model S and Model X offer a large touchscreen in the centre console of the car that is used to control most of the cars features and to display information about the car, navigation, media etc. A screen to dynamically show the driver information about the cars status also substitutes the instrument panel. This reliance on digital interfaces was new in the car industry at the time the Model S was presented and still sets Teslas apart from other vehicles. While this interface concept itself likely to please the more technologically interested drivers, it also enables the user interface to change dynamically. Teslas are connected to the internet over an integrated cellular data connection and receive over-the-air (OTA) updates to their software.

OTA-updates to the software have, to the authors knowledge, first been used by Tesla Motors to update a cars driving functionality and user interface. The updates work, at least from the end-users perspective, similar to software updates on a smartphone. Updates delivered over the air to the Model S have tweaked the performance to make the car accelerate faster and recently enabled a partially autonomous driving mode called “autopilot” to accelerate, break, steer and switch lanes automatically as well as a new feature called “summon” to let the car park itself and drive in slow speeds without a driver in the car. (“Blog”, 2016) Updates like these, which add new features beyond minor updates to navigation maps and the like might offer a new source of delight and hedonic experiences beyond driving to users even after they have settled in with the car. When looking at Chitturi et al. (2008), this could lead to greater customer loyalty.

Unique features like the “autopilot” and “summon” arguably offer limited pure utilitarian value, Easter eggs and similar features none at all. Instead, these features promote hedonic experiences and add to the symbolic value of Teslas being advanced and in many

ways the superior cars. As concluded by Egbue and Long (2012), technology enthusiasts are likely to be early adopters of EVs, that is, if they perceive EVs to be superior in performance to ICVs. These features that enable positive experiences with the car beyond driving are likely to add to just that perception.

While traditionally EV-marketing has focused on the "greenness" of the car, Tesla Motors mainly advertises their cars as being superior in performance and features speaking directly of hedonic and symbolic experiences one could buy. These are of course also linked to instrumental attributes like the size of the battery and motors. In Tesla's communication, not necessarily using fossil energy to have all of that seems more like a bonus point.

As the previously named attributes show, Tesla in many areas has answers to points perceived problematic with EVs. Problems like driving range, charging and lower hedonic values are all addressed. With over 100'000 Model S sold, the Model S having won several awards by car magazines and more than 325'000 pre-orders just one week after the presentation of the more affordable Model 3, Tesla's strategy seems to work.

Discussion

User experience and the perspective of utilitarian, hedonic and symbolic values are useful to reason about problems perceived with electric vehicles. For many of these EV attributes, possible reasons could be assigned. A focus on enhancing hedonic qualities of EVs is likely to lead to greater success of EVs. While utilitarian values individually should not make a difference to consumer choice because most drivers mobility needs are met by even the average EV (Chitturi et al., 2007; Pearre et al., 2011), they have their influence on hedonic as well as symbolic values (hedonic/symbolic function; Schuitema et al., 2013) and therefore still are important. This is consistent with the findings by Franke et al. (2012) of "range anxiety" mainly being a psychological barrier while this does not mean that the technical premises are to be neglected. Beyond the technical progress, solutions like the Tesla

Supercharger network could significantly improve the fulfilment of basic needs like in this case autonomy and therefore the overall user experience of electrical vehicles. Further, positive experiences beyond driving (Eckoldt et al., 2013; Knobel, 2013) could, as discussed by the example of the Tesla Model S, indeed add to the need satisfaction and enrich the overall user experience as well as hedonic and symbolic values of an electric vehicle in such a way as to enable them to be perceived as being superior in performance to ICVs by technology enthusiasts and therefore convince them (Egbue & Long, 2012).

Most of the available literature on the perception of electric vehicles was published around the years 2010 to 2013. As EVs themselves, the EV market and accompanying developments like the growing network of public charging points for EVs and much more media attention due to new models have evolved rapidly in the meantime, further research should re-evaluate the perception of EVs and review perceived problems with EVs. It is for example questionable whether a Tesla Model S driver is comparable in terms of signalled personality traits to a Mitsubishi i-MiEV (a small and narrow light weight car) driver as reported by Skippon and Garwood (2011). Additionally due to their marketing, looks, size, price and performance Tesla cars seem to be able to reach out to higher income drivers compared to traditional small EVs.

Further, empirical evaluation is needed to support assumptions made in this paper. It will, for example, be interesting to examine the influence of charging point networks on range perception among EV drivers. Additionally, an empirical investigation of the fulfilments of needs as well as the hedonic and symbolic values deriving from numerous features and attributes mentioned could help to confirm or reject their assumed effects. While it seems that electric vehicles like the Tesla Model S offer a lot of hedonic and symbolic value, it would be interesting to empirically determine whether that is true, as what these cars

are perceived exactly, what it is about them that delights people and how they compare to both earlier EVs and ICVs of similar category.

This paper provides an overview of the existing literature about the perception of EVs, discusses possible reasons for perceived problems and hopes to inspire empirical work on reviewing the assumptions made to provide a structured and evidence-based foundation for further EV development to successfully meet drivers needs and therefore contribute to the transition to a more sustainable individual transport.

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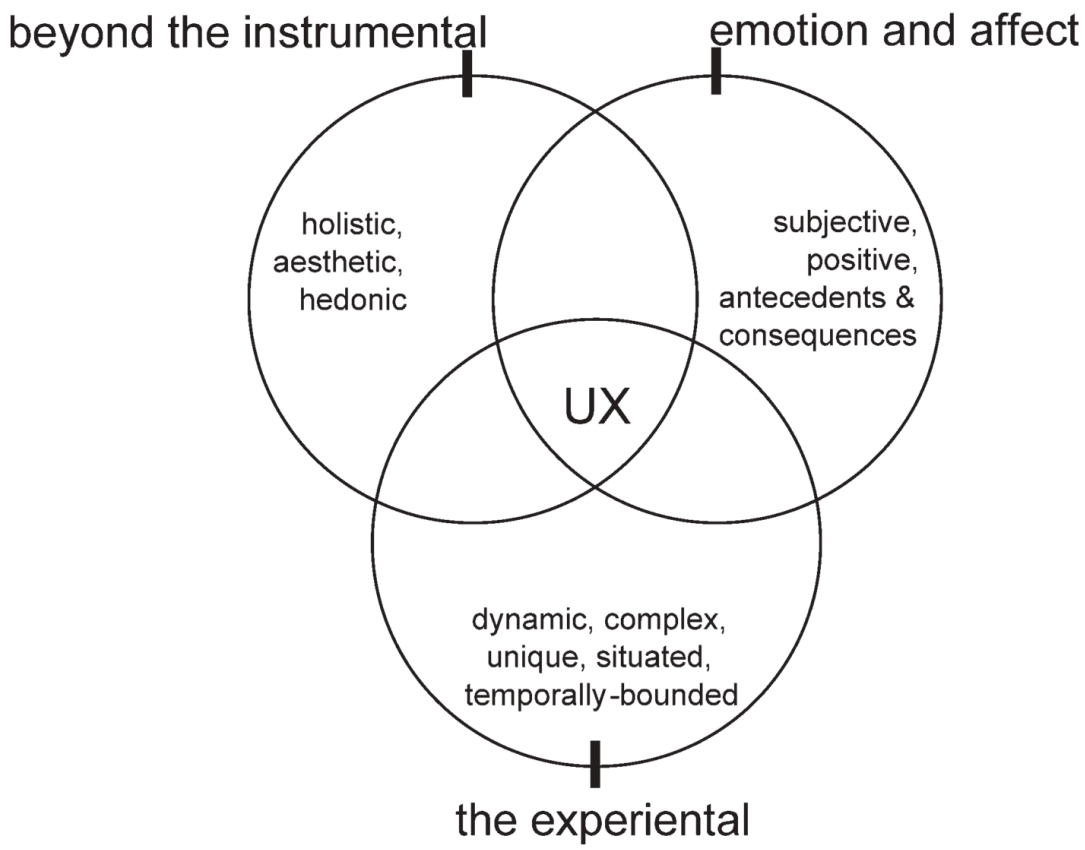
Appendix A

Figure 1



Note. Figure from Hassenzahl & Tractinsky (2006, p. 95)

Appendix B

Table 1

Overview of the most common needs and their description

Need	Description
autonomy	Feeling like you are the cause of your own actions rather than feeling that external forces or pressures are the cause of your actions.
competence	Feeling that you are very capable and effective in your actions rather than feeling incompetent or ineffective.
relatedness	Feeling that you have regular intimate contact with people who care about you rather than feeling lonely and uncared for.
self-esteem	Feeling that you are a worthy person who is as good as anyone else rather than feeling like a "loser."
security	Feeling safe and in control of your life rather than feeling uncertain and threatened by your circumstances.

Note. Table from Sheldon et al. (2001)