

Available online at www.sciencedirect.com**ScienceDirect**

Transportation Research Procedia 4 (2014) 387 – 390

**Transportation
Research
Procedia**

www.elsevier.com/locate/procedia

Mobil. TUM 2014 “Sustainable Mobility in Metropolitan Regions”, May 19-20, 2014

BEVs beyond Range Anxiety – Cognitive Interviews to Elicit the Perception of Mode Choice ¹

Ines Kawgan-Kagan ^{a,*}, Stephan Daubitz ^a^a *Technical University Berlin, 10587 Berlin, Germany*

Abstract

Electric mobility comprises a variety of transportation systems, notably the combination of public transport and electrically powered vehicles. It serves as an inherent part of future urban integrated mobility concepts. From the users' perspective, e-mobility has so far been discussed via a comparison of cars with internal combustion engines (ICEV) and battery electric vehicles (BEV). As a result, discussions have focused on vehicle range, costs and battery charging times. However, cognitive perceptions and emotions play a significant role in the formation of preferences in mode choices. A special research design reveals that individuals take an interest in more characteristics of modes of transport than those that are known from previous research. In addition, three anticipation clusters can be identified for individuals. Respondents perceived BEVs either with a high similarity to ICEVs, to urban public transport or as being similar to pedelecs and segways. These results lead to the conclusion that when studying the acceptance of BEVs, a comparison between ICEVs and BEVs is not sufficient to grasp the complete user perspective.

© 2014 The Authors. Published by Elsevier B.V. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/3.0/>).

Selection and peer-review under responsibility of Technische Universität München

Keywords: Battery Electrical Vehicles; Repertory Grid Technique; Comparison of Modes of Transport; Subjective Perception; Emotions

1. Introduction

Electric mobility comprises a variety of transportation systems, notably the combination of public transport and electrically powered vehicles. It serves as an inherent part of future urban integrated mobility concepts. For the users' perspective, electric mobility has so far been discussed based on a comparison between cars with internal combustion

* Corresponding author. Tel.: +49 30 314 26313; fax: +49 30 27875.
E-mail address: ines.kawgan-kagan@tu-berlin.de

¹ A full version is submitted for publication in Transportation Research Part F: Traffic Psychology and Behaviour

engines (ICEVs) and battery electric vehicles (BEVs). Therefore, the focus has been placed on range, costs and charging times. However, cognitive perceptions and emotions play a significant role in the formation of preferences in mode choices. The potential for a shift towards electric mobility can only be successfully identified if these perceptions and emotions are considered in the development of products and business models. This research is part of the study of transition potentials in the sphere of electro-mobility funded by the Federal Ministry of Economics and Technology in the research project "E3 - Combined Charging System". The focus of this project is the development and demonstration of combined AC-DC stations for charging BEVs at several selected locations in Berlin. This is solely an abridged version of the full paper, which is to be published in *Transportation Research Part F: Traffic Psychology and Behaviour* and giving a detailed description of the method and result.

2. Theoretical Background

When analyzing and interpreting the acceptance and perception of e-mobility, previous studies have treated BEVs in isolation from other modes of transport or simply compared them to ICEVs (i.e. Globisch et al., 2013; Jarass et al., 2013; Neumann et al., 2010). The focus has been on aspects such as acceptable ranges or initial costs. Quantitative surveys aimed for identifying connections to socio-demographic backgrounds, experiences, mobility patterns, preferences for other modes of transport and other persuasive factors such as attitudes towards environment or technology: For the majority of BEV owners and potential customers consistent socio-demographic characteristics have been identified. According to international studies, early adopters of BEVs show a higher income and education, they are middle-aged men usually living in a household with more than one car (Globisch et al., 2013; Peters and Hoffmann, 2011). Overall, characteristics regarding attitudes are not as consistent and even contradicting: The EV market segment generally shows a higher environmentally awareness and technological affinity (Schuitema et al., 2013; Jensen et al., 2013; Neumann et al., 2010). Most of the studies reveal lifestyle (Peters and Hoffmann, 2011) as well as technological and economic reasons as important motivating factors for buying an EV (Tran et al., 2013). Other studies contradict, naming interest in cutting-edge technologies as the crucial factor and not environmental issues (Pierre et al., 2011). Qualitative surveys presented mainly associations, disadvantages and fears regarding electric cars such as analyzing range anxiety (Nilsson, 2011). Moreover, apart from ICEVs, no other modes of transport have been taken into consideration while studying respondents' perception. When respondents were asked about their preferences, they had to select from options provided by the researchers; personal perspectives have hardly been taken into account.

In the 1950s, George Kelly developed the personal construct theory, which considers personal perspective when attempting to understand and analyze individuals (Kelly, 1955). Kelly refused to accept an objective truth and allowed people to construct their own systems of how to perceive and interpret their environment. This system of constructs is changeable and reflects a situation as it is perceived at a specific moment in time. The importance of single constructs in interpreting one's surroundings and even the constructs themselves can readily change.

3. Method

Kelly created a method for eliciting these constructs to help understand the world as it is seen by each individual. This repertory grid method, as it is known, sheds light on the unique and specific perception of an individual, on how a single respondent sees and evaluates the surrounding world. Originally used for therapeutical purposes (Kelly, 1955; Riley and Palmer, 1975), the scope of the method broadened in order to provide answers to questions about the perception of objects and people, situations and topics, and it is now used in many other fields of science. Although Kelly originally established his qualitative method as a counter to methods that seek to measure objective factors in order to categorize people, in many newer studies the quantitative data of grids was used to identify respondents' scope of perception and cluster them accordingly. By comparing the grids of different respondents, common patterns of perception can be identified. Since the aim of the present study is to show the range of perceptions concerning electric cars, respondents were asked how they see BEVs not in isolation from, but rather in comparison with, other modes of transport, so as to take the focus off the direct comparison with ICEVs. Thus, the aim of the present research is to identify the scope of perceptions concerning BEVs and to show which aspects lead to a positive or more positive assessment of BEVs and to gauge the relative impact of these aspects. The second aim is to situate BEVs within the

personal systems of a given individual, in contrast to other modes of transport, including public transport facilities and electric vehicles such as pedelecs and segways.

4. Results

4.1. *The Scope of Perception of Battery Electric Vehicles*

The qualitative and quantitative analyses of the data collected in twenty repertory grid interviews show different perceptions in the field of electric mobility. One special focus is the perception of BEVs in comparison to other modes of public and individual transport, as well as local and long-distance transport. We presented a scope of constructs for assessing different modes of transport within the context of e-mobility and identified shared constructs across the sample. In addition to characteristics that have been used in previous research or sometimes have simply been postulated as decisive, we have shown other aspects that matter to individuals. By comparing BEVs to several modes of transport, we showed a wider range in the assessments of BEVs than in previous studies. In particular, costs as a factor does not play a dominant role in the perception of different modes of transport for individuals with a higher affinity for cars. Reliable information about the environmental impact of BEVs needs to feature more prominently in public debates, since many respondents stated distrust regarding this issue.

4.2. *Different Perception of Battery Electric Vehicles*

The perception of BEVs is quite heterogeneous even across the sample. Clustering according to the similarities of BEVs with other modes of transport, reveals three different groups of perceptions:

- High level of similarity to ICEVs
BEVs are not distinguished from other modes of transport according to their engine type, but rather in terms of their accessibility, availability and the possibility of travelling individual ways. Safety and protection against the elements, as well as private space are constructs that play a larger role in the comparison of different transport options.
- High level of similarity to public transport
Public transport as a part of urban mobility shows similarities to BEVs. Here there are no strong mismatches between BEVs and other modes of transport. The situation determines the mode choice. Collective transport, driving a private car and covering longer distances are not crucial factors in the assessment of BEVs.
- High level of similarity to pedelec and segway
Driving BEVs is seen as a fun activity. Innovation and environmental aspects shape the perception. Range and mobility routines play an important role in the assessment of BEVs.

These generated clusters of construct systems show that there is no discrete perception of BEVs, as has been assumed in previous studies. The differences we have outlined should be taken into account in further research, in order to address them appropriately. When evaluating acceptance, the subgroups of potential customers have to be identified according to their subjective perception of BEVs. Each of these three clusters has a different perspective on BEVs. Thus, specific strategies need to be elaborated in order to facilitate a shift towards more sustainable modes of travel. These strategies need to meet the requirements of individual perspectives on modes of transport, since it is clear that they differ greatly. As we have shown, incentives have to be created in accordance with specific transportation needs.

5. Discussion and Summary

Construct systems are sensitive to actual experience with driving a BEV, and the latter can be seen as a crucial factor in the assessment of BEVs. Generally, it can be said that experience with driving a BEV leads to a more positive perception of the vehicles. Once respondents reflected on their actual mobility patterns, it led to increased acceptance of the presumed limitations concerning ranges and battery charging processes, but a high level of rejection is still

evident. This points to the necessity of providing more information and education concerning the capabilities of BEVs as an everyday mode of transport.

The aim of the research has been to understand the subjective perception of people who have a high affinity for cars by using an innovative approach. Combining qualitative and quantitative approaches, the repertory grid technique developed by Kelly based on his personal construct theory sheds light on the user perspective on e-mobility. The research design using this repertory grid technique takes into account subjective perception, utilization and requirements in the field of electric mobility in order to outline the potential for a shift in this direction. Some disadvantages of using RGT became apparent such as long and partially exhausting interviews as well as inconsistencies during the process of the interview. Nevertheless, analyzing BEVs not simply by comparing them to ICEVs but seeing them within the context of a wide range of modes of transport produces more general statements on the assessment of BEVs, without specifying in advance the differences between BEVs and ICEVs.

References

- Globisch, J., Schneider, U., Peters, A., Roser, A. and Wietschel, M. (2013) Early adopter unter der Lupe. Elektroautos - wer ist jetzt schon e-mobil und wer kann sich vorstellen, eines zu kaufen?. *Internationales Verkehrswesen*. 65 (2), pp.46-49.
- Jarass, J., Frenzel, I. and Trommer, S. (2013) Early Adopter der Elektromobilität in Deutschland Internationales. *Verkehrswesen*. 66 (2), pp.70-72.
- Jensen, A.F., Cherchi, E. and Mabit, S.L. (2013) On the stability of preferences and attitudes before and after experiencing an electric vehicle. *Transportation Research Part D: Transport and Environment*. 25 (0), pp.24-32.
- Kelly, G.A. (1955) *The Psychology of Personal Constructs*. New York: W. W. Norton.
- Neumann, I., Cocron, P., Franke, T. and Krems, J.F. (2010) Electric vehicles as a solution for green driving in the future? A field study examining the user acceptance of electric vehicles. In: Krems, J.F. , Petzoldt, T., Henning, M., ed. *Proceedings of the European Conference on Human Interface Design for Intelligent Transport Systems*, Berlin, Germany, April 29-30 2010, Lyon: Humanist Publications, pp. 445-453.
- Nilsson, M. (2011) *Electric vehicles: An interview study investigating the phenomenon of range anxiety*, Public deliverable: Task 5000 Lindholmen Science Park, Sweden: Elvire.
- Peters, A. and Hoffmann, J. (2011) *Nutzerakzeptanz von Elektromobilität. Eine empirische Studie zu attraktiven Nutzungsvarianten, Fahrzeugkonzepten und Geschäftsmodellen aus Sicht potenzieller Nutzer*, Karlsruhe: Fraunhofer ISI.
- Pierre, M., Jemelin, C. and Louvet, N. (2011) Driving an electric vehicle. A sociological analysis on pioneer users. *Energy Efficiency*. 4 (4), pp.511-522.
- Riley, S. and Palmer J. (1975) Of Attitudes and Lattitudes: A Repertory Grid Study of Seaside Resorts. *Journal of the Market Research Society*. 17, pp.74-89.
- Schuitema, G., Anable, J., Skippon, S. and Kinnear, N. (2013) The role of instrumental, hedonic and symbolic attributes in the intention to adopt electric vehicles. *Transportation Research Part A: Policy and Practice*. 48, pp.39-49.
- Tran, M., Banister, D., Bishop, J.D.K. and McCulloch, M.D. (2013) Simulating early adoption of alternative fuel vehicles for sustainability. *Technological Forecasting and Social Change*. 80 (5), pp.865-875.