Integrating the "E" in Public Transport

Information and Communication Needs for Electromobility

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Abstract. In this research, we describe an empirical study, which aimed at exploring the acceptance for electromobility within public transport (e.g. electric buses). While electric cars are increasingly receiving public attention, electromobility in public transport is less known so far. Understanding individual arguments of adopting electromobility within public transport, the identification of possible pro-using motives as well as perceived drawbacks is essential in order to individually tailor a sensitive public communication. A questionnaire was carried out in which 208 lay people indicated the level of acceptance and the intention to use electromobility within public transport. In order to get a broad insight into argumentation lines and cognitive user models, perceived benefits and barriers were explored as well as potential circumstances (conditional acceptance factors), which might shape acceptance in the future.

Keywords: Electromobility · Public transport · Electric buses · Technology acceptance · User diversity · Adoption behavior of novel technologies

1 Motivation and Related Work

Today's cities and urban environments face a bundle of complex and, aggravating, interdependent challenges in the next decades. Increasing climate change and environmental threats by air pollution (e.g., CO_2 -emissions), decreasing shortcomings of fossil oil resources, urging societies to place emphasis on renewable energies. Also, the profile of dwellers and traveller has considerably changed over the last years. Due to demographic developments, diverse people with different biographical profiles and mobility needs require a novel, and context-adaptive mobility concepts [1].

Electromobility is one of the promising energy supply technologies, which could be a potent escape from the shortcomings in fossil energy, not only for automobiles but also for public transportation. The potential of electric mobility has been studied mostly for vehicles, from a technical [2], economic [3], logistic [4], environmental [5] point of view. Social science research showed hat there is considerable struggle for electric vehicles to create appropriate markets [6], at least in Germany. A high consumer acceptance for

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alternative fuel vehicles is an important prerequisite to determine the practicality of a successful implementation [7]. Still, however, there is some reluctance to accept electric mobility for vehicles [8]. Yet, there is only few research connected to electromobility within public transport systems which is the main focus of the current study.

2 Questions Addressed and Logic of the Exploratory Approach

In this study we focus on user opinions regarding the use of electromobility in the context of public transportation, comparing perceived usage motives towards buses in contrast to E-Buses. Also, we explored the conditional acceptance by asking participants under which circumstances they would be willing to adopt electro-mobility within the public transport sector. In order to learn which using motives militate in favor of using alternative energy means in public transport and which kind of using barriers might be prevalent, we rely on a focus group study [9] prior to this study. The argumentation lines raised in the focus group discussions were taken up in the questionnaire study reported here.

3 Method

As independent variable the type of vehicle (bus vs. E-Bus), gender and age (young: 20–40 years, middle-aged: 41–60 years, older: 61–75 years) were examined. Dependent variable was the level of acceptance (benefits) and non-acceptance (barriers). Acceptance argumentations were categorized in different argumentation lines: environmental-, cost-, comfort-, trust- and technology-related argumentations for both, benefits and barriers. Also we asked for potential conditional circumstances, under which participants would accept electric buses.

The questionnaire items were based on previous empirical work [9]. The questionnaire was delivered online and focused on different acceptance items (Fig. 1).

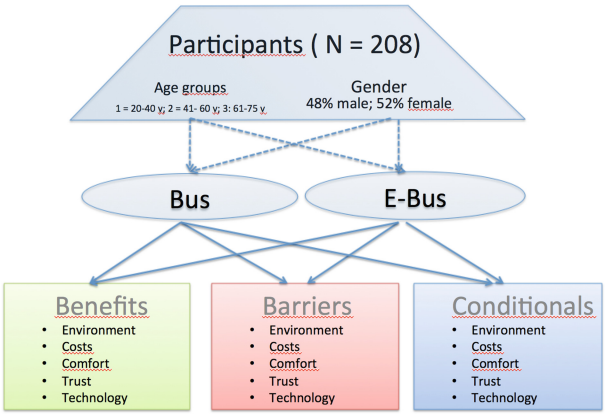

Fig. 1. Structure of the questionnaire

Benefits/Barriers of ***buses and E-Buses***: The motives and barriers were conceptualized along five dimensions (identified on the base of user argumentations in the focus groups, which had been carried out prior to the questionnaire study [9]. Per dimension, we used three items and summarized the answers to an overall score. (Table 1). In addition, we asked for conditional circumstances, which would participants convince to make use of E-Buses. In general, 14 items were formed, taken again from the argumentations of previous focus groups [9].

"I would use E-Buses, if" (1) fuel costs further increase (2) tax reductions would be offered (3) families with many children would have free access (4) seating comfort would be higher (5) buses would take the most direct route (6) more luggage would be allowed (7) bus drivers would be checked for driving ability (8) security at bus stations would be assured, especially at nighttime (9) hooligans and rowdies would have no success (10) the German security standard would be guaranteed (11) buses would equal the most recent technological standard (12) the CO_2 emission in buses would be controlled for (13) there would be a quality seal for buses, and (14) if passenger could monitor emission status.

Table 1. Item examples for the evaluations of benefits and barriers of Buses and E-Buses. Items had to be answered on a Likert Scale (1 = I do not agree at all, 4 = I completely agree)

Bus	Benefits: reasons for using the bus	Barriers: reasons for not using the bus
Environment	It would help to protect the environment	Buses have a high energy consumption (heavy weight)
Costs	It saves costs on the long run	Bus tickets are expensive
Comfort	I do not need to look for parking spaces	Cleanliness and hygiene are low in public buses
Trust	Bus technology is reliable for me	Low trust in driving styles of bus drivers
Technology	Public transport has mature technology	Buses are not prepared for windstorms
E-Bus	Benefits: reasons for using the E-Bus	Barriers: reasons for not using the E-Bus
Environment	Its battery can be used to store the surplus created by wind turbines	To operate a fleet of such buses more power plants need to be built
Costs	It saves costs on the long run	Lower operational costs only benefit the operators
Comfort	It creates less traffic noise	To go easy on its battery the heater cannot be used in winter.
Trust	It will deliver me to my destiny reliably	I do not trust the technology
Technology	It conforms to novel safety standards	The lack of engine sounds increases the risk of accidents.

In total, 208 persons (18–75 years) volunteered to take part (49 % women). Participants were reached through the social networks of younger and older adults and reacted to advertisements in the local newspaper.

4 Results

Data was analyzed by using M(ANOVA) procedures with repeated measurements. The significance level was set at 5 %.

4.1 Perceived Benefits and Barriers

In a first step, the perceived benefits of buses and E-Buses are focused at. In Fig. 2 descriptive outcomes are shown for each of the argumentation categories (for which the single items were summed up). The MANOVA yielded significant effects of the bus type regarding environmental-related benefits ($F(1,197) = 54.4$; $p < 0.000$), also regarding cost-related benefits ($F(1,195) = 16.9$ $p < 0.00$), comfort-related benefits ($F(1,195) = 6.1$ $p < 0.02$), also for trust-related arguments ($F(1,198) = 73.2$ $p < 0.00$) and technology-related benefit perceptions ($F(1,198) = 148.4$ $p < 0.0$). As can be seen, only comfort arguments favor traditional buses over E-Buses - in all other categories the E-Bus is seen more beneficial. Neither age nor gender did significantly impact the perceived benefits in both bus types.

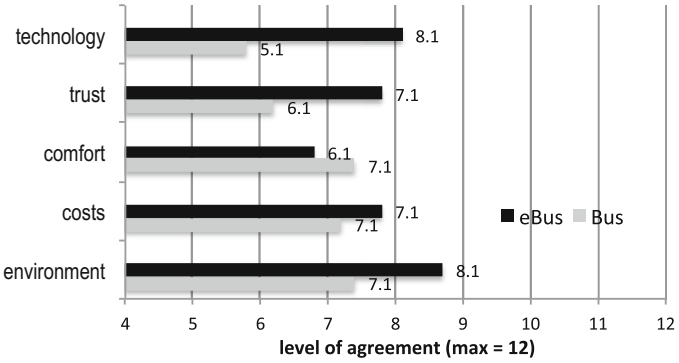

Fig. 2. Level of agreement (means) for the perceived benefits on different argumentation dimensions for buses and E-Buses (4 = not at all, 12 = completely agree)

A next analysis is directed to the perceived barriers (Fig. 3).

In Fig. 3, descriptive outcomes are depicted (along the five dimensions). As found, there were significant differences in the perceived barriers between buses and E-Buses in nearly all dimensions: environment ($F(1,193) = 4.7$; $p < 0.03$), costs ($F(1,194) = 43.3$ $p < 0.00$), comfort ($F(1,196) = 658.9$; $p < 0.000$) as well as trust-related barriers ($F(1,191) = 31.8$; $p < 0.00$). In contrast, perceptions with respect to technology-related barriers of buses and E-Buses are comparably high.

While gender did not impact perceived barriers, age was a significant source of barrier perception. With increasing age, costs for the E-Bus are seen less negative ($F(2,194) = 4.9$; $p < 0.008$), the trust in E-Buses is higher ($F(2,198) = 4.1$; $p < 0.002$) and technology-related barriers are seen as less negative ($F(2,187) = 3.9$; $p < 0.04$).

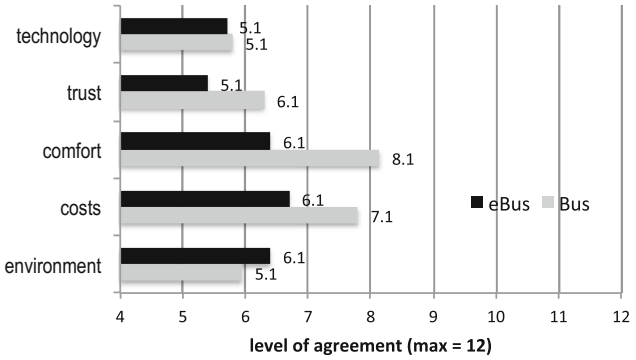

Fig. 3. Level of agreement (means) for the perceived barriers on different argumentation dimensions for buses and E-Buses (4 = not at all, 12 = completely agree)

4.2 Conditional Acceptance Criteria

Finally, participants had to indicate which conditional circumstances would increase the acceptance to make use of E-Buses (Fig. 4). Age did not impact conditional acceptance. However, women showed to have a significant higher conditional acceptance in contrast to men ($F(1,178) = 2.4$; $p < 0.004$).

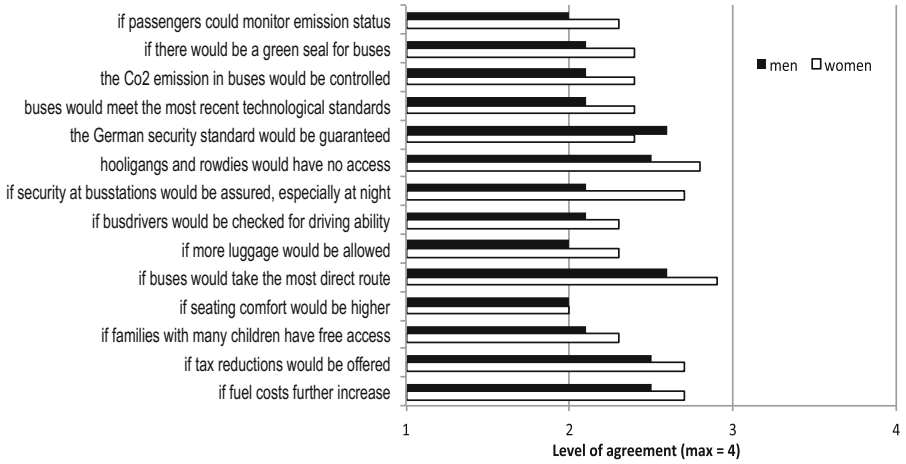

Fig. 4. (Dis)agreement to conditional acceptance (1 = not at all, 4 = completely agree)

For men the only argument which militates in favor for using E-Buses in the near future is that the German security standard would be guaranteed in E-Buses ($F(1,178) = 4.6$; $p < 0.000$).

5 Discussion and Future Research

In this study, perceived benefits and barriers of laypeople towards electric buses were assessed as well as the willingness to adopt electromobility in public transport respecting conditional acceptance arguments. Outcomes contribute to the understanding of major public opinion drivers for and against electric mobility in public transport. Overall, electric buses provide higher benefit perceptions than drawbacks – taken from the higher agreement to the benefits in contrast to the perceptions. Major positive arguments are the eco friendliness of the technology and the cost-savings on the long run. On the barriers' side, comfort, trust in the technology and high costs are seen as detrimental. Beyond the overall high uncertainty of the novelty of the technology, which drives the non-acceptance, it is interesting that the very same arguments are used for benefits and barriers. This is valid for the perceived trust in the technology (which is high for the novel E-Buses and at the same time low as the technology seems not to be mature enough) but also for the perceived costs (cost reduction on the long run is positive; high asset costs are negative). Gender and age were significant drivers of acceptance. Among conditional acceptance, women especially stress safety and security issues (at night, at bus stations, threat by other passengers). While these findings corroborate recent research in public transport [10], the raised concerns - though serious – are not specifically connected to electro-mobility but to public transportation in general.

Critically, one could argue that acceptance can only be assessed if persons rely on personal experience with using electric buses, which is still only scarcely available, at least in Germany. Acceptance might be thus formed by knowledge gaps and limited information. Consequently, individual beliefs, uncertainty as well as perceptions risks come into fore. In order to shape public acceptance, a diligent information policy and transparent communication rationale in this field is of high importance.

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