Interview study: How can Product-Service Systems increase customer acceptance of innovations?

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ABSTRACT

Since customer acceptance is responsible for the success of innovative products, this study investigates how Product-Service Systems (PSS) influence customer acceptance of innovations. Using the example of electric vehicles (EV) in carpools, interviews were held with four PSS providers and four PSS customers from Germany and Sweden. The results of the interviews were then analyzed according to Rogers’ theory of the diffusion of innovations: Providing innovative products as PSS can increase customer acceptance by reducing performance gaps that exist between innovative and existing technologies. The main gaps found with EVs are their limited range and high purchase costs. Customers perceive those gaps as less considerable if they rent EVs in a carpool.

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Introduction

The key to the success of technological innovations is customer acceptance (see the Technological innovations section). If customers accept a new technology and are willing to pay for the technology’s advantages, products involving technological innovations become successful. Rogers [1] claimed that innovations need time to diffuse into society. One example of this is the iPad, by Apple. The Apple Newton, which was launched in 1993, lacked customer acceptance, while 15 years later the Apple iPad became a great success. Even though both products had similar product designs, the iPad was more successful. This paper considers the customer acceptance of technological innovations. It deals with the question of how Product-Service Systems (PSS) can help increase customer acceptance by accelerating the diffusion of innovation. According to Tukker [2], PSS focus on customer requirements and enable faster innovations. Vandermerwe and Rada [3] stated that PSS support the diffusion of innovations. Rogers [1] defined five factors relating to innovations that are perceived by customers and that influence the customer acceptance. This study proves Rogers’ factors using the example of electric vehicles (EV) in carpools. Based on Tukker’s categorization of PSS, a carpool is the business system for use-oriented PSS. The customer pays for the utilization period and for the distance if it exceeds a defined range limit. Four top managers from carpool providers and four carpool customers from Germany and Sweden were interviewed and analyzed according to Rogers’ factors. The managers not only see the provider’s internal processes, but also act as representatives of the companies and speak for the company’s understanding of the customers’ needs. The analysis shows how PSS can increase customer acceptance. It studies differences between station-based and free-floating carpools, as well as between full EV carpools and mixed carpools (i.e. EVs and combustion-engine vehicles). Since the carpools are located in Germany and Sweden, carpools from both countries were compared to one another.

This paper deals with customer acceptance of innovations. It examines only business-to-customer (B2C) applications, i.e. the relationship between carpool companies and private users, not business-to-business (B2B) applications. In addition, the terms “user” and “adopter”, a term from innovation theories, can be applied. Nevertheless, they have the same meaning in this case: the B2C-customer is defined as the end user, the person who actually uses the innovation. This person is the decisive factor in the evolution of the innovation.

Research methodology and structure

This work is based on the Design Research Methodology (DRM) defined by Blessing and Chakrabarti [4]. It delivers a set of methodologies to “help make design research more effective and efficient”. The DRM layout consists of four different stages:
research clarification (clarifying research goals), descriptive study I (collecting and analyzing empirical data to increase knowledge), prescriptive study (support for the research problem), and design study II (evaluating prescriptive study to assess its value). The research types differ in their sequence and the coverage of research stages. This work focuses on the first three stages. The research clarification is review-based. This literature review focuses on the terms “customer acceptance”, “Product-Service Systems”, “innovation” and “electric vehicles”, and it results in the research questions. The descriptive study I is a comprehensive study. Semi-structured interviews were used for this study. The interviews are designed in accordance with the research questions and described in the section Research Questions and Design of Interviews. The descriptive study analyzes and interprets the interviews by comparing them to the approaches identified in the literature. Fig. 1 shows the research methodology and its stages in connection to the chapters of this paper.

This work first presents the theoretical background of PSS and innovations. It first defines the research questions, then presents the interviews and their analyses. The interpretation shows how PSS can be used to raise customer acceptance of technological innovations, based on the assumptions made by Rogers [1]. The last section of this paper is a conclusion and an outlook for future work.

Theoretical background

The basic research consists of two topics, Product-Service Systems (PSS) and customer acceptance of innovations. First, the work introduces PSS and explains the focused kind of innovations. Then, it defines customer acceptance and clarifies its implications for this work. The next subsection analyzes the question of how PSS can help to increase innovations’ performances. Beyond other theories that explain customer acceptance of innovations, this paper focuses on the Diffusion of Innovations theory first stated by Rogers [1] in 1962.

Product-Service Systems

Product-Service Systems (PSS) integrate product and service components in an integrated market offering [5–7]. PSS are characterized by integrated lifecycle phases, e.g. planning, development, delivery, and use [8,9]. While several authors define the term PSS as the service and product components included [6,7,10], Manzini and Vezzoli [11] characterize PSS as an innovation strategy, [12] and [5] define PSS as a value proposition. PSS imply a paradigm shift from selling technical products to fulfilling customer demands [5]. PSS have a wide range that Tukker divides into three main types [2]: (1) Product-oriented PSS are dominated by the product content and incorporate product-related services such as maintenance or consulting for product usage; (2) Use-oriented PSS incorporate renting, sharing and pooling of products (car sharing is an example of a use-oriented PSS); (3) Result-oriented PSS are dominated by the service content, e.g. a functional result may be the transportation of a person without the means of transport having been defined. The term “servitization” is often used in literature and describes the transformation from selling a stand-alone product to providing a PSS [13,14]. Other related terms in literature are performance based contracting [2], maintenance outsourcing [2], functional sales, and functional (total care) products [15]. Those terms describe subcategories of PSS, e.g. maintenance outsourcing is a special case within a product-oriented PSS. The overall concept of those approaches is called PSS.

PSS promise benefits for the provider, the consumers, and the environment. The dematerialization of PSS decouples economic growth and sustainability [5,6,12]. Benefits for the customer are higher customer values because of a shift in the providers’ scope from selling technical products to fulfilling customer needs [2,11]. The possible distinction from the competition is seen as beneficial for the provider [5,6,12,16]. Other potential benefits include long-term customer relationships [17], higher customer loyalty as well as higher revenues due to expanding business activities by services [18].

Technological innovations

Authors from multiple disciplines have created definitions for the term innovation [19,20]. One way in which it can be defined is the “generation, acceptance, and implementation of new ideas, processes, product or services” [21] or “the successful exploitation of new ideas” [22]. An invention’s novelty and benefits do not have to be superior but market success must be achieved, and this depends on customer acceptance [23]. In a technological context, an innovation is an innovative technology. For a technology to achieve customer acceptance, a product or service is needed that involves the technology and carries the technology to the customers. As this research focuses on customer acceptance of technological innovations, the innovative technology cannot be considered separate from the product. Therefore, this article deals with product innovations that are innovative because they include an innovative technology, e.g. electric vehicle (technology: electric drive system, product: vehicle), MP3 player (technology: MP3, product: music player), digital camera (technologies: image sensor, digital storage medium, product: camera). This study refers especially to innovative technologies that are in competition with existing and established technologies in similar products, e.g. electric vehicles compete with internal combustion engine vehicles, MP3 players have competed with CD players, digital cameras compete with analog cameras. The innovativeness on which this paper focuses has to be extensive enough for customer acceptance to justify greater efforts to implement a PSS. The study focuses on radical innovations and system innovations [20] that are more likely to fail in customer acceptance, compared to incremental innovations in system components. Hauschildt and Salomo [20] differentiate between four content-related categories of innovations: technical (products, processes), organizational (management, cultures, structures) and business-related (business model, market structure) [20]. Thinking in those categories, this study focuses on technical innovations. Since the transition toward
PSS affects the business model (gaining profit by selling the tangible product or by rendering services), PSS can be seen as business-related innovations. From this point of view, this paper claims that the customer acceptance of a technical innovation can be increased by integrating it in the business-related innovation PSS.

**PSS for increasing innovation performance**

Sakao et al. [24] and Schenk et al. [25] discuss the role of technologies within PSS. Sakao et al. [24] show how a PSS may encapsulate new technologies and thereby prevent knowledge transfer to the user. Schenk et al. [25] discuss the possible enhancement of disruptive technologies by means of servitization. The underlying theory is the S-curved performance improvement of technologies, as stated by [26]: The introduction phase is characterized by a slow increase in performance, which is followed by a phase of rapid performance improvement: the growth phase. At the end of the technology lifecycle, only incremental improvements remain, which slow down performance improvement: the maturity phase. When technological innovations enter the market they often have to cope with performance gaps in comparison with established technologies. Schenk et al. [25] formulate the hypothesis that integrating the technology into a PSS can overcome these performance gaps. Thereby, the (performance) disadvantages of a new technology may be compensated with services offered by the PSS. This may allow innovations to be launched on the market earlier, as illustrated in Fig. 2.

The literature mentions several different terms to describe the recipient of services: client, customer, consumer and user. These terms may differ slightly in meaning, e.g. client implies a more passive relationship, whereas customer and consumer imply more than a marketing aspect, i.e. needs are involved [27]. Accordingly, the terms customer acceptance, consumer acceptance and user acceptance are all used. The terms customer and consumer may not be used as synonyms, as the customer is not always identical to the consumer, i.e. the end user.

**Customer adoption and acceptance**

Multiple disciplines provide definitions for customer acceptance from different perspectives. Psychological science considers acceptance independently of the customer–product relationship. It links acceptance to humans in general, and defines criteria that are needed to achieve acceptance. Authors from psychology define the normative, cognitive, and conative aspects [28–30] that describe human behaviors and attitudes. However, they do not mention when and how those aspects are relevant for acceptance. The psychological attitude defines acceptance as the basic affirmative attitude of acceptance subjects, dependent on the context, the situation, and the reference object [12,16]. In the case of customer acceptance, the acceptance object is the customer and the reference objects are products or innovations. The context and the situation is the purchase situation, in which a product is needed. However, this situation focuses not only on the point of sale. Scientists from business and economics concretize those aspects on the customer and buyer decision process [31,32]. By this “decision process” they mean more than just the purchase decision at the point of sale. They also describe factors arising before the purchase as well as factors arising afterwards in the usage phase or other lifecycle phases. The terms customer adoption and acceptance distinguish between factors arising before and after the purchase and after the first contact with the product: Customer adoption is a pre-stage and a necessary condition for acceptance. Adoption involves all elements that are considered before the customer decides on a product. This decision is not the same as the purchase decision, but includes the decision to try out or test a product [31,32]. In addition, customer acceptance includes effects from the usage phase. Customers must have used the product on a practical and continuous basis and they must be satisfied with its benefits [29,33]. This process-oriented view of customer acceptance is a reasonable means of investigating how PSS can increase customer acceptance. Approaches that deal with human attitudes are too abstract to be linked to PSS and for the influences between them and PSS to be analyzed. Psychological aspects themselves are too easily influenced by PSS to be isolated. Disturbance variables are too numerous and effective, making them more relevant for the acceptance than the combination of innovations and PSS. Due to the effects of disturbance variables, simply comparing customers’ product purchase decisions to PSS purchase decisions is not an appropriate way to analyze the effects of PSS on customer acceptance of innovations. It is claimed that interviews help to determine providers’ and customers’ motivations for PSS. Based on these considerations, the next section discusses several approaches for defining customer acceptance that are relevant to innovations.

**Customer acceptance of innovations**

Several authors explain the factors and reasons behind technology acceptance and innovation acceptance [1,34–36]. The task-technology fit theory of [37] focuses on IT and defines eight factors (compatibility, quality, ease of use/ training, etc.) that describe a measure for task-technology fit. The Unified Theory of Acceptance and Use [38] unifies several approaches to modeling technology acceptance for building a market analysis framework. This theory focuses only on products for the Internet that can be seen as services. The factors influencing technology acceptance defined by several authors [1,34–36] are similar to and based on each other. For instance, [37] mentions, “ease of use/ training”, [1] calls it “difficult to understand/use” and in the work of [35], it is called “perceived ease of use”. As stated before, a process-oriented understanding of customer acceptance is a more reasonable means of explaining how PSS can increase customer acceptance. This study is based on Rogers’ work, because this work considers the process of customer acceptance of innovations as a diffusion process, and a process-oriented approach is needed. Rogers’ work is the approach with the most extensive process-oriented character. Rogers [1] defines diffusion of innovations as “the process by which an innovation is communicated through certain channels over time among the members of a social system”. The success of an innovation is measured by the rate of adoption, with Rogers using the terms “adoption” and “acceptance” synonymously. In addition to the nature of the social system, time, and communication systems, the perceived attributes are the dominant influencing factor on the
adoption rate. The five attributes are discussed below: relative advantage, compatibility, complexity, trialability, and observability. Relative advantage describes the perceived superiority of an innovation compared to the previously-used technology that it replaces. Sub-dimensions are economic profit, low initial cost, a decrease in discomfort, social prestige, time and effort savings, and immediacy of reward. Relative advantage has the highest influence on the rate of adoption of all attributes considered; the higher the advantage for adopters, the more likely they are to accept the innovation. Compatibility is the perceived consistency with the values, experiences, and needs of potential adopters. Complexity is the perceived difficulty involved in understanding and using an innovation. Trialability is the ease with which potential adopters can experiment with an innovation. The easier it is for a potential customer to test the innovation, the more likely it is for the innovation to spread quickly. Observability is the visibility of an innovation’s results to others. Communication channels influence the rate of adoption. For example, mass media can spread knowledge about an innovation faster, while interpersonal communication has a stronger influence on a potential adopter’s attitude. Different types of innovation decisions include deliberate decisions by the customer, collective decisions, e.g. by the members of a social system, and authority decisions by a few people that possess power, status, or technical expertise.

The “Diffusion of Innovations” framework explains the process of adopting an innovation and predicts customer acceptance. The question of whether only the five factors described by Rogers are sufficient for predicting customer acceptance will be examined in the following. Also, the applicability of his theory in the context of PSS has to be justified. As the Diffusion of Innovations theory by Rogers has been widely acknowledged in the scientific world; many authors have since dealt with his thoughts, in different research fields and also within the context of PSS. The most influential authors are considered in the following.

Dunphy and Herbig [39] examine the acceptance of innovations related to the customer. They also claim that Rogers’ five factors are relevant for determining the success of an innovation. They propose integrating a sixth factor, which is the perceived risk of an innovation. It is defined as “the degree of perceived risk associated with the innovation” [39]. The higher the risk, the less likely it is that the consumer will accept an innovation. The authors approve Rogers’ five factors, which are relative advantage, compatibility, complexity, trialability, and observability, for predicting customers’ acceptance or rejection of an innovation. They add perceived risk as an additional important factor that Rogers did not explicitly address.

Sahin [40] examines the applicability of Rogers’ five factors in various educational technology-related studies. He shows that these factors are “useful predictors of the adoption of an innovation.” When Herbig and Day [41] look at customer acceptance of innovations more closely, they also claim that customer acceptance is the first and most important aspect when dealing with the introduction of a new technology onto the market. Furthermore, they also include the factor of risk in their considerations. They show that product innovations generally have a higher rate of adoption than service innovations. According to Herbig and Day [41], this is based on the fact that product innovations are easier to communicate and demonstrate, and they have a lesser perceived influence on other parts of life, e.g., personal or social life. They point out that service innovations may have a more significant influence on society, e.g., electronic banking or computerization. Table 1 summarizes the factors influencing customer acceptance on which this work is focused.

Analyzing the factors of customer acceptance reveals several touch points between customer acceptance of innovative products and the customer-related benefits of PSS. Trying the innovation is one requirement for adoption [1] that a use-oriented or result-oriented PSS can easily provide: While paying only a small amount for using the product instead of buying it outright and paying the entire cost of purchase, the customer is able to try before he or she accepts the innovation. The PSS approach allows ownership to be shifted from user to provider, i.e. product usage and product ownership are decoupled. This transformation of ownership is associated with the transformation of risk: If the innovation fails, the provider has to take the risk and customers might appreciate this risk transformation [16].

To identify how PSS can increase customer acceptance of technical innovations, managers and possible customers of car-sharing companies were interviewed. The next subsection discusses challenges and problems facing EVs and discusses why car sharing is an appropriate approach to overcoming those challenges. After this, the literature review is concluded and the research questions are defined.

Use case: electric vehicles in car sharing

This work discusses reducing performance gaps in new technologies by integrating the technology into a PSS offer. This work uses electric vehicles (EVs) in car-sharing systems in Germany and Sweden as an example of this application. This section gives an introduction to EVs as well as to car-sharing systems.

The most important challenges for future societies mainly address two issues: climate change and future mobility concepts. In this context, EVs are a promising means of providing a solution to both challenges: EVs fueled by renewable energy sources can significantly decrease the environmental pollution resulting from today’s main mobility forms, which are dependent on fossil fuels [42]. However, an essential performance gap is inherent with EVs, compared to cars with an internal combustion engine: the lower energy density of Li-Ion traction batteries, longer charging times, uncertain durability of the batteries, as well as the lack of a widespread charging infrastructure [43,44]. In addition to these concerns, a study from the German P3 Group reveals that consumers are only willing to pay a low premium for EVs [45].

Steinhilber et al. [44] state that the future success of EVs depends on the development of new business models. This paper discusses customer acceptance of EVs in car-sharing systems. EVs and gasoline–electric hybrid vehicles are a key trend in car sharing [46].

Car sharing can be seen as a short-term model of car rental and is thereby an example for a use-oriented PSS [47]. There are different types of car sharing, e.g. station cars, whereby cars are taken and returned at defined stations. Multi-nodal shared-use vehicles rely on multiple stations [48]. In free-floating car-sharing

<table>
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<th>Table 1 Factors of customer acceptance.</th>
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<tr>
<td>Source</td>
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<tr>
<td>Rogers [1] Relative advantage</td>
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<tr>
<td>Rogers [1] Compatibility</td>
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<tr>
<td>Rogers [1] Complexity</td>
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<td>Rogers [1] Trialability</td>
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<td>Rogers [1] Observability</td>
</tr>
<tr>
<td>Herbig and Day [41] Risk</td>
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systems, cars are distributed throughout a certain area of a city, the carpool business area. Cars can be taken from anywhere and parked everywhere, as far as allowed, throughout the entire business area.

In 2012, the German Car-Sharing Association [49], which represents most of Germany's biggest car-sharing companies, issued a position paper on the integration and usage of EVs in carpools [49]. It argues that, until now, economic reasons have prevented the rate of EV diffusion onto the market from increasing, as there is no economic benefit due to high purchase costs. Also, vehicle size – the EVs currently available are mostly smaller city cars – as well as anxiety concerning the vehicles' range still speak against increasing market coverage. The German Car-Sharing Association therefore sees carpools as an ideal element in overcoming these limitations: Since carpools are commonly used for shorter travel distances (usually less than 35 km), the limited operating range is of a lesser concern here. Nor is vehicle size an issue, because most car-sharing services are based in large cities, where small vehicles are favorable. Furthermore, mixed carpools including EVs as well as conventional gasoline cars can improve market coverage, as EVs can be used for short city distances and conventional gasoline cars for longer-distance travel. The economic influence of high purchasing costs is not relevant for carpool users. Carpool users do not take any risks if they only pay to use EVs rather than to own them. Other influences of electric mobility on customer acceptance are as follows: EVs in carpools can pave the way for new EV user groups through a trialability effect. People who want to try out EVs can quite easily do so with a carpool. Still, car-sharing providers have some challenges to overcome: First, they have to inform customers about the new technology and reduce unfounded fears. Second, the user has to know how to drive and charge the EV, which is also a lack-of-knowledge – information deficit. Third, users have to know how to find an EV with sufficient range: carpool companies can assist in this regard. Overall, the German Car-Sharing Association's position paper draws the conclusion that EVs fit into car-sharing systems well, because they provide environmentally-friendly mobility due to zero CO2 emissions when fueled by renewable energies. Also, Shaheen and Cohen highlight gasoline–electric hybrid and EVs as a key trend in car sharing in the coming years [46]. However, they do not discuss the reasons for this.

Research questions and design of interviews

Research questions have been set up based on the remarks above. Rogers' diffusion of innovations theory [1], enhanced by the perceived risk factor, was identified as an appropriate theory for examining and predicting customer acceptance of innovations, also in the context of PSS. These six factors are used in the case of EVs in carpools and the factors allow a detailed assessment of the customer acceptance of EVs in carpools. Therefore, this framework will be used to evaluate the factors that make customers use or not use EVs in car sharing. This input gained in the literature study leads to the following research questions:

- Does the integration of EVs in carpools increase customer acceptance by decreasing disadvantages for the customer, i.e. is a PSS a suitable way to bridge the performance gap in a new technology?
- Do the factors defined by Rogers describe customer acceptance of EVs?
- How and on what scale do the factors influence customer acceptance of EVs?

The results of this study may provide insights for designers as to how they have to design a PSS in order to increase customer acceptance of technological innovations. PSS planners and designers who define services and business models for PSS, including technological innovations, can include the results of this study in order to influence the factors stated by Rogers.

The answers on which the research questions are based present a process-oriented view of customer acceptance, while focusing on technical innovations. An interview study will answer these questions. Data for the study was acquired by in-depth, semi-structured interviews with CEOs from four car-sharing companies in Germany and Sweden, as well as with customers. The data was analyzed in two dimensions: First, the factors describing customer acceptance of EVs in car sharing were identified. These factors were examined in detail in order to investigate which specific aspects lead to customer acceptance. Furthermore, these factors were compared to different types of carpools (station-based and free-floating carpools, or full EV and mixed EV carpools). This showed that the car-sharing strategies differ in their effects on customer acceptance. Furthermore, it showed which type of carpool is the most promising for increasing the usage of EVs in general, as well as in car sharing in particular. Second, the results were compared to the findings of the literature study in order to examine whether carpools are really able to overcome EV disadvantages. German and Swedish carpools were compared and contrasted in order to analyze national differences. This resulted in the following research questions, which refer to EVs and carpools:

- How do the types of carpools and the number of included EVs affect customers?
- What type of carpool is needed to increase customer acceptance of EVs?
- What are the differences between German and Swedish carpools with regard to customers, business models, and EV integration?
- Why do German and Swedish carpools differ?
- What future developments can be expected in carpools in Germany and Sweden?

To show how the interview study was set up, the next subsections describe the design of the interviews.

Design of interviews with car-sharing providers

Interviews were held with top-level car-sharing company managers in order to learn about customer behavior. Those CEOs were familiar with the main problems customers experience in using the product. Marketing employees were not taken into consideration because they are not allowed to share customer-related information. In total, four interviews were held; two of them with major Swedish and two with major German car-sharing operators.

The study includes the same number of station-based and free-floating car-sharing systems. The third characteristic, which was different between the carpools examined, is the percentage of integrated EVs. As a prerequisite of this study, all the carpools need to have EVs already integrated. Two of them consisted exclusively of EVs, whereas the other two comprised mainly of a conventional gasoline vehicles, integrating a few battery EVs, as well as hybrid electric vehicles. Table 2 characterizes the companies.

The context of the study was international, to allow researchers to develop a better understanding of the influence of different factors and surrounding conditions: when two different, international markets were compared, deeper insights were expected, also based on the differences between these markets. Therefore, the study discussed the differences between carpool concepts in Sweden and in Germany.

The same interview guideline was used for all interviews to ensure comparability. The first part of the interviews was dedicated to the general use of EVs in car-sharing companies,
Table 2
Characteristics of the four carpools examined.

<table>
<thead>
<tr>
<th>Company</th>
<th>Type of carpool</th>
<th>#1</th>
<th>#2</th>
<th>#3</th>
<th>#4</th>
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</thead>
<tbody>
<tr>
<td>Professionals</td>
<td>Station-based</td>
<td>Station-based</td>
<td>Free-floating</td>
<td>Free-floating</td>
<td></td>
</tr>
<tr>
<td>Country</td>
<td>Sweden</td>
<td>Sweden</td>
<td>Germany</td>
<td>Germany</td>
<td></td>
</tr>
<tr>
<td>Vehicles</td>
<td>Full EV</td>
<td>Mixed EV</td>
<td>Full EV</td>
<td>Mixed EV</td>
<td></td>
</tr>
<tr>
<td>Position</td>
<td>Top-level management</td>
<td>Top-level management</td>
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with questions that involving the exact number of EVs included in the carpool as well as the reasons for integrating EVs in the carpools. The role of EVs as an innovation in car sharing, the future perspectives of car sharing as well as the effects of EVs in carpools on overall customer acceptance of this technology were investigated (sample question: What is your strategy for advertising the fact that you use only EVs in your carpool?). The second part of the interviews then focused on customer acceptance of the EVs integrated into carpools, in particular examining customers’ reasons for using EVs instead of conventional gasoline cars. The interviews also looked more closely at user difficulties with the handling of EVs and the future development of EV user structure (sample question: Thinking of your customers’ feedback, what are the reasons your customers give for not using electric vehicles?). The first part of the interview was analyzed based on the topics of EV user group characteristics, differences between the Swedish and German car-sharing markets and future challenges and developments surrounding the use of EVs in carpools. The second part, which focused on customer acceptance of EVs, was analyzed based on a framework by Rogers. The six factors were used to structure and categorize the replies given by car-sharing officials.

Design of interviews with car-sharing customers

Although the interviews with customers for car-sharing company officials were as unbiased and neutrally verbalized as possible, the opinions and arguments of these officials could still be influenced by their positions and company perspectives. Corresponding interviews were held with potential customers in order to deal with this matter and double-check the findings of the company interviews. The group of possible car-sharing users, i.e. users who have not previously used car sharing on a regular basis, was defined as a target group. Existing carpool users are already considered in the company interviews. Thus, the focus of the customer interviews lies strongly on the risks of EVs in car sharing and on reasons why customers have not yet used EVs in car sharing. One selection criterion is the user’s country, i.e. whether they are from Sweden or Germany, so as to cover both markets that were involved in this study. Male and female customers were selected, in order to identify possible differences in their views. Interviewees were selected from four groups based on their age. Very young and very old people are not a target group, as they are either not yet allowed to drive or are no longer using innovative services such as car sharing. The people interviewed differed in their employment, to ensure that a cross section of the most common employment types was represented. Furthermore, they had different backgrounds (technical, economical, etc.). Since the academic background of the interviewees was also expected to be relevant, especially in terms of their understanding and knowledge of electric mobility technology, as well as the concept of car sharing, this parameter was also taken into account so that interviewees with a mix of technical experience were selected. Because the city size is relevant for the critical mass of users for free-floating car sharing, the interviewees’ origins were also considered. Table 3 characterizes the customers interviewed.

The interviews were based on the company interviews, and include a similar interview guideline. The interviews start with a few statistical and personal questions to confirm that the selection criteria apply to the interviewee selected. The second and longer part of the interviews focuses on reasons for and obstacles to the interviewees’ willingness to use EVs in car sharing, thus identifying their reasons for accepting this technology (sample question: Why would you use a conventional gasoline car rather than an EV in car sharing?). Also, the factor of risk is evaluated in detail to find out whether the company interviews reveal insights, and to understand how EVs in car sharing have to change in order to be attractive to a larger group of people (sample question: What difficulties do you anticipate with the handling of EVs in car sharing?).

The interviews were held in person, except for the interview with “company #3”, which was a telephone interview. Interviews were recorded in writing. The following analysis used the transcripts as a basis.

Analysis and interpretation

The transcripts of all interviews were analyzed according to Rogers’ six factors. Once the results of the providers’ interviews had been presented, the results from customers’ interviews were shown. The purpose of interviewing customers was to validate the statements made by providers.

Providers’ interviews

The interviews have revealed that carpool providers have two main incentives for integrating EVs:

1. Environmental friendliness of EVs, especially the zero direct carbon dioxide emissions.
2. To learn technical aspects and details of EVs, learn how to integrate EVs into an existing carpool and learn about behavior and acceptance of customers that use EVs.

Two interviewees mentioned that their carpools’ advertisement strategies focus primarily on the fact that they use EVs. The other two cases do not actively promote the use of EVs. The results

Table 3
Characteristics of the four customers interviewed.

<table>
<thead>
<tr>
<th>Customer</th>
<th>#1</th>
<th>#2</th>
<th>#3</th>
<th>#4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td>Female</td>
<td>Female</td>
<td>Male</td>
<td>Male</td>
</tr>
<tr>
<td>Age</td>
<td>&lt;30 years</td>
<td>&gt;50 years</td>
<td>40–50 years</td>
<td>30–40 years</td>
</tr>
<tr>
<td>Job</td>
<td>Student</td>
<td>Housewife/part-time work</td>
<td>Employee</td>
<td>Freelancer</td>
</tr>
<tr>
<td>Professional background</td>
<td>Other</td>
<td>Other</td>
<td>Technical</td>
<td>Economical</td>
</tr>
<tr>
<td>Residence</td>
<td>Small city (&lt;250,000)</td>
<td>Large city (&gt;1,000,000)</td>
<td>Small city (&lt;250,000)</td>
<td>Medium city</td>
</tr>
</tbody>
</table>

concerning the usage rates of EVs in contrast to those of conventional cars are quite different among the four carpools: One company claimed to have substantially lower usage rates for EVs. Two interviewees mentioned that usage rates of EVs were on a similar level to that of gasoline cars. One carpool’s usage rate of EVs even exceeds that of conventional gasoline cars.

All carpools plan to increase the number of EVs used in their carpools in the future. Full EV carpools are trying to enlarge their businesses if it is economically worthwhile to do so. Mixed EV carpools want to raise the percentage of EVs in their existing carpools before launching new, fully-electric carpools.

The four carpool providers have different views on the customers’ incentives for using EVs. Three providers cited EV performance and comfort advantages such as faster acceleration, fewer vibrations and lower noise levels as reasons for customers to drive an EV. All interviewees described environmental friendliness as a relevant aspect for customers. However, one interviewee claimed that zero direct emissions play a role for only a very small group of environmentally-friendly users. The four carpool representatives pointed out that fear of difficulties in handling the new technology, e.g., estimating the driving distance correctly, as well as insufficient range or long charging cycles, acts as an acceptance barrier for customers. Three of the four carpools claimed that these disadvantages were not insurmountable. All interviewees mentioned that customers enjoy being able to test EVs in carpools on a daily basis. However, carpool providers assessed the relevance of this factor differently: one carpool considers this factor as reason number two for using an EV, while two carpools consider it an important factor among others. Since the registration process in a carpool is perceived as complicated, two interviewees pointed out that testing an EV at a car dealer is at least as important for customers as testing in a carpool. Three interviewees saw the customers’ green image as motivation for using EVs in carpools: some customers want to be seen as drivers of EVs because they want other people to consider them innovative, modern, and sustainability oriented. Both station-based carpool providers mentioned charging risks and range anxiety as relevant for them. One interviewee cited difficulties with winter conditions and the poorer EV performance that results.

Analyzing the providers’ interviews allowed us to quantify the level of compliance of interviewees with Rogers’ six factors. Every factor includes several sub-dimensions. If an interviewee has mentioned a sub-dimension, the level of compliance has been increased by one. Since the factors differ in their number of sub-dimensions, the level of compliance was normalized to a maximum of ten (meaning that all sub-dimensions were mentioned) and a minimum of zero (meaning that no sub-dimensions were mentioned). Fig. 3 shows the results for all four cases as spider networks.

All factors are covered by at least two interviewees; however, some interviewees do not consider every factor. With regard to relative advantage, all interviewees addressed the economic profitability. They provide EVs at the same cost as conventional cars: users are not willing to spend more money on EVs, according to two interviewees. One interviewee named economic profitability as the most important criterion for deciding on EVs in carpools, while two interviewees claimed that economic profitability does not influence customer acceptance. One of those two interviewees justified this statement by quantifying the costs of conventional cars and the costs of EVs on a similar level. Another interviewee admitted that EVs might be more expensive for the carpool provider. However, the fact that EVs are primarily used for shorter-distance-trips compensates for this disadvantage. In summary, EVs are not more profitable, neither for carpools nor end users. None of the interviewees mentioned low initial costs, because this aspect seems to be less relevant for customer acceptance in car sharing. Customers do not directly afford initial costs in car sharing, unlike when purchasing a car for ownership. As the initial costs are greater for EVs than for conventional cars [43,44], this aspect reveals an advantage for EVs in car sharing. All carpool providers pointed out the decrease in discomfort issues of EVs, such as lower noise levels, higher acceleration rates and lower internal vibration levels. Since users tend to book luxurious cars more frequently than basic vehicle models, this might persuade the user to book more EVs. Three interviewees mentioned social prestige and qualified this aspect differently. There are two user groups: The first group wants to be “hip and modern” and tends to use EVs as they include a new technology. The other group is the group of so-called LoHas (Lifestyle of Health and Sustainability). Members belonging to LoHas worry about sustainability and they want to produce zero emissions in transportation. Three representatives of carpools mentioned effort and time savings, even though EVs offer no clear advantage over other vehicles. All interviewees claimed that users choose the car based on geographic proximity, rather than the type of engine. This factor might cause an increase in customer acceptance if EVs are available closer to users. Three interviewees addressed the immediacy of reward, because their users experience positive feelings after driving an EV. They attribute this immediacy of reward to the decrease in discomfort issues.

In summary, the factors of economic profitability, decrease in discomfort, and effort and time savings are similarly relevant for all carpools. The aspects of social prestige and immediacy of reward (people feel good after used a “green” car) are more relevant for full EV carpools, because these seem to attract more users focusing on sustainable mobility. Those users consider EV car sharing to be a promising concept. However, no relevant differences between station-based and free-floating systems were identified.

![Fig. 3. Customer acceptance factors identified in provider interviews.](image-url)
All interviewees mentioned compatibility in general as well as compatibility with their values and beliefs. The main statements in this regard are users’ concerns for the environment. The group of LoHaS, in particular, prefers EVs because of the zero carbon dioxide emissions [50]. This kind of compatibility is closely related to the social prestige aspect of relative advantage. Three carpoolers agreed with the compatibility with previously-introduced ideas and they describe their users as technology and future-oriented people. Those people are familiar with new technologies and tend to use new technologies. The combination of two innovations, EVs and car sharing, makes EVs in car sharing more attractive to those people. The compatibility with new communication methods, such as a booking system using a smartphone app, raises this level of attractiveness. Only one interviewee addressed the compatibility with needs in a B2B market. Since legal regulations force larger organizations to decrease their carbon-dioxide footprint, larger companies take advantage of having more EVs in their car fleet. However, no such need was mentioned in a B2C market.

The interviews revealed that users of free-floating carpoolers seem to be more technologically savvy and their smartphone usage is highly compatible with their knowledge of previously-introduced ideas, such as the use of smartphones for mobility purposes. Compatibility with values and beliefs showed that the users of full EVs and EVs are more social and interested in environmental matters.

All four carpool representatives referred to complexity in terms of the difficulty involved in understanding a technology. Users have reservations concerning the new technology, because they do not understand the charging process and the electric drive. Female users, in particular, are noted to be afraid of electricity and charging columns. Furthermore, users are afraid of the limited range of EVs: users can barely estimate the distance of their journey, and overestimate the reserve ranges of EVs, which are shorter than the reserve ranges of gasoline cars. Such user barriers do not apply to plug-in hybrid electric vehicles (PHEVs), because PHEVs do not have the same range limitations as pure EVs. Even though those weaknesses are present and relevant, carpool providers are able to reduce them by making users aware of the range issue using different screens and warning explanations.

The difficulties that are both experienced and anticipated seem to be higher in station-based car sharing systems than in free-floating systems. This might be caused by the fact that charging is not relevant to free-floating systems: users take the closest car that is sufficiently charged, no matter whether it is electric or gasoline powered. Furthermore, the distances covered in German free-floating systems may be shorter than the average trips from Swedish station-based carpoolers, as customers in Sweden often use vehicles from carpools for longer trips.

The four interviewees described the factor of usage difficulty as relevant. While usage itself and the ease-of-use are comparable to conventional cars, users have problems with charging and with the limited range of EVs. Since charging stations differ in terms of methods of payment and identification as well as in the type of electric plug used, not every charging column is compatible with every car. This variety of charging stations complicates the charging process. If users have their own charging stations in their private garages, they perceive the lengthy charging time (6–9 h) as negative. The limited range during winter is a serious problem for many users [51].

Difficulties with the new technology seem to arise in every user group, because no differences were identified between full EV and mixed EV or between station-based and free-floating carpools.

The trialability factor was mentioned in all four interviews. The most important reason for customers to use and test an EV in a carpool is curiosity. Some users are willing to go longer distances to reach an EV than to get to the next conventional gasoline car, just to test drive an EV. Other customers have accidentally taken EVs because, geographically, they were the closest vehicles. This testing aspect is relevant for people who would consider buying an EV, because if they test and experience an EV, this increases the likelihood they may consider owning one. One interviewee pointed out that the majority of users want to buy an EV after they have tested it in a carpool. Moreover, testing an EV in a carpool is considered less complicated than doing so at a dealership, especially if users are already registered at a mixed carpool. All kinds of carpoolers considered the trialability aspect to be an essential criterion for customers using EVs in carpools. Mixed EV carpools benefit from the testing opportunity, because users already registered with such carpools can easily try an EV instead of a gasoline car.

Three carpool providers discussed observability and ease of observing. As vehicles belonging to a carpool are scattered widely throughout a city, they are visible for many people and customers. Providers mark their vehicles as carpool vehicles and highlight the EVs with a special design. However, one provider cannot discern any influence on customers who identify those cars in the street. Some potential customers consider it relevant that their friends or relatives may use EVs and talk doing so. Customers who have used EVs in B2B carpools tend to use EVs in B2C carpools for private purposes. Only one interviewee addressed the ease of communicating mentioning that some customers are influenced by word-of-mouth distribution.

Three interviewees described two relevant factors for risk as perceived by customers: the perceived risk of getting stuck due to EVs’ limited range and the risk of low availability, that is, that users cannot find an EV with a sufficient battery energy level. The risk of low availability applies only to station-based carpools, as free-floating systems allow users to select another car matching their desired range. One interviewee estimates the risks as essential to the success of EVs in a carpool, because users will not accept any risks. Mixed EV carpools have an advantage with regard to range anxiety, because users can select gasoline cars if they are planning longer trips. This advantage of a mixed EV carpool reduces the customers’ fears surrounding limited range and increases the acceptance of EVs.

Customers’ interviews

Since customers who have not yet adopted EVs were preferred as interview subjects (see the Customer adoption and acceptance, and Design of interviews with car-sharing customers sections), none of the customers interviewed had ever driven an EV. However, all of them expected to benefit from using EVs in car sharing. They considered EVs in car sharing to be sustainable if the electricity for EVs is generated by renewable energy sources. Only two interviewees mentioned better driving behavior, such as faster acceleration and fewer vibrations. The costs difference between EVs and gasoline cars that customer would consider acceptable depends on their environmental concerns. Interviewees who are slightly more concerned about the environment than average would accept slightly higher costs, while interviewees whose concern about the environment is much greater would accept a cost increase of up to 50%.

Customers’ reasons for using gasoline cars are related to the performance limitations of EVs. Customers prefer gasoline cars for long-distance rides or rides to the countryside, because gasoline cars can refuel more quickly than EVs can recharge. Nevertheless, interviewees mentioned that the disadvantages of EVs are not relevant to car-sharing systems, because customers use car sharing for short trips in cities and they are free to select a car with a sufficient range. None of the interviewees had a crucial reason that would prevent him or her from using EVs in car sharing. They are afraid that they might not find a charging station in an urgent
situation, and that they might estimate their driving distance incorrectly. One customer interviewed, claimed that using EVs would give off a cool and innovative image and that an EV user might act as a role model for other potential users.

One group of interviewees regards governmental subsidies as helpful when it is sure that EVs really help the environment. Others strictly dislike subsidies and reason that the technology of electric mobility needs to conquer the market without artificial help.

Although two out of four interviewees agreed that testing an EV in a carpool in a natural, everyday environment increases the acceptance of EVs, none of the interviewees had considered registering for a carpool solely in order to test drive an EV. When customers had to choose between buying an EV and using an EV in a carpool, most interviewees clearly opted for using it in a carpool. This was mainly for financial reasons. Carpool customers do not have to foot the bill for high purchase costs or unpredictable maintenance costs.

The four customer interviews were analyzed in order to verify the statements made by providers and to identify further issues not mentioned by providers. Fig. 4 shows the factors brought up by customers in underlined font, factors by providers are in italic font and factors by both providers and customers are in bold font.

The customers interviewed addressed every acceptance factor except for observability. With regard to relative advantage, customers confirmed the companies’ statements. Interviewees use EVs in carpools because of social prestige and advantages such as faster acceleration or fewer vibrations. The customers added a new point based on the environmental aspect: using EVs in cities might reduce fine dust emissions. Recently, the need to reduce fine dust emissions has become increasingly relevant in European cities. They also mentioned the factor of compatibility between providers’ interviews, with the exception of corporate and legal policies, since European companies do not have any legal policies for private persons that motivate people to use EVs. With regard to complexity, customers also mentioned range anxiety and the lack of charging poles, but solely in rural areas. They did not consider technological difficulties such as different plugs, as the providers did. This might be due to the fact that none of the customers interviewed own an EV and none of them had ever recharged one, therefore, they could not be aware of this problem. Statements from both customers and providers overlap with regard to the factor of trialability. With regard to risk, interviews with both customers and providers revealed different findings: customers are afraid of getting stuck only in rural areas but not in the city. Observability was the only factor customers did not mention, which correlates with the fact that providers also attributed less importance to this factor. It is possible that customers did not mention observability as a factor because they live in cities with a small number of EVs. Furthermore, existing EV concepts are based on conventional vehicle concepts, which are not identifiable as EVs for usual private consumers.

In summary, the customer interviews validate the findings of the company interviews. They mentioned similar arguments, which led to the same conclusion: the customer acceptance factors by Rogers are a valid model for describing customer acceptance of PSS. Integrating the new EV technology into the car-sharing PSS reduces the typical disadvantages of EVs.

Findings of the interview study

As seen above, all six customer acceptance factors described in the literature play a role in customer acceptance of EVs in car sharing. The methods by which the interview results were analyzed cannot value the factors, however, the interviews gave the impression that relative advantage and trialability are the two most influential factors. Compatibility is essential only for a very small group of environmental-friendly users. Complexity and perceived risk still seem to be relevant for users of EVs in car sharing.

Nevertheless, carpool companies are able to design car-sharing offers that are better in terms of complexity or perceived risk, e.g. by making it easier to use, and learn how to use, an EV. The factor of observability seems to play only a minor role in customer acceptance: either people are aware of EVs, or EVs in car sharing are not observable enough to influence public awareness. The use of EVs (trialability factor) is perceived to be more important than the observation of EVs.

Hence, to increase acceptance of EVs in car sharing, carpools should focus especially on improving and on pointing out the advantages of EVs. Furthermore, they should focus on reducing the complexity of EV use.

Customer acceptance in four types of car sharing

The user groups of full EV and mixed EV carpools differ in their attitude toward sustainability and environmental friendliness. Users of full EV carpools consider themselves to be environmentally friendly and their concerns about the environment motivate them to use EVs in carpools. The marketing strategy of full EV carpools focuses mainly on the sustainability aspect and satisfies this demand for sustainability. A small group of mixed EV carpool customers, who are also concerned about the environment, use EVs from an environmental perspective. However, this group is relatively small compared to the entire group of mixed EV carpool users. This difference between user groups is reflected in the size and growth of full EV carpools, which have significantly fewer users than mixed EV carpools. The small size of the target group limits the growth of full EV carpools. However, we are likely to see significant growth in the number of people who observe the LoHAS principles, which will put full EV carpools in a better position in the future.

Fig. 4. Customer acceptance factors in customer and provider interviews.

Another reason for the greater success of mixed EV carpools is the more flexible portfolio that is available to customers. If customers plan a trip that is too long for EVs, they are able to take a conventional car from the same carpool.

Most customers of mixed EV carpools who decide on EVs are attracted by the innovativeness of such vehicles. The trialability aspect is more important for this group than for customers of full EV carpools. The majority of customers registers with a mixed EV carpool with the intention of driving conventional cars rather than EVs. Once customers are already registered with a carpool, it is easy for them to test EVs. This kind of carpool reduces the barriers faced by potential customers who may wish to test drive an EV. One of the carpool types stated that a large number of all customers have used and tested EVs, even though the number of EVs available in that carpool is relatively small. One provider interviewed stated that the onlyissue in increasing customer acceptance of EVs is persuading drivers to test them. The relative advantages and compatibility of EVs will ensure their success, as long as people test them. Since mixed EV carpools motivate people to test EVs, the concept of car sharing is a useful approach in order to increase customer acceptance of EVs.

Free-floating systems are more suitable for shorter trips and distances. This makes them more suitable for today’s EVs, which provide a transportation solution for shorter distances but not for longer distances because of limited ranges. Hence, fewer complexity and risk issues arise for customers of free-floating systems. Fig. 5 provides an overview of the four carpools investigated and their characteristics.

Differences between Swedish and German car-sharing systems

When the differences between carpools in Germany and Sweden were considered, two main aspects are obvious. Today, only station-based carpools exist in Sweden. In Germany, large free-floating systems have emerged over the last three years. They show growth rates in Germany of over 130% in 2013 [52]. This may be due to two relevant aspects that were mentioned in the interviews: one is that free-floating systems seem to be an evolution of station-based systems. Five years ago, Germany had mainly station-based carpools. It is possible that Sweden has not yet begun the evolution toward free-floating carpools, but that this step may soon begin. The other reason is that Swedish cities are smaller than German cities. Free-floating systems first emerged in large German cities, such as Berlin, Hamburg, Munich, and Cologne. In Sweden, only Stockholm is comparable in size (897,700 inhabitants in 2013). However, successful free-floating systems do exist in smaller German cities such as Ulm (117,541 inhabitants). Other larger Swedish cities such as Malmö (312,994 inhabitants) or Gothenburg (533,271 inhabitants) are considered suitable for free-floating systems. This issue is connected more to the evolution of car sharing than to the size of the cities. Political issues, e.g. the availability of parking licenses for free-floating systems are also relevant (according to providers’ interviews).

The second difference between the two countries is the focus on safety: the interviews revealed that Swedes are extremely focused on car safety. Many public institutions, as well as large corporations, have policies that permit the use of cars only with a five-star ranking in the Euro NCAP crash test. This limits the applicability of EVs to those that have a five-star ranking. In Germany, this aspect was not mentioned in a single interview (neither customers’ nor providers’ interviews) and therefore seems to have less influence on customer acceptance.

Increasing customer acceptance by PSS

Relative advantage and compatibility, such as environmental benefits and better driving performance, are inherent to the use of EVs. Furthermore, it has been shown that car-sharing companies (i.e. the provider of the Product-Service System) can reduce the complexity of EV usage. This also leads to customers perceiving fewer risks connected to the use of EVs in car sharing. Observability is the only factor that seems to be less important for customer acceptance. Hence, it finally comes down to trialability: the final step in convincing customers to use EVs, in general as well as in carpools, is to persuade them to test drive an EV and make them aware of the relative advantages. This can be achieved by gradually introducing EVs in large, existing, free-floating carpools with mainly conventional gasoline cars. Here, EVs are used in the manner that is closest to their most advantageous field of use. Then, the proportion of EVs in these mixed carpools can be gradually increased as customers get used to the technology and their fears are assuaged. Over the long term, the performance of EVs (range and charging times) will ameliorate. In this case, introducing the new EV technology in the car-sharing PSS may increase overall customer acceptance. Integrating EVs into a carpool can overcome both existing and perceived disadvantages. To sum up, this leads to the conclusion that the theory is valid for EVs in car sharing, and PSS are a suitable way to bridge performance gaps between old, established and new technologies.

This study showed that implementing EVs in car sharing can increase customer acceptance of EVs. Considering this statement in a broader sense, we can surmise that using the concept of PSS helps to increase customer acceptance of innovative products. The PSS protects the customer from the drawbacks of the innovation and increases its relative benefits. Examples of disadvantages of EVs are high purchase costs and limited ranges. The PSS’s ability to offer cars for short distance trips mitigates this weakness. Moreover, renting the car to the customer instead of selling it reduces the negative effect of high purchase costs: PSS can increase products’ relative advantages. PSS may also reduce the complexity of innovative products and make them more attractive to customers. Providing suitable services (e.g. the carpool company is responsible for charging EVs, not the customer), will diminish complex challenges for customers. PSS can also break down barriers...
preventing customers from trying out or testing a product, which increases the product’s trialability. Since renting or leasing a product is easier for the customer than purchasing it, PSS provide products that can be tested more easily. If the PSS provider owns a physical product and rents it to the customer, the provider is free to determine, and modify, the product’s design. This enables the provider to increase the product’s observability. EVs in carpools could be equipped with a distinctive logo or color to make the car conspicuous to other drivers or pedestrians. PSS can also increase customer acceptance of risks. By taking over the responsibility of uncertain activities for the customers, the provider reduces the risk to the customers. Potential EV customers might not know how to maintain an EV, therefore maintenance of EVs is an uncertain activity for them. In a carpool, providers are responsible for maintaining EVs, which reduces the risk to customers. Furthermore, back-up solutions can reduce risks. The conventional cars in mixed EVs carpools serve as a back-up solution for EVs.

The PSS can influence five factors in a positive way; only the effects of PSS on the factor of compatibility should be considered more differentiated. Even though EV car sharing is compatible with LoHaS values and beliefs, this cannot be generalized to all innovative PSS regarding other customer groups. However, the sustainable character of PSS [12] may convince people who believe in the innovation to adopt EVs [50]. Beure et al. [53] reported that users prefer to own a product rather than renting it, because owning a product gives them more flexibility and a better feeling [53]. Adding suitable services may enable the PSS to make the product more compatible with previously-introduced ideas or technologies. In the case of EVs in carpools, such a service was the smartphone booking app [54,55].

In conclusion, the benefits PSS brings for the diffusion of product innovations are based on the trialable character of PSS. While customers tend to avoid buying a product innovation in the early phase of diffusion, PSS do not force customers to purchase the innovation: Customers can try the product once or several times to verify that the innovation does, indeed, add value. Once they have tested the innovation, people might talk to friends, relatives, or colleagues about their experiences, whether or not they decide to purchase the product innovation. This accelerates the diffusion process and motivates other people to test the innovation. Furthermore, while testing the product, potential customers become familiar with the innovation and learn about its benefits and weaknesses.

Conclusion and outlook

This paper shows that providing innovative products as PSS can increase customer acceptance of innovations. This finding is based on interviews held with PSS providers of EVs and used the theory of diffusion of innovations as a theoretical basis, which has also verified the relevance of this theory. Furthermore, those findings were double checked and the validity of the results verified in customer interviews. The weaknesses of this study are related to the nature of interview studies. The interviewees’ credibility has to be called into question. Managers of carpools, in particular, have to consider their position in their company and cannot make statements that are critical to their company. They might tend to overrate the advantages and chances of carpools, and possibly underestimate risks or conceal problems involved with EVs and carpools. However, customers’ interviews were analyzed in order to redress this problem, because customers do not have the same motivation to make inaccurate statements as managers. Another weakness of interviews is that the interviewees may not express all of their comments, feelings and thoughts. This weakness was reduced somewhat by the structure of the interviews, according to the six factors, but it cannot rule out the possibility that interviewees may forget important points. The number of providers and customers interviewed, four each, is not considered representative. This number is not representative for a fair analysis of customers’ and providers’ statements using questionnaires or surveys. Since this is a qualitative, not a quantitative, study, however, the number is sufficient. The target groups were analyzed in depth and not in breadth. The study and results are based on the “diffusion of innovations” by [1]. This theory enabled the interviews to be structured logically. Weaknesses and criticism of this theory are also applicable to this work. It was shown that PSS can increase the customer acceptance regarding the factors of relative advantage, risk, trialability, observability, complexity, and, in part, compatibility. However, the PSS approach still has some limitations concerning the factor of compatibility. Future work might focus on planning and designing PSS to become more compatible. As stated in the introduction, PSS can bridge performance gaps facing innovative technologies and can also facilitate an earlier market readiness of innovations. This work identified ways in which carpool companies can reduce EV disadvantages and limitations. Nevertheless, future research must be conducted in order to gather further evidence, as well as to investigate different categories of PSS according to [2]. So far, the theory stated with [25] seems to be promising, but needs further scientific judgment.

There is still a need for research in order to plan and design an innovative PSS, because PSS have disadvantages in terms of other customer acceptance factors [16,56,57]. Authors [16,56,57] identified several factors such as trust, financial aspects, and flexibility that describe negative influences of PSS on customer acceptance. Those factors also have to be considered in PSS planning and design stages. The focus lies on innovative products and on how to increase their customer acceptance. However, certain products do lack in customer acceptance despite their innovative character. The lack of customer acceptance is also caused by factors such as cost, reliability, and availability of products, and there is still a need for research into how those factors can be influenced by PSS [58]. Future work should focus on those other factors and how PSS can be planned and designed to reduce the influence of customer barriers [59–61].

This work has identified and detailed differences between the German and Swedish car-sharing markets. In particular, the assumption that free-floating carpools represent an evolution from station-based carpools is a hypothesis that may be validated in the coming years. It will be relevant to examine whether, and if so, under which circumstances and surrounding conditions free-floating carpools will emerge in Sweden. Development of full EV carpools in Germany and Sweden is of interest, especially in relation to the larger and faster-growing mixed EV carpools. The development of the proportion of EVs included in carpools is to be considered in detail. The creation of government incentives may also play an important role and could lead to future differences between Germany and Sweden. This work provides a glimpse into differences in customer acceptance, but the findings and assumptions need to be verified with a broader scientific basis, especially the statement that free-floating mixed EV carpools may play a decisive role in increasing customer acceptance of EVs. Studies involving users of these different kinds of carpools could offer insights.

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