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Service Innovation for Sustainable Urban Electromobility: A Systemic Approach to Economic and Social Adoption

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Abstract

The transition to urban electromobility faces significant challenges in regions with underdeveloped public transport infrastructure. This study investigates how service innovation can drive economically sustainable adoption by integrating technical solutions with stakeholder collaboration and user engagement. Through a systemic-relational framework, we collaborated with municipalities, industry partners, and academic institutions to develop and test solutions across four critical dimensions: (1) scalable charging infrastructure, (2) innovative business models, (3) multi-actor coordination mechanisms, and (4) socio-cultural acceptance strategies. A case study in a mid-sized German city demonstrates that combining technical deployment with value-added services not only reduces operational costs but also unlocks new revenue streams and shifts mobility behaviors. A key finding is the "flow factor"—emotional engagement through experiential marketing and user-centric design—which significantly boosts adoption rates and usage intensity. Our analysis highlights the necessity of aligned policy incentives, strategic investment frameworks, and cross-sector partnerships to build resilient electromobility ecosystems. The paper concludes with actionable recommendations for policymakers and industry leaders to accelerate sustainable urban mobility through service-driven innovation.

Keywords: service innovation, urban electromobility, sustainable mobility, business model innovation, stakeholder collaboration, charging infrastructure, behavioral adoption, flow factor

Introduction

Many studies conducted the future of electromobility (e-mobility) in urban areas (e.g. Pötscher et al. 2010; Boston Consulting Group 2009). Transforming and changing urban mobility into sustainable mobility, e-mobility is considered as a future innovation by taking certain issues into account (Döring 2012, p.563-571). The transition into e-mobility will thus be a challenge and a chance for urban regions to design an environmentally friendly and sustainable mobility form. Urban areas as traffic agglomerations are more likely to become livable cities which also was stated in the work of Gehl (2010). Making cities of the future people-friendly means recreating cityscapes on human scale which includes changing demographics and changing lifestyles. Cities has to be developed lively, safe, sustainable and healthy (Gehl 2010). The transition from petroleum-driven mobility through to e-mobility makes the entire transport system environmentally friendly.

Most of the mobility activities happen in a space of few kilometers, 90% of the cars drive less than 50 km per day (Wietschel & Dallinger 2008). That means that cars are "standing vehicles" for up to 97% of their entire lifespan (Wietschel & Dallinger 2008, p.8-16). These road journeys can be covered by e-mobility without any problems of limited range or loading capacity (Zumkeeer 2011). About 85% of the population is living in cities or regiopolitan areas; in this socio-geographic area most of the short distance traffic happens which is suited for the use of e-mobility (Fraunhofer IAO/PWC 2010; Cresswell 2011; Sheller/Urri 2006; Joos 2011).

Compared to conventional energy resources, e-mobility is energy efficient. As its energy resources are diversified, e-mobility is economically interdependent. The energy supply of electric vehicles is climate-neutral if only renewable energy sources are employed.

E-mobility continues to benefit from the advantage due to the zero-emissions in cities greatly relieving from exhausts and particulate matter. Furthermore, it is considered to be noise-reducing. The range problem is a theoretical problem as 80% of all road journeys are less driven than 50 km per day (Wietschel & Dallinger 2008). However, there are technical and economic arguments against e-mobility as well. The battery technology has needs to be improved because its acquisition is still too costly. Compared with normal drivers, its energy costs are lower especially in the short distance traffic. The charging infrastructure has to be extended. Using e-mobiles is not only linked with technical advantages and disadvantages, but also with a huge amount of social-cultural barriers of acceptance (German Federal Ministry of Traffic, Building and Urban Affairs (BMVBS) 2009). Compared to technical limits, these „soft" barriers are far more difficult to resolve from a social scientific perspective.

Up to now, the discourse on e-mobility concentrates very much on technical issues. The delays and great deal of resistance hinder most innovation progresses. To hampering factors that prevent electromobility we noticed socio-cultural problems

that are of very high relevance in terms of promoting electromobility as service innovation in regiopolitan areas. This issue has been attended insufficiently and so, it is noticed as a research lack in the context of promoting new mobility in Germany. The Fraunhofer Institute for Systems and Innovation Research (ISI) focused on the issue of the acceptance level of electromobility in the society (ZEIT-online 2011). A problem of acceptance is a problem of information. In this project, we counter this challenge by developing a communication strategy by establishing a competence center for e-mobility. However, people learn best when they are actively involved in the learning process that means that users can practically test e-mobiles and e-bikes. Testing and using e-mobility has been identified as key promoters of social acceptability.

The rest of the paper is structures as follows: Problem statement, methodology and empirical case study, results and conclusion.

Problem Statement

A change towards e-mobility is not only related to the change vs. replacement of vehicles, but also to a change in infrastructure, market actors and business models. It signifies a change of social-cultural systems regarding mobility habits, practices and values (Peters et al. 2012). This can be achieved by changes in behavior and changes of contexts for instance through a change in the public discourse around e-mobility and increasing the attractiveness for the users so that the "coolness of flow" factors rises (Bergmann et al. 2015).

In most of the studies on e-mobility, user acceptance of e-mobility is indicated to play a key role in terms of new mobility. The probability of rational justified changes is lower than raising the emotional perception by using electromobility and increasing visibility (Schneider et al. 2013). In Germany, cars still have a function of distinction and status although this just decreases in the younger generation (age of 20-30) whereby the older generation is still too much fixed on cars as a status symbol (Bratzel 2011). This entails that the issue of mobility is not purely a technical issue. Mobility habits and concepts are strongly socially influenced and shaped by habitual behavior (Bergmann & Daub 2016). Younger generations are currently undergoing a transformation towards a sharing and collaborative economy that includes a mobility change to share and use cars instead of owing them (Timescout 2010; Gsell 2015).

This research project started in 2014 and is still in progress. Its goal is to promote and develop regional e-mobility by a network of different actors. This field research is located in Siegen, a regiopolitan area in Germany. The city of Siegen is a university town with about 19.000 students that shows the big relevance and the need of a well-frequented local public transport (University Siegen 2016). At this point, the project realization faces difficult challenges as there is no developed infrastructure for new mobility.

The objective of the project is to introduce the conditions of e-mobility in an urban and rural structured area by a networked innovation cooperation with 5 regional companies including the city of Siegen and the University of Siegen which happens in 4 development steps. There is a research lack of introducing and analyzing regional e-mobility by an integrated network of different actors in a field with no developed infrastructure for new mobility. The central goal of the project is the integrated development of service innovation of technical and non-technical manner based on network with project partners. Specific application-orientated approaches will be developed in this field to transform cross-linked systems of regional mobility into e-mobility. This happens in four separate and collaborative processes. The goal is to connect and realize these service developments. The challenge is to introduce the conditions of e-mobility in an urban area without a well-frequented local public transport by a networked innovation cooperation. The project is divided into four development steps. We have the expectation that the integrated project partners will realize these four development steps.

ECARPOOL = Converting the fleet into e-mobility

RESTRO = Service system regional charging stations (local charging stations)

EMOCAS = Service system e-mobile-carsharing

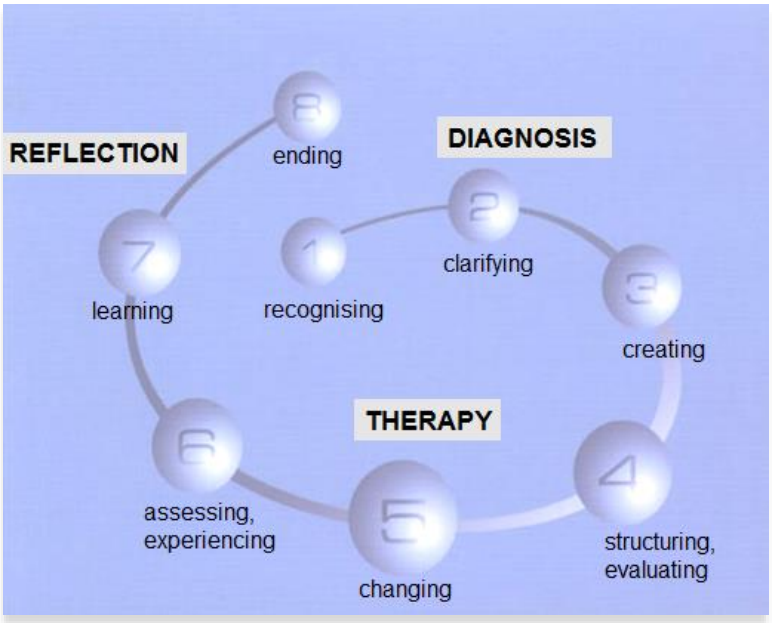
KOREMO = Service and competence-center for regional e-mobility.

In most cases, isolated and technology - focused innovation strategies are considered in terms of promoting e-mobility in Germany. Combining these four different development steps in a networking approach with integrated project partners makes this project innovative. Developing service innovation for e-mobility in an urban but rural area requires a contextual-relational approach (systemic theory) to integrate all actors in this process (Seidl & Becker 2006; Luhmann 2001).

Methodology

We work with the systemic-approach to develop service innovation. This approach is based on the process design of the “Solution Cycle” according to Bergmann that consists of three main steps: diagnosis step, realization (therapy) and reflection (Bergmann & Daub 2008).

Figure 1: The Solution Cycle as a Process Design



(Source: Bergmann 2014, p.23)

Based on this systemic-relational approach, solutions for complex problems within a social constructed reality become more possible. This will be achieved by an iterative communicative interaction process. Following this approach, the project can be divided into three main project stages. The first stage of the networked innovation process is designed perceptually (diagnosis) which is characterized by the step one (recognizing) and step two (claryfing) as the foundation of the four innovation developments. Throughout the entire project, the diagnosis step is most relevant and decisive for the further development of the project. After many workshops in the years 2014 to 2016 with project partners, discussions with experts, integration of different actors, public relations and networking, the project is now located in the process between diagnosis and realization.

Results

The project is a networked innovation project which is built up into four different developing sectors (Ds) and seeks to introduce the conditions of e-mobility in the city of Siegen. In the Ds ECARPOOL the key question is how the conversion of the company car fleet of the city can be realized in electromobility. The Ds RESTRO (local charging stations) deals with the question how and to what extent a charging system for the regiopolitan area can be established. In the Ds EMOCAS (e-mobile carsharing) various issues are processed, such as how an e-mobile-sharing system can be established in the city area. The fourth developing sector KOREMO (competence center for e-

mobility) focuses on the design and practice of a public information point for electric mobility as a central issue.

Level of development in the developing sector ECARPOOL

The objective was preparatory work for the analysis of mobility in the city. Moreover, the mobility analysis should be realized by an appropriate professional institution. For example, the city administration pays more attention on the internal vehicle procurement in the public order office that electric cars are being purchased. The cars are used in urban areas and the electric vehicles are particularly well suited for the intended use. Moreover, many contacts have been initiated in the region and the regional policy to promote electric mobility. The city has also been strongly involved in the development of the discussion about charging stations and initiated contacts with a regional manufacturer of charging stations. State of affairs is that two quick charging stations were provided by this manufacturer and are free of charge. These charging stations are intended to supplement the public charging stations infrastructure.

Level of development in the developing sector RESTRO

Establishing a public nationwide charging infrastructure with "multi-chargers" would be too expensive. Business models need to be developed with a combination of home charging, charging stations for employers and the public charging infrastructure on the basis of an investor model. In the selection of operators of charging stations, an investor or sponsor model has proven to be the best possible solution for the first phase of the project. In workshops, a framework has been set to connect possible charging stations suppliers with potential buyers or investors. In the work of these development workshops, the expertise of two further regional charging station manufacturers has been integrated. Critical to see are the (six) different and incompatible accounting systems of the operators of charging stations so that standardization seems important here.

At the start of the project, three public charging stations (double charging points) with six charging points existed in the city. From the perspective of the public utility company putting up charging stations only in combination with an electric-carsharing system is useful and otherwise the charging stations are used insufficient. Here the billing method is considered to be problematic, especially if the accounting systems of individual power providers are not compatible (roaming systems). This aspect is considered to be extremely important for a comprehensive supply with charging stations because it limits the usability of the charging stations and is regarded as a major obstacle to the establishment of a charging station network.

Level of development in the developing sector EMOCAS

In the regiopolitan area Siegen, the supplementation with other concepts is meaningful and cooperation with other decision-makers as well as organizations and

institutions should be established (network expansion). Neighborhood-based solutions are discussed. Ways to create a combination of living and housing related to car-sharing are currently studied with other partners. For the housing industry it is a possibility to create a more attractive value.

The development of a semi-public car-sharing can be a viable business model. During the day (e.g. from 7am to 5pm) the vehicles are used by organizations or companies and serve as service vehicles and on the weekends and evenings or at night the vehicles will be provided to citizens under car-sharing terms. The car pool should include not only electric vehicles but also vehicles with combustion engines or hybrid technology to cover longer distances. This mixed form on offer is meaningful to make people familiar with the new technology, reduce tension and to alleviate the "range discussion". Furthermore, turned out in the diagnosis that a purely electric car sharing in a rural area that still has no previous experience with car-sharing services, cannot be operated profitable.

Level of development in the developing sector KOREMO

An important knowledge of the first “e-mobility conference of Siegen” in 2014 was the great interest of citizens in the wide range of electric vehicles. It was stated that this interest was associated with a lack of experience and a lack of information. The exhibited electric vehicles have been extensively and continuously used by visitors of all ages. As part of the objective concept, the core tasks, were defined and already first approaches to public relations were developed. The exhibition concept revealed two sub-areas. Companies are offered an initial consultation for their vehicle fleet management. Furthermore, the center realizes through workshops a close cooperation with policy makers and stakeholders. Citizens can check locally through various electric vehicles and sea trials. This is made possible by the project partners and a further newfound value partner.

At the interface between the two groups, information and mobility events are regular organized by the competence center and a virtual mobility platform is going to be set up, which acts as a focal point for citizens and businesses. Suggestions for improvement can be posted and discussed.

Conclusions

This paper outlined that the future of electromobility is in urban areas. The end of the automobile (path-) dependency forces cities to move beyond car-based city planning. Therefore, the mobility culture has to be changed by two central factors: the mental approach to mobility options and the infrastructural conditions. The transition into electromobility will thus be a challenge and a chance for urban regions to design an environmentally friendly and sustainable mobility form. Urban areas as traffic agglomerations are more likely to become livable cities which also was stated in the work of Gehl (2010). In regiopolitan or urban areas most of the short distance traffic happens which is suited for the use of electromobility. The change towards

electromobility is not only related to the change vs. replacement of vehicles, but also to a change in infrastructure, market actors and business models. It signifies a change of social-cultural systems. This can be achieved by changes in behavior and changes of contexts. In most of the studies on electromobility, user acceptance of electromobility is indicated to play a key role in terms of new mobility. The probability of rational justified changes is lower than raising the emotional perception by using and testing electromobility.

Our project goal is to introduce the conditions of electromobility in an urban and rural structured area with a high automobile- dependency. We work in a networked innovation cooperation with regional companies. The central goal of this work in progress is the integrated development of service innovation of technical and non-technical manner based on network with project partners. Developing service innovation for electromobility in an urban and rural area requires a contextual-relational approach to integrate all actors in this process. We expect the development of specific application-orientated approaches in this field to transform cross-linked systems of regional mobility into electromobility. This happens in four separate and collaborative processes. The goal is to connect and realize these service developments. Two key results have been emphasized as critical factors for e-mobility success so far:

Emotional perception by using experiences of electromobility has a positive effect on the social acceptability of electromobility which raises the "coolness resp. flow factor" of electromobility.

A well-developed infrastructure of the local public transport is fundamental to change the automobile-focused mobility culture and promote future mobility that isn´t about less mobility, but rather a different way of being mobile and using different types of mobility solutions.

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