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Product-Service Systems across Life Cycle

Business Models for Electric Mobility

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Abstract

Which business models successfully compete in the electric mobility market? High initial costs for electric vehicles and a slow adoption to the mass market result for many companies in almost insurmountable barriers to entry. The presented article introduces a framework for the analysis of e-mobility business models by defining central business model patterns, customer segments and essential key values of electric mobility. Thereby, the aim is to systematically identify e-mobility business model potentials. From the perspective of all stakeholders involved, this helps to overcome existing barriers to entry. Interviews with several mobility, energy and infrastructure providers have been conducted to apply the theoretical framework and to ultimately answer the opening question as follows: Those business models which at least address one aspect of the so called "multifunctional utilisation of electric vehicles" or a high service orientation have the best chances to successfully compete in the electric mobility market.

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Keywords: E-Mobility Framework; service-oriented Business Models; multifunctional Utilisation

1. Introduction

Currently, the lifecycle costs of electric vehicles are high [1]. However, there is the potential of cost savings during the operation time [2]. The high initial price for the electric vehicle with its integrated traction battery raises the lifecycle costs, but the required energy for electrical driving is less expensive than gas for conventional cars. Consequently, business models which increase the utilisation of electric vehicles and therefore reduce the costs per kilometre are needed. This demand is met by the multifunctional utilisation of electric vehicles which includes the following three aspects:

- The cooperative utilisation of electric vehicles enables the collective and coordinated usage of the same electric vehicle by heterogeneous user groups.
- The cooperative energy management comprises the aimed integration of electric vehicles in the energy supply as controlled loads as well as decentralised energy storages.
- The supra-regional charging increases the user-flexibility and supports the cooperative utilisation as well as the energy management.

The innovation adaption curve by Rogers [3] describes how new technologies are accepted by customers. Presently, electric mobility can be located in the transition of the innovators to the early adopters phase [4] where just a few companies make offerings, and only for a small market.

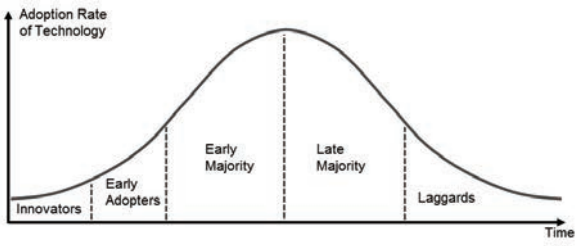

Figure 1: Typical Innovation Adoption Curve for a new Technology following [3,5]

Hence, a precise understanding of existing business models and their potential to enhance the multifunctional utilisation of electric vehicles is required in order to lower the barriers to entry for companies willing to invest in electric mobility. For this reason, the presented paper introduces a framework for the

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systematic analysis of e-mobility business models. Based on this analysis, energy, infrastructure and mobility providers are empowered to methodically define new business model potentials which close the initially described gap. In chapter 2 and 3 the framework's elements are theoretically derived. Chapter 4 defines the framework for e-mobility business model potentials in detail, whereas the framework's actual application is shown in chapter 5. Chapter 6 sums up the central findings and gives an outlook on future research.

2. E-Mobility Business Models

In section 2.1 the central findings of the literature review of electric mobility business models are presented. Based on this review five identified business model patterns are described in detail in section 2.2. A closer look on these patterns results in six so called key values for electric mobility, which are introduced in section 2.3.

2.1. Literature Review

This section constitutes the essential findings of the literature review on electric mobility business models and their associated frameworks. The basic parameters of the literature review are:

- 27 key words in English and German language (e.g. e-mobility business model; electric car business; electric car-sharing; e-mobility framework etc.)
- search engines: Elsevier, ScienceDirect and google.scholar
- 230 suitable literature sources
- mainly considered publication period from 2009 to 2016

A detailed investigation of different business model types and e-mobility frameworks for business models reduces the amount to 67 relevant publications. They are distinguished into 18 monographs, 17 journal papers, 16 conference papers, 2 working papers and 14 other sources (including project reports and surveys).

Figure 2 shows the total number of often described e-mobility business models in the selected literature. One literature source can be assigned to various business model patterns. In addition, one column presents existing e-mobility frameworks.

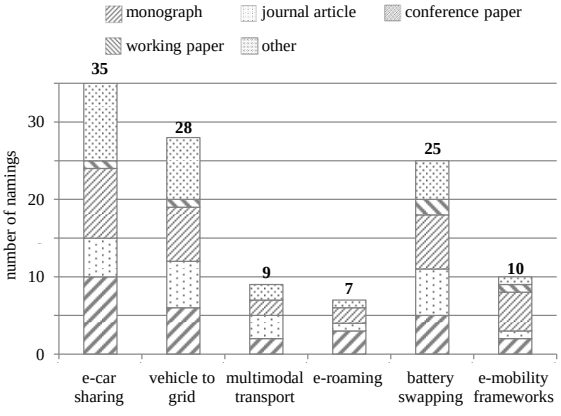

Figure 2: Central E-Mobility Business Models and existing E-Mobility Frameworks in the analysed Literature

2.2. Central Business Model Patterns for E-Mobility

Subsequently, the identified business model patterns from literature review are described in detail.

E-Car-Sharing

High fixed costs for power-driven vehicles, few parking space in urban areas [6] and the behavioural change from property to use [7] as well as the loss of importance of a vehicle as a status symbol [8] are significant driving forces for e-car-sharing. E-car-sharing contains an electric vehicle fleet which is offered to a closed user-group in a defined business area. Normally, the application time of the vehicle is clearly shorter than in rental business [9]. A crucial advantage is the value co-creation between the customers and the car-sharing provider. For instance the customer has the possibility to earn extra bonus when loading an electric vehicle [10].

Intermodal Transport

Intermodal transport is the combination of individual and collective transport. The customer makes use of different transportation modes and services to manage the distance. In that case the electric vehicle is always a part of an intermodal transportation solution. An intermodal mobility provider bundles the transportation offerings from other providers [9] on one platform and runs the central billing. Furthermore, the route planning and combination of transportation modes is organized by the provider and offered as a service.

Vehicle-to-Grid (V2G)

Private vehicles are actively in use in an average of 4% of the time. In consequence, vehicles are potentially available 96% of the time [11]. In the V2G business model pattern the mentioned standstill times of electric vehicles and ultimately the capacity of the integrated transaction batteries are used in return for payment of a fee. Battery owners can earn money while the electric vehicle is connected to the grid. Grid operators are able to purchase battery capacities for regulating short term load peaks and storing renewable energies [12]. Normally, an aggregator is needed who bundles the connected capacities of the vehicles to one megawatt units for the grid operator [11]. This means, connecting the electric vehicle to the power grid has benefits for the owner of the battery, the aggregator and the grid operator.

Battery Swapping

Primarily, this business model pattern compensates the high cost component of the traction battery compared to the full electric vehicle price. Equally, the risk of early ageing batteries and technological leaps [9,13] as well as long charging times can be reduced through battery swapping. Battery swapping requires a compatible interface between electric vehicle and swapping station [13]. Under this prerequisite, the battery swapping provider has a contract with the customer, which contains the automated swapping of discharged to charged batteries for the electric vehicle. As the owner of the battery pool, the provider follows his own optimised charging strategies [13], whereas the customer possesses a battery only temporary. The swapping principle is similar to the gas station