Leibniz Universität Hannover

'Data-based Services in the Vehicle-to-X Market – Developing B2B Business Model Approaches for Data-based Services in European Markets'

Masterarbeit

zur Erlangung des akademischen Grades „Master of Science (M. Sc.)" im Studiengang Wirtschaftsingenieur der Fakultät für Elektrotechnik und Informatik, Fakultät für Maschinenbau und der Wirtschaftswissenschaftlichen Fakultät der Leibniz Universität Hannover

vorgelegt von

Name: Lafeld   Vorname: Philipp

██████ ██████████   ████ ████████

Prüfer: Prof. Dr. rer. nat. M. H. Breitner
Betreuer im Unternehmen: Steffen Zacharias

Ort, den: Hannover, den 31.03.2022

Table of Contents

1 Introduction

1.1 Motivation and relevance of the topic

To counteract climate change, one of the biggest challenges is the flexible storage of renewable energy [3]. Unlike fossil fuels, renewable energy needs to be stored after it is produced, as it is not continuously available. Due to this fluctuating availability, continuous supply relies on intermediate energy storage [4]. Furthermore, this increasing but inconsistent delivery of renewable energy amplifies big challenges. On the one hand, load peaks must be absorbed ad on the other hand, the reliability of the supply has to be guaranteed. In order to maintain the balance of the electricity grid, the energy supply must match the energy demand, or the energy must be temporarily stored [5]. This is a major challenge for the energy industry. There are several ways to store electrical energy. An example are accumulators (in the following thesis the term 'battery' is used instead of 'accumulator' as this term is more common) for electric vehicles (EVs). Due to the increasing demand for electric vehicles, the production of batteries is also increasing [4, 6, 7]. Consequently, the batteries in the electric vehicle offer additional storage capacity during the time when they are not used. This storage capacity offers opportunities for a new approach to the interaction between the electric vehicle and the electricity grid. Most electric vehicles today can only draw the energy from the electricity grid. However, by using bidirectional chargers, it is also possible to feed electrical energy back into the electricity grid [8]. This technology is called 'Vehicle-to-Grid' (V2G) and belongs to the umbrella term 'Vehicle-to-X' (Vehicle-to-Everything or in this thesis: V2X). The first considerations and concepts for the V2G principle already date back several years, being first mentioned in literature in 1997 [9]. The V2X technology is considering the use of electric storage in the batteries of electric vehicles for uses other than powering the vehicle. The best-known applications of this technology besides V2G are Vehicle-to-Building (V2B) (increasing self-generated renewable energy or powering in times of outages), Vehicle-to-Load (V2L) (powering a remote site or load without power connection), Vehicle-to-Vehicle (V2V) (Transmission of electrical energy to other EVs in emergencies) [1].

Large fleets of electric vehicles offer correspondingly large capacity of storage and thus additional opportunities for an intelligent and profitable interaction between the vehicle and the grid. For example, concepts for bus fleets could be developed so that the buses, due to their predictable use, would be beneficial in providing storage capacity during driving downtime and in developing smart charging strategies for the entire fleet [10, 11]. Also, an intelligent interaction between vehicle, building and potential solar energy systems could provide a reliable and sustainable energy supply at e.g., home or at a workplace while the vehicle is not in use [8]. For example, the Nissan Leaf e+ with a 62-kWh battery can store the energy of four days for an average Japanese home [12]. There are already some V2X pilot projects [13, 14,

15] whose aim is to find out whether V2X technology could offer opportunities for a flexible, sustainable, and reliable energy supply [16].

1.2   Research gap, objective, and questions

Participants in the V2X market have already made concept proposals and ideas and formulated first business model approaches. Nevertheless, there are many challenges and areas where further research is needed. First, it is necessary to understand the complexity of the market for V2X service and their economic sustainability. Concepts on potential revenue streams and sustainable business models need to be further developed, implemented, and tested. Along with this understanding also, participants in this market must be identified clearly, and their expectations must be clarified. A comprehensive analysis of the stakeholders, their interests, and their relationships is necessary and has not yet been sufficiently carried out. Important stakeholders could stem from the energy sector, the automotive industry or government authorities, but also end users [17]. Especially in the energy sector, individual stakeholders have different experiences using electric mobility and also with the evaluation of the accumulated data. These experiences need to be considered when developing business models and require further research. Furthermore, the differences between different countries, e.g. in terms of standards or status of V2X technology, are an important point of further investigation which lead to a better understanding of the whole V2X market [17, 18, 19]. The hardware components to enable bidirectional charging are currently not used in most electric vehicles, but this is expected to change. Car manufactures, like e.g. VW, have recently announced that from 2022 onwards they produce their electric vehicles only with bidirectional charging components [8, 20, 21]. Considering the findings and challenges so far, V2X could have a great potential to become a relevant part of a sustainable energy supply and it should be investigated further.

Consequently, the first objective of this master's thesis is to identify the expectations, motivation, and objectives of the relevant stakeholders in the European V2X markets as well as other relevant countries. In addition, the status quo, and future opportunities especially in the direction of standardisation in these markets is examined. On this basis, the main objective of the work is to develop B2B business model approaches that take into account the previously mentioned points and examine the services in terms of their data. Due to a larger total battery storage in a fleet of EVs compared to the storage of a single private EV, it makes sense to start the investigation of business model approaches in the B2B area [10]. As two special areas of this market, research in the V2G and V2B markets takes the lion´s share in this thesis. Furthermore, a geographical focus is placed on countries in the emerging European market. Against this background the first two research questions motivate this master's thesis:

> *RQ1:   Which countries are emerging as key players in the V2X market?*

> *RQ2:*   *What is the status quo and which opportunities exist especially regarding standards in these markets?*

As mentioned above, the development of a business model focuses on the B2B field. To gain an understanding of the market and its participants in this area, answering the following research question is helpful:

> *RQ3:*   *Who are the relevant stakeholders in the V2X markets and what are their expectations, their motivation, and their objectives when participating in these markets?*

As defined above the general framework is limiting this thesis to data-based services in the V2X market. In conclusion, the focus is placed on data-based business model approaches instead of general business model approaches in the V2X market. Based on this defined framework and the preceding research questions, the main research question is:

> *Main RQ:*   *How can a sustainable B2B business model for data-based services in a V2X market be implemented?*

1.3   Methodical procedure and structure

In the following, the structure of this thesis as well as the methods, theories and models that were employed to answer the research questions and reach the objective of the thesis are explained. The study is based on data from literature and studies that have already been carried out in addition to collected data based on qualitative interviews. Accordingly, the thesis follows the principle of empirical work with qualitative methodology. Its content is divided into three main parts which are developed through three steps as shown in Figure 5. These main parts are: a literature review with the theoretical background, an analysis of the expectations, objectives, and motivation of stakeholders through interviews, and the development of data-based business model approaches.
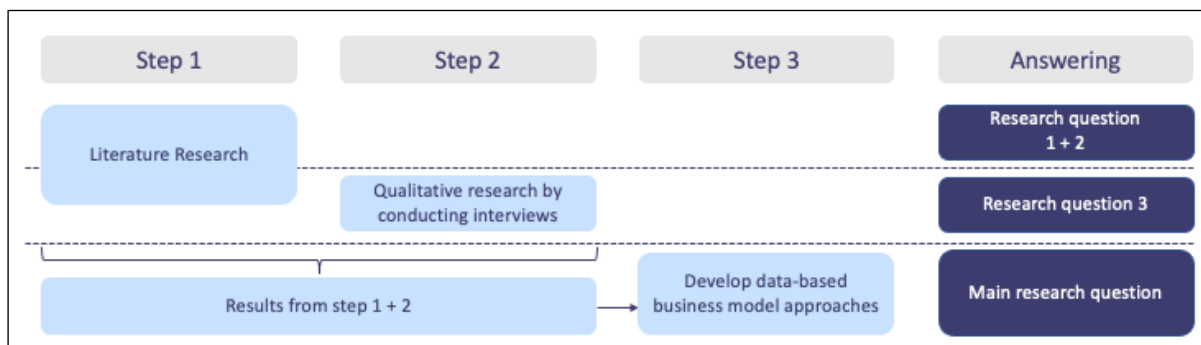

Figure 5: Methodical procedure and structure of the thesis

In the first main part in Chapter 2, a theoretical, systematic literature review is carried out and the first two research questions as well as a part of the third one are answered. To ensure methodological rigor this review follows the five steps by Vom Brocke et al. [22]. The

background is divided into the following main sections: Vehicle-to-Everything (V2X), data-based services, stakeholder, and business model. First the V2X and the bidirectional charging technology are examined in detail. Furthermore, the different energy markets in Europe as well as the status of the V2X markets in different countries are examined, so that the relevant countries can be identified in this section. The regulatory and technical standardisation and the related possibilities for a V2X market in these countries are also further investigated. Consequently, this section addresses the first two research questions. In the next section, data-based services are defined and their connection to the mobility and energy sectors are investigated in detail. Due to the collaboration with the Robert Bosch GmbH (RBG), their current data-based services in the connected mobility environment are used to show an example of data-based services. The third section defines and identifies stakeholders and shows methods to analyse their expectations, objectives, and motivation. The last section of this theoretical background deals with the topic 'business model'. Research in the context of business models, especially in the area of data-based business models, is very dynamic and not consistent in every respect. There are many different definitions for different business models [23, 24]. For this reason, the thesis focuses on the theoretical elaboration of business models in the field of business informatics and the area of data-based business models. In a final step, the connection to a stakeholder analysis in the context of the creation of business models is pointed out.

The second main part in Chapter 3 and Chapter 4 deals with an analysis of the expectations, objectives, and motivation of the relevant stakeholder in the B2B sector of the European V2X markets regarding the use of data-based services, based on interviews. This analysis primarily intends to answer the third research question. The methodology chosen for this examination are problem-centred [25] interviews with one or more selected experts from each relevant stakeholder group. Semi-structured interviews are suitable for gathering qualitative information. While they are less prescriptive, they allow for common themes between interviewees to be established. An interview guide should serve as an interview instrument. The preparation of these interviews was based on the results of the literature review. At this point, to conduct the interviews, the key stakeholders need to be identified and there must be an understanding of relevant issues in V2X markets. To follow the objective of the qualitative research the V2X market was simply discussed and a lot of information such as answers to questions about, for example, the market, stakeholders, experiences, or existing business models were gained [26]. In the following steps the collected data were subsequently analysed according to Kuckartz [27].

The third main part in Chapter 5 contains the development of sustainable B2B business model approaches for data-based services in European V2X markets. The use and interpretation of the results from both the literature review and the qualitative research are fundamental here as their combination determined the conditions for sustainable business models in the B2B field in V2X markets. The described chapter aims to answer the main research question. Since this thesis is written in cooperation with Robert Bosch GmbH (RBG), the next step is to deduce the business

model approaches. It was investigated if and how the data-based business model approaches are transferable to the RBG services. Before the limitations and the conclusion, this thesis finishes with a discussion of the results achieved and recommendations for action.

8 Conclusion

This master's thesis aims to identify the expectations, motivation, and objectives of the relevant stakeholders in the European V2X markets as well as relevant countries. It aimed to establish the status quo and opportunities, especially in the direction of standardisation, in these markets and, based on this, to develop sustainable B2B business model approaches for data-based services in the V2X market.

Based on the literature research, in addition to the development of theoretical foundations, the possible relevant countries for the V2X market, which is still in its infancy, were identified. Especially with the current development standard of these countries, namely the UK, the Netherlands, Germany and Denmark, challenges of the energy system can be counteracted by means of V2X technology. For the implementation of V2X technology, the review also identified and demonstrated standards as well as their potential and further requirements, especially on the hardware and software side. Even though there are already trends and expectations towards standards such as the ISO 15118 standard or the CCS connector in Europe, there are many uncertainties and questions that still need to be clarified. Furthermore, a stakeholder analysis identified various stakeholders from the areas automotive industry, the charging industry, the energy industry, electric vehicle owners and miscellaneous.

In the next step, problem-centred interviews were conducted in the form of a qualitative study to explore the expectations, motivation, and goals of the relevant stakeholders. These confirmed trends of decentralisation of energy supply in addition to many microgrids as well as the resulting challenges in energy storage. Even if the V2X market still faces hurdles such as regulation, digitalisation, organisation or profitability, the technology is seen as having great potential, which has already been recognised by various market participants such as manufacturers or service providers. This potential has been identified more precisely by means of potential value pools and service specifications, and based on this, two business model approaches have been proposed with the assumption of a developing V2X market. The first approach describes a platform for EVs and customers with energy management needs, on which V2X services from different providers can be offered in a data-based way. In the second approach, the data arising from the V2X market is used to generate value from this data through Big Data projects and data analysis and to offer this to the individual market participants. However, it is worth mentioning here that while both models are data-based in one form, the first one claims to set up the V2X services and bring market participants together and thus can also be considered service-based and the second one is purely data-based and creates value with the analysis of data. These business model approaches were then transferred to Robert Bosch GmbH as a potential provider of the models, and further recommendations for action were made both in general and in the direction of RBG.

Overall, this thesis can be seen as an assessment of the current state and potential of the V2X market. Two options are presented as to how a sustainable participation in the market would be possible. The great potential of the storage possibilities of electric vehicles should always be compared with other storage possibilities. It is important to always consider current events, as the state of research in this market can change almost daily. However, the proposed business models were developed based on assumptions as future models and thus show great potential to participate in the market even in the event of rapid development. It is quite possible that V2X technology will be a puzzle piece in the future energy market, where the use of data analysis from the second business model can be applied not only to V2X technology but also to other applications in the energy system.

It is recommended for future research to develop scenarios on how the market can develop more precisely and under which conditions. These studies would make it easier to specify business models and service offerings. Issues such as data security, regulations and legal issues must also be investigated in more detail and developments can be assessed. Especially when it comes to data, questions of security and data ownership are inevitable in the future and should be further analysed. Specific to the business models, as the next step a more detailed analysis of potential partners, providers and customers is recommended.