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Will They Die Another Day? A Decision Support Perspective on Reusing Electric Vehicle Batteries

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WILL THEY DIE ANOTHER DAY? A DECISION SUPPORT PERSPECTIVE ON REUSING ELECTRIC VEHICLE BATTERIES

Research in Progress

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Abstract

The diffusion of electric mobility suffers from an immature and expensive battery technology. Reusing electric vehicle batteries (EVBs) is a prospective opportunity for lowering the total costs of ownership of electric vehicles and using scarce natural resources more efficiently. However, to determine how to reuse a battery is a complex decision problem. In this study we set out to develop a design theory for a class of decision support systems (DSSs) that implement two main functions: First, a consideration set of feasible reuse scenarios is compiled based on an assessment of a battery's structure and condition. Second, an offering is configured based on bundling batteries with customized services. We conclude with an outlook to our ongoing design science project that will, amongst others, explore to what extent systems instantiated from the design theory can remedy adverse effects caused by the 'lemon market' properties of the second-hand battery market.

Keywords: Decision Support Systems (DSSs), Software Architecture, Electric Vehicles, Electric Vehicle Batteries, Service Science, Sustainability.

1 Introduction

With the emerging Energy Informatics research field, the Information Systems (IS) scientific community has recently found a way for addressing the global need for environmental sustainability and further fostering the Green IS landscape in research and teaching (Watson et al., 2010). Following a solution-oriented view on IS research, the potential for applying IS to reduce energy consumption, carbon-dioxide emissions and solving other environmental problems is brought into focus (vom Brocke et al., 2013). Electric mobility is a subfield of Green IS research (Kossahl et al., 2012). It is characterized by the electrification of individual and public transportation and new business models that emerge in this area. However, research on electric vehicles (EVs) and on electric vehicle batteries (EVBs) in the Green IS field is scarce.

After having been removed from cars, EVBs might be reused in different scenarios. An EVB is a complex power storage device for supplying an EV's electro motor with electric current (Burke, 2009). Due to a deterioration of the cell material, EVBs are proposed not to be used in EVs after their capacity drops below 80% of their initial capacity (constraining the vehicle's maximum range) or the internal resistance of the cells has doubled (inhibiting the amount of energy provided to the car). Reuse scenarios include stationary applications such as for the smart home (Sachenbacher et al., 2012), as an uninterruptible power supply (UPS) (Cready et al., 2003), as big energy storage for stabilizing green energy (Knowles and Morris, 2014; Patten et al., 2011), or for residential load leveling (Beer et al., 2012; Burke, 2009). Amongst others, BMW (evworld.com, 2013) and Chevrolet (Howard, 2013) are conducting proof-of-concept projects to document that EVBs can be reused. It has been predicted that with an increasing diffusion of electric mobility, millions of EVBs will be available for reuse scenarios by the end of this decade (Lache et al., 2008; Pillot, 2012). Apart from generating additional profits by reusing EVBs, e.g., EU law holds manufacturer accountable for recycling EVBs to lower their ecological footprint (EU directive 66/2006/EC). Both arguments strongly motivate developing concepts and artifacts, such as information systems, supporting the reuse of EVBs.

The research question answered in this study is: What properties have to be implemented by decision support systems (DSSs) for aiding decision makers with the tasks of (a) identifying suitable reuse scenarios for an EVB and (b) configuring a value proposition including physical goods and services that gets accepted by customers? We set out to sketch a design theory (Gregor and Jones, 2007) for a class of decision support systems that can aid decision makers to identify the most appropriate reuse scenario for each individual EVB removed from EVs. This decision is based on (a) the type of the battery, (b) the condition of the battery, and (c) the usage history and cell degradation experienced by the battery cells along its lifecycle. Against the backdrop of the Lemon Market Theory (LMT) proposed by Akerlof (1970), the market for reused batteries can suffer from imperfections, even leading to its complete disintegration. Countering these effects, the battery has to be offered along with customized services, accounting for a customer's unwillingness to take the risk of buying a 'lemon' battery.

The remainder of the paper is structured as follows. In Section 2, previous research regarding EVBs for electric vehicles, organizational decision-making, and service science is reflected. In Section 3, reusing EVBs is identified as an organizational decision problem comprising programmed and non-programmed decisions. In Section 4, a design theory is sketched to describe a class of DSSs that can aid decision makers with identifying and designing reuse scenarios for EVBs. In Section 5, instantiating and evaluating the design theory is outlined, based on the LMT. Section 6 concludes the paper.

2 Theoretical Background

2.1 Literature Review

No significant research has been performed in the Green IS community to support the reuse of EVBs. Querying the AIS Electronic Library with the search string "electric AND mobility AND battery AND green" revealed eleven results, three of which are concerned with topics related to vehicle-to-grid integration (Brandt et al., 2013a, 2013b; Wagner, Brandt, et al., 2013). The other papers deal with business models for sustainability (Brandt et al., 2012; Lee and Casalegno, 2010; Schmidt and Busse, 2013), electric car sharing (Lee and Park, 2011), the optimal placement of electric charging stations in smart cities (Wagner, Götzinger, et al., 2013), intermediaries in information infrastructures (Khanna and Venters, 2013), an overview on information systems in automobiles (Brandt, 2013), and the transfer of research results on sustainability to developing countries (Krüp and Hanelt, 2013). A search in the literature databases 'Scopus' and 'Web of Science' identified no other related papers.

2.2 Electric Mobility and Electric Vehicle Batteries

Electric mobility is supposed to transform mobility towards sustainability. However, many hurdles impair customers' acceptance of EVs, including high purchase prices, low ranges and long charging times (Peters et al., 2011). In particular, the limitations of our current battery technology are responsible for low customer acceptance rates, since it is mainly the battery which causes the high purchase prices of EVs, even if the value of the battery deteriorates over time (NPE, 2012).

The high initial payments for EVBs mainly arise from the valuable components and materials an EVB is composed of. Structurally, EVBs are designed for modularity (Amirault et al., 2009). The basic elements of EVBs are battery cells that are serially or parallelly connected with each other as a battery module. Again, by interconnecting several battery modules the battery itself, the so-called battery pack, is shaped. Since the current battery technology requires operating in a certain range of temperature, heating and cooling devices are applied to the battery pack. There are further factors influencing an EVB's condition and general performance (Dhameja, 2001). For monitoring and controlling the EVBs' vital functions, such as temperature control, charging and discharging processes, an embedded system, the so-called battery management system (BMS), is installed. The EVB's physical structure is completed by putting all these subcomponents into a battery case.

Recent research has shown that lithium-ion technology, which is usually applied to EVBs, suffers from memory effects, too (Sasaki et al., 2013). Consequently, the remaining capacity of EVBs decreases over time. Considering an EVB's schematic lifecycle, the EVB's end of first life within an EV is reached when the state of health (SOH) drops below a threshold of 80% (Burke, 2009; Cready et al., 2003). Then, the EVB's true end of life (EOL) is reached when its SOH drops below 50%. In between this range the reuse of EVBs seems reasonable to lower the lifecycle costs, since extending an EVBs' operating life allows for the opportunity of generating further added value.

The economic potential of this endeavor has already been forecasted (Becker, Sidhu, et al., 2009). With an increasing number of EVs' sales the number of potentially reusable EVBs grows (Harrop, 2012; Trigg and Telleen, 2013). Additionally, possible second life applications will increasingly request for used and, thus, low-priced EVBs. Due to the fact that used EVBs do differ in quality and condition, an individual EVB does not meet every reuse scenario's requirements. Hence, bringing together vendors and customers of used EVBs is a complicated decision problem.

2.3 Organizational Decision-Making and Decision Support Systems

Human decision-making has originally been proposed to involve activities of intelligence, design, and choice (Simon, 1977, p. 41). In the intelligence phase, the problem is defined; in the design phase, the alternatives are created and explored; in the choice phase, the 'best' alternative is chosen.

Since the 1960s, computers and IS have provided entirely new opportunities for management decision-making. In his seminal work on the new science on management decision-making, Simon (1977, p. 45) identifies decisions made by executives as a continuum of programmed (i.e., well-structured) and non-programmed (i.e., ill-structured) decisions. Programmed decisions are "repetitive and routine, to the extent that a definite procedure has been worked out for handling them so that they don't have to be treated *de novo* each time they occur" (Simon, 1977, p. 46, italics in the text). Non-programmed decisions are "novel, unstructured and unusually consequential. There is no cut-and-dried method for handling the problem because it hasn't arisen before, or because its precise nature and structure are elusive or complex, or because it is so important that it deserves a custom-tailored treatment" (Simon, 1977, p. 46). Based on this argumentation, Simon (1977, pp. 49-64) further suggests that computers and IT can do both, modernizing programmed decision-making and aiding human decision makers with new functionality and tools to deal with non-programmed decisions.

A decision support system (Arnott and Pervan, 2012; Arnott, 2006; Hosack et al., 2012; Huber, 1981; Sprague Jr., 1980; Turban and Watkins, 1986) is a subordinate class of analytical information systems to enable complex decision-making and problem solving (Shim et al., 2002). Usual DSS software architectures include database management capabilities, modeling functions, and graphical user interfaces to augment a decision maker's ability to deal with the structured part of a decision problem, as a "human-machine, problem-solving system" (Shim et al., 2002, p. 112). For supporting decision makers with the unstructured parts of decisions, DSSs provide "flexible queries languages" (Shim et al., 2002, p. 113), such as data warehouses and OLAP, that humans can use as a working environment for identifying and compiling the information required to make their decisions upon (Shim et al., 2002). Model-based DSSs may apply optimization models for identifying optimal solutions (Power, 2000).

2.4 Lemon Market Theory and Product Service Systems

In his Noble-Prize winning Lemon Market Theory, Akerlof (1970) argues that markets “in which buyers use market statistics to judge the quality of prospective purchases” (Akerlof 1970, p. 488) incentivize vendors to market goods with a lower-than-average quality. Akerlof (1970) traces this problem to an asymmetry of information regarding the ‘true’ quality of a good. Whereas vendors are supposed to be able to estimate the quality of the products they offer, no reliable information is made available to customers, such that the customer cannot distinguish a bad product from a good product. Since under this rationale buyers are unwilling to pay a price premium for a high quality product, the ‘lemons’ drive the ‘cherries’ out of the market, leading to a shrinking or even dissolving market.

While Akerlof (1970) illustrates his LMT with the market for used cars, it can be assumed that most observations will also hold true for markets for used EVBs. A vendor possesses a huge amount of different used EVBs with varying characteristics, performance data, and conditions. The vendor is provided with detailed information about the batteries, e.g., condition data, historical data about an EVBs’ first life, and possibly even knows about the potential power curve of similar batteries in their second life. However, the customer might not get access to all of these data or is just incapable of making a judgment on the suitability of an EVB for the targeted application. Consequently, there is asymmetric information between sellers and buyers of used EVBs.

A customer needs in-depth information on an EVB for making an optimal decision. Following the LMT, it can be assumed that this information asymmetry drives the customer to expect that the offered used EVBs are lemons, i.e. have a bad quality or are inadequate for their intended purpose, and so, the customer is only willing to pay the price for a lemon. Hence, it is reasonable for the vendor to actually only offer lemons as they sell at the same price as EVBs of higher quality. This chain of events can lead to a shrinking market, or might even let the market dissolve (Akerlof 1970).

Mechanisms have to be put into place to counter the adverse effects of the market for used EVBs. One option could be to eliminate the information asymmetry by providing both partners an equal share of information on the battery. However, the complexity of EVBs as goods and the various factors influencing EVBs’ suitability for a specific scenario would likely render it difficult for an (unskilled) customer to conduct a proper assessment. A second option is to provide guarantees and other complementary services to signalize that the battery actually is of high quality.

In service science, such an offering of an integrated value bundle consisting of physical goods and associated services that are provided along the whole lifecycle of the product has been discussed under the terms ‘product service system’ (PSS), ‘IPS^2’, or ‘value bundle’ (Becker, Beverungen, et al., 2009). PSS are used to provide customers with unique value propositions, increasing the customers’ loyalty (McAloone, 2006). Furthermore, offering a PSS is a strategy for companies to create and sustain competitive advantage, introduce new product ideas, or enter a new market. Customers can benefit from solutions that are tailored to solving their individual needs, creating a high value-in-use (Mont, 2002; Vargo and Lusch, 2004). To offer PSS in a mass-customization approach, its physical goods and service components have to be modeled, such that they can be configured to fit a particular customer’s needs (Becker, Beverungen, et al., 2009).

3 Reuse of EVBs as a Decision Problem Requiring a DSS

Based on the phases of organizational decision processes proposed by Simon (1977), we conceptualize the decision problem of selecting a reuse scenario for EVBs as a four-step process (Figure 1).

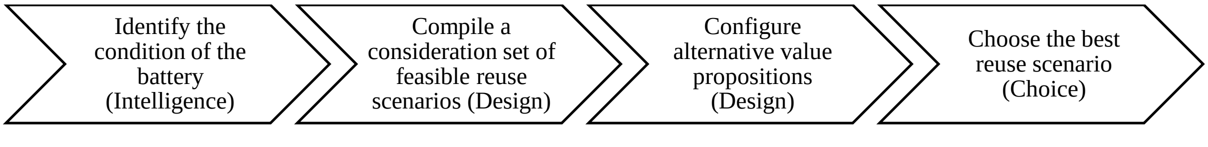

Figure 1. Decision Process for Reusing EVBs in Second Life Applications

First, in an intelligence phase the technical properties and the status of the battery need to be assessed in order to determine, if the battery is good enough to be reused, at all. This assessment comprises (a) identifying the components and structure of the battery according to its bill-of-material, (b) evaluating its condition, at least with respect to its capacity and internal resistance (Burke, 2009), and (c) tracing the history of cell degradation experienced by the EVB during its first life in the EV (Sachenbacher et al., 2012). While the digital bill-of-material must be supplied by the manufacturer of the battery, the information required to assess the battery’s condition and history can be explored by performing a read-out of the battery management system (BMS). A BMS provides information about the battery, such as its state-of-health (SOH) and state-of-charge (SOC) and ensures safe operation (Lu et al., 2013; Xing et al., 2011). Based on this information, the expected cell degradation of the battery during its second life application might be assessed, such that the expected lifetime can be estimated.

Second, in a design phase a consideration set of feasible reuse scenarios for this EVB needs to be compiled, based on comparing the technical properties of an EVB with the technical requirements towards the battery in different application scenarios. For instance, an EVB for residential load leveling has to support a peak power rating of 10 kW, an average power rating of 1 kW and will be used daily for providing 3-4 kWh of energy (Cready et al., 2003). In contrast to this, an EVB utilized as telecommunication backup has to provide 5kW in average and a capacity of 25-50 kWh in case of emergency (Burke, 2009). Against this backdrop, compiling a consideration set of applicable reuse scenarios is considered to be a programmed decision task that can be performed by a DSS, as soon as the requirements of the reuse scenario and the technical properties of the EVB have been specified.

Third, another design phase is carried out, based on the consideration set of applicable reuse scenarios. We conceptualize this phase as a creative and non-programmed design task that is focused on configuring an individualized value proposition that is offered to a customer. The value proposition may consist of the EVB itself and value-added services that make the battery fit better into the reuse scenario. Services to be offered along with the battery might, e.g., comprise engineering services, consulting services, maintenance services, or recycling services. On the other hand, services can also be used to transform the business model of reusing EVBs towards as-a-service business models, in which a customer does not actually buy the battery, but pays a usage fee based on the number of loading cycles of the battery (Tukker and Tischner, 2006). The latter has the advantage that a customer does not have to take the risk of buying a bad battery (i.e., a ‘lemon’) and might be more willing to reuse an EVB that has been used in an EV before. The configuration task is a complex endeavor, in which detailed requirements of individual customers are assessed, based on which services are bundled with the EVB into unique offerings (Becker, Beverungen, et al., 2009).

Fourth, the decision maker needs to choose the ‘best’ reuse scenario. This decision can be made based on different criteria. For instance, the decision maker might select the alternative that provides the highest difference between the customer’s willingness-to-pay and the provider’s cost of providing the value proposition, or rely on more cooperative scenarios (Backhaus et al., 2010).

4 An IS Design Theory on DSS for Reusing EVBs

Subsequently, a design theory is suggested to describe a class of DSSs supporting the aforementioned organizational decision process. A design theory outlines how things ought to be (Gregor, 2006; Walls et al., 1992). Gregor and Jones (2007) propose a design theory to consist of eight components (Table 1), based on work by Walls et al. (1992) who suggested an IS design theory to be “a prescriptive theory based on theoretical underpinnings which says how a design process can be carried out in a way which is both effective and feasible” (Walls et al. 1992, p. 37).

The purpose and scope of the envisioned design theory is to support a human decision maker with information (a) to build a consideration set of viable reuse scenarios for a particular EVB and (b) to configure a value proposition that can be offered on the market, such that a customer is willing to reuse the battery. This value proposition is envisioned to include the EVB itself, along with different value-added services, such as engineering services, reconfiguration of the battery, or refurbishment.

Implementing the functionalities for realizing these purposes, various constructs have to be modeled and implemented. First, a modeling language for describing different type series of EVBs has to be designed, based on which different battery types can be modeled (Klör, Bräuer, et al., 2015). This modeling language has to provide language constructs to describe (a) EVBs and their components (e.g., battery modules, battery cells, battery management system) in a hierarchical model, such as a bill-of-materials; (b) the current condition of the EVB, including its capacity and internal resistance, such that its applicability to be reused can be assessed; and (c) the usage history experienced by the EVB, including the progression of its decrease of performance, as identified from the data of the BMS (Monhof et al., 2015). Second, the requirements towards the EVB in different reuse scenarios must be modeled with another modeling language, including constructs for describing the required electric capacity, size of the battery, and intended frequency of charging the battery. Third, constructs must be modeled to match a battery with reuse scenarios that are technically feasible, or to find a suitable EVB for reuse in a scenario, respectively.

Components of a design theory	Reflection of the components in the design theory	Theoretical background and justification
Purpose and scope	Assist a human decision maker to effectively and efficiently (1) build a consideration set of feasible reuse scenarios for an EVB and (2) configure a value proposition for a customer, based on the battery and value-added services.	Organizational decision-making (Shim et al., 2002; Simon, 1977); Service science (Becker, Beverungen, et al., 2009; Vargo and Lusch, 2008)
Constructs	EVBs, master data, condition, use history, reuse scenario, requirements, battery condition, classification, threshold	Receiver Operating Characteristics (Fawcett, 2006); EVBs (Burke, 2007; Chan, 2007)
Principles of form and function	(1) Describe EVBs / scenarios; (2) identify EVB master data; (3) determine condition of an EVB and requirements in a scenario; (4) explore and evaluate alternatives, (5) configure offering, (6) offer value proposition to customer	EVBs (Burke, 2007; Chan, 2007; Lukic et al., 2008); Mass Customization (Duray et al., 2000); Modeling of PSS (Becker, Beverungen, et al., 2009)
Artifact mutability	Design time: Implement system as (a) expert system, (b) decision support system, or (c) online marketplace. Run time: (a) Define standard offerings based on configured value propositions; (b) Build up knowledge base for accelerating the decision process.	Design of IS (Hevner et al., 2004; Peffers et al., 2007); Mutability of IT artifacts (Nandhakumar et al., 2005; Sein et al., 2011)
Testable propositions	(a) The predictive accuracy (precision/recall) is high; (b) The willingness to accept and willingness to pay of customers is high; (c) the adverse effects of a 'lemon' market are avoided.	Receiver Operating Characteristics (Fawcett, 2006); Willingness-to-Pay Analysis (Hanemann, 1991); Lemon Market Theory (Akerlof, 1970)
Justificatory knowledge	EVBs, Decision Support Systems, Service Science, LMT	LMT (Akerlof, 1970); DSSs (Shim et al., 2002)
Principles of implementation	Online Marketplace, Decision Support System, Expert System, Data Warehouse	Design of MIS and DSS (Arnott and Pervan, 2012)
Expository instantiation	Instantiation of the design theory is planned as a web-based decision support system.	Design science research (Hevner et al., 2004); Action Design Research (Sein et al., 2011)

Table 1. Design Theory for DSSs for Reusing EVBs from Electric Vehicles

A DSS implementing the proposed design theory must first provide functionality to describe additional batteries and reuse scenarios in the system. Second, the EVB type must be identified, such that the master data record of this battery can be accessed. Third, the current condition of an EVB must be determined by exporting the data from the battery's BMS. Fourth, the DSS is supposed to match the properties of the EVB with the requirements of all reuse scenarios that have been described in the system, and list the scenarios in descending order of fit. All scenarios whose fit is below a predefined threshold are then excluded, leading to a reduced consideration set of alternatives compiled for further analysis. A configuration component must be implemented to aid the decision maker with setting up a suitable value proposition (including services, e.g., transportation (Klör et al., 2014)) for each of the remaining alternatives. After choosing the best alternative, an offer can be issued to the customer.

We conceptualize IT artifact mutability at design time and run time of the system. At design time, the design theory can be instantiated in different IT artifacts, including a Management Information System, a DSS, or a Data Warehouse (Arnott and Pervan, 2012). At run time, the functionality for generating the consideration set and configuring the value propositions might be routinized, based on building up a knowledge base of successful reuse decisions and standardized value propositions. The IT artifact will emerge dynamically, shaped by the organizational context into which it will be embedded.

Hypotheses that can be tested to evaluate the IT artifacts instantiated from the design theory include (a) measuring the adequacy of building the consideration set, in particular with respect to the precision and recall of the decisions (Fawcett, 2006); and (b) a willingness of a customer to accept the value proposition, leading to a higher willingness to pay than offering the battery without services (Hanemann, 1991). While the design theory can be implemented with different IS, including online marketplaces and data warehouses (Arnott and Pervan, 2012), we plan to instantiate the theory in a decision support system and evaluate the system against the backdrop of the LMT (Akerlof, 1970).

5 Instantiation and Evaluation of the Design Theory

In its basic form, a design science research project comprises two activities: build and evaluate (March and Smith, 1995). In their paper on Action Design Research (ADR), Sein et al. (2011) propose design to be an interwoven process of *building*, *intervention*, and *evaluation* that is conducted to develop “the initial design of an IT artifact, which is further shaped by organizational use and subsequent design cycles” (Sein et al. 2011, p. 41). In this process, an IT artifact is designed to solve the actual problem encountered in a scenario. General design principles are abstracted from the properties of the IT artifact for identifying the features that an IT artifact must have to resolve a class of problems. This stage is built on the three design principles of recognizing the *reciprocal shaping of the IT artifact and the organizational context in which the artifact is applied, learning among the participants due to their mutually influential roles, and authentic and concurrent evaluation*, recognizing evaluation not as a process that follows design, but conceptualizing both as highly interwoven (Sein et al., 2011).

5.1 Designing a DSS Architecture for Facilitating the Reuse of EVBs

Although various definitions of DSSs have evolved over time (Power, 2007) certain architectural concepts have been established. DSSs have to comprise three main components: (1) *database management system (DBMS)*, (2) *model base management system (MBMS)*, and (3) *graphical user interface (GUI)* (Shim et al., 2002; Sprague and Watson, 1982; Turban et al., 2007). In the context of DSSs (1) a DBMS supplies users with data access and provides integration of internal and external data that is intended to be relevant for the decision-making process. (2) A MBMS offers functionalities in order to build and access decision models that are applied for solving decision problems in the scope of the DSS. (3) For enabling interactions with its users a graphical user interface (GUI) is implemented.

Since reusing EVBs implies dealing with programmed and non-programmed decisions, software components have to be designed to support both kinds of decisions. In both cases, the decision maker has to compile models (such as a rating model for evaluating an EVB’s condition), data (such as the EVB’s usage history) and individual inputs (such as specific PSS configurations), resulting in recommended and feasible solutions the decision maker may further evaluate and, consequently, decline or accept. With close reference to the DSSs’ literature, we develop a DSS architecture for reusing EVBs.

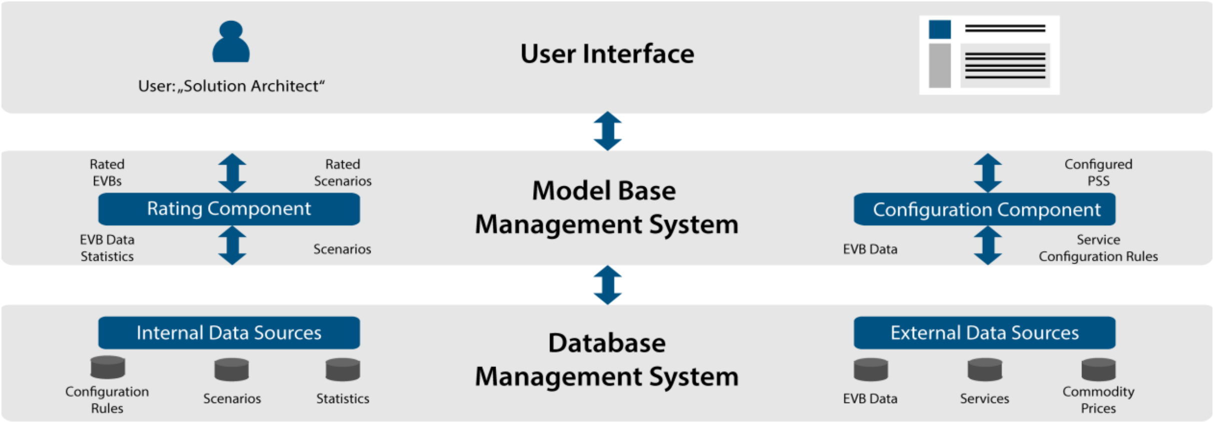

Figure 1. Architecture of the DSS for Reusing Used EVBs from Electric Vehicles

The proposed architecture (Figure 2) reflects the general components of the DSSs' literature and supports the user's two-fold decision-making process. In our perception the system's key user, the decision maker, interacts with the DSS via a dialogue component in order to find optimal scenarios for an EVB's reuse. The decision maker applies two major models successively by (1) rating the EVB for which an optimal decision has to be made, followed by (2) configuring a PSS to solve the customer's problem. Based on the results of a market study we conducted, it is likely that the DSS is operated by an intermediary selling the battery on behalf of an EV OEM (Klör, Beverungen, et al., 2015).

5.2 Intervention, Evaluation, and Learning

Since vendors of used EVBs want to sell their high-quality batteries for an appropriate price, whereas customers want to make sure that they do not spend their good money on a 'lemon' battery, the DSS needs to be designed based on Lemon Market Theory as a kernel theory. Additionally, Lemon Market Theory can be used as a theory for evaluating how well the designed IT artifact works with respect to setting up and sustaining a market on which used EVBs are being traded for second life scenarios.

The DSS has to be designed to address the properties of a lemon market. Consequently, symmetric information on the status of the EVB must be made available to vendors and buyers, preventing effects of adverse selection and moral hazard (Akerlof 1970, p. 493) and costs of dishonesty (Akerlof 1970, p. 495). In addition, the prospects of using services to provide guarantees (Akerlof 1970, p. 499), such as by bundling maintenance services into the offering or providing the EVB as-a-service such that the seller takes over the risk of providing the battery, must be assessed. We plan to perform this evaluation in a quantitative study, in which the willingness to accept and willingness to pay of customers for configured value propositions is assessed, building on the hypotheses stated in the previous section.

5.3 Expected Contributions of the Design Theory

We expect our research to make significant contributions to theory, by introducing the reuse of EVBs from electric vehicles into IS research, and developing a design theory for a class of information systems that support decisions concerning the reuse of EVBs. Our research is embedded into a larger design science research project that is performed as a consortium research project (Österle and Otto, 2010). We envisage first empirical results from this project and an instantiated software prototype of the design theory to be available for discussion at the conference. Successfully implementing DSSs for reusing EVBs might provide a contribution to lower the ecological impact of mobility services, lower the initial price of EVs, and accelerate the diffusion of green mobility solutions.

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