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RESEARCH PAPER

On the move towards customer-centric business models in the automotive industry - a conceptual reference framework of shared automotive service systems

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Abstract
Digitalization drives automotive original equipment manufacturers (OEMs) to change their value propositions and open-up towards greater collaboration and customer integration. The shift towards services implies a transformational change from product- towards customer-centricity. This study proposes a conceptual reference framework (CRF) out of a business model perspective to systematize automotive service systems. The CRF presents relevant dimensions and dependencies between the involved stakeholders and the necessary infrastructures in order to facilitate digital service conceptualization in the early phases of the service design. The artifact is developed based on a literature review and conceptual modeling, then iteratively evaluated by means of guideline-supported interviews from three different perspectives and applied to a real problem statement within a case workshop. The results suggest value creation for automotive services occurs in shared mobility networks among interdependent stakeholders in which customers play an integral role during the service life-cycle. Additionally, the results deepen the understanding of service business model development under consideration of industry-specific aspects and suggest the framework to be a beneficial structuring tool that can save resources and specify solution finding.

Keywords Business model innovation · Service systems · Automotive industry · Reference framework · Digitalization

Introduction

Industries, like products, proceed through distinct cycles and stages as they mature. Novel technologies and an alternating competitive environment pressure incumbents to react to these changes by updating and enhancing their business operations. Companies that fail to do so will be replaced by competitors that are "quicker or more efficient in bringing significant innovations to market" (Klepper 1997, p. 164). In this respect, digitalization challenges many manufacturing industries as prevalent business areas are rapidly evolving and are expected to continue in this way (Piccinini et al. 2015). Digital advancements and shifting customer expectations propel the development of new automotive business models (BM) (Hildebrandt et al. 2015) and change how value is concepted in companies (Ramaswamy and Ozcan 2018). Vehicles are no longer regarded as isolated tangible goods, but as objects that integrate different stakeholders, devices, functions, and data into coherent systems of value co-creation (Svahn et al. 2017).

The advent of these technologies has enabled new ways of providing mobility-related networked businesses (Firnkorn and Müller 2012), such as shared vehicle usage (Kessler and Buck 2017, p. 115), connected services (Kaiser et al. 2017), and autonomous and platform services (Yang et al. 2017). In addition, the view is spreading that customers are not just consumers of goods, but value adding contributors (Ramaswamy and Chopra 2014) and the center of gravity of

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developed services (Kowalkowski et al. 2017). Novel insights on how vehicles are used and the way in which mobility is consumed becomes accessible when the generated and platform-processed data is harvested (Pillmann et al. 2017).

In this context, OEMs and their suppliers have started to position themselves as both goods and service providers (Terler and Knöbl 2016; Bosler et al. 2017), which can be observed in cases such as Volkswagen's MOIA project (Volkswagen Media Services 2016) or Daimler and BMW with their existing car sharing initiatives (BMW Group 2018; Daimler AG 2018). Providing automotive services is seen to be a differentiation instrument for both building competitive advantages (Porter and Millar 1985, p. 85) and generating new income sources (Suarez et al. 2013). Consequently, the focus of manufacturers' business activities expands from producing goods towards developing integrated solutions by bundling vehicles with additional services. OEMs have opened up to foster interactional creational processes (Ramaswamy and Ozcan 2018) and gradually changed their perspective towards viewing vehicles as product-service offerings that provide both usage-based value (Schäfer et al. 2015) and additional values such as intelligent mobility, increased safety, or individualized comfort (Heinrichs et al. 2012).

However, the development of these solutions challenges OEMs as innovations in the automotive industry have historically been centered on the quality and features of manufactured goods (Firnkorn and Müller 2012). Providing services within their current value networks goes far beyond an OEM's present competencies, its suppliers, and its service providers (Schäfer et al. 2015). Initial efforts for differentiation by offering digital services in the early 2000s failed (Hoffmann and Leimeister 2011), and most OEMs remain mainly product-centered organizations (Mahut et al. 2015). Their predominant BM is largely unaltered, and service innovation proceeds to take place among industry newcomers, as are the cases of UBER, Lyft, and Tesla.

In this paper we investigate automotive services and their applications within service systems (SS) by reviewing literature with the objective of conceptualizing them within an ordering framework out of a BM perspective. An ordering framework is intended to help OEMs in their effort to develop service-based BMs and shall guide them in the conception phase by categorizing and systemizing SSs in the automotive industry. There has been extensive research on the notion of servitization and how it affects the BMs of manufacturing firms (Vandermerwe and Rada 1988; Baines et al. 2009; Vendrell-Herrero et al. 2016). However, the prevalent approaches only address parts within the field and industry specifics are mostly ignored or not taken into account (Adrodegari et al. 2017). So far, methods that support industry-specific processes are scarce and have not been sufficiently addressed (Chanias and Hess 2016). Most companies are challenged by the efforts to offer integrated solutions because of their inability to design and implement service BMs successfully (Bounfour 2016, p. 31). Further, it remains to be analyzed how customers and other stakeholders can be integrated into digital value-creation processes underlying a shared service offering, especially within the context of the automotive industry (Schumacher et al. 2018). Based on these preliminary considerations, we aim to answer the following research question:

How can original equipment manufacturers be supported in the conceptualization of automotive service systems taking into account relevant stakeholders?

We answer this question by systematically reviewing literature with the aim to discover a candidate set of terms. We categorize the terms by adapting and building upon the Business Model Canvas (BMC) by Osterwalder and Pigneur (2011) and conceptually modeling the connections between them. Upon this, we designed an initial reference framework and evaluated it by means of guideline-supported interviews with OEM representatives, a BM researcher, and an external automotive industry expert. Further, the reference framework was applied and refined after having conducted a workshop involving a real problem case.

The article is structured as follows. Second section describes the background of service-centered BMs and explains the methodology applied for creating the conceptual reference framework (CRF). Third section presents the findings and describes the processes for each step in detail. Fourth section presents the evaluation strategy and evaluation results, and the fifth section discusses the scientific and managerial implications, as well as the limitations. Finally, the article concludes with a summary and outlooks on future research steps.

Background and methodology

Background

Historically, OEMs have built their businesses around goods-oriented BMs, where customers are seen as consumers rather than collaborators in the value-creation process (Orsato and Wells 2007; Ibusuki and Kaminski 2007) and the way in which the goods or vehicles are used has been of less importance (Ng et al. 2012). In contrast to this goods-centered perspective, Vargo and Lusch (2004) introduced service-dominant logic (SDL) that assumes the customer as the center of value creation with goods being means of services. In this respect, automobiles are seen to be vehicles for the provision of services and work in SSs wherein stakeholders operate by "using information, technology, and other resources to produce specific product/services" (Alter 2017, p. 1828). SSs are thus a dynamic combination of resources that are connected through shared information usage in which value is co-created by technology and people (Maglio et al. 2009). Therefore, an automotive SS can be broadly defined as a network of people, technology, and organizations that create and deliver mobility-related services. Existing SS concepts offer few possibilities for OEMs to particularly plan the service development while factoring in relevant stakeholders and the necessary infrastructure. A recent literature review of Frost and Lyons (2017, p. 228) found that present research lacks the application of SS concepts to specific domains and propose to direct research towards "ontologies that are more responsive to the intentionality of actors in the system, as well as the effects of their interactions."

Service provision and innovation will only occur if an organization is able to monetize them via its BM. Research on BMs arose with the proliferation of the electronic market in the 1990s and its novel approach of doing business (Morris et al. 2006; Bucherer et al. 2012; Gibson and Jetter 2014). Though a generally accepted definition of what constitutes a BM does not exist (Bankvall et al. 2017), we follow the definition by Osterwalder and Pigneur (2011) who describe a BM as the way in which companies capture, deliver, and create value. As the research on BMs has matured, understanding has grown with regard to definitions (Timmers 1998; Morris et al. 2006), classifications (Timmers 1998; Burkhart et al. 2011), evaluations, dimensions, frameworks (Osterwalder 2004; Al-Debei and Avison 2010), and the relationship between BMs and strategy (Massa et al. 2017). A variety of concepts and frameworks has been introduced to capture and initiate BMs that differ in extent and depth, which comprise: Timmers' (1998) three step-approach, the six core components by Morris et al. (2006), Osterwalder and Pigneur's (2011) nine-component BMC, and the St. Gallener Business Navigator methodology by Gassmann et al. (2014) among others.

The focal concept of any BM is the creation of value (Amit and Han 2017) that is closely aligned to the perspective one applies, distinguishing between supplier-centric, customer-centric, and stakeholder-centric views (see Table 1 following Mele and Polese 2011). As creational procedures occur in complex global networks rather than isolated local processes (Maglio and Spohrer 2013), the value-creation paradigm shifts from a single "service system managing particular stakeholders" (Mele and Polese 2011, p. 41) towards the collaboration as partners of multiple SSs in networks. Within these networks, tangible and intangible resources are exchanged and shared among the participants to achieve certain objectives, suggesting that the customer is one of many beneficiaries, as all stakeholders co-create value to the SS and expect it in return.

Generally, these BM concepts have only taken generic aspects into account without considering industry specifics (Veit et al. 2014) and the enhancement towards product-service BMs (Beuren et al. 2013; Massa et al. 2017; Reim et al. 2017), leaving both academic and industrial comprehension needs with regard to their design and implementation (Leitão et al. 2013; Alt and Zimmermann 2014; Massa et al. 2017). Studies demand support in the understanding of an OEM's servitization process along with the research on relational aspects and value-creation networks (Brax and Visintin 2017). In addition, existing concepts on SSs lack usability and design orientation (Alter 2012). The majority of studies focus on the customer-service provider interaction within the SS (Andreassen et al. 2016; Atiq et al. 2017), but do not consider that value creation happens in complex networks involving multiple stakeholders that can act as both customers and service providers.

Methodology

In order to support OEMs in the conceptualization of digital services, we develop a reference framework by which we intend to assist the understanding of the automotive services domain and provide an enhanced communication base for academic and business stakeholders (Frank 2007, p. 120). A CRF is useful for both researchers and practitioners at different levels (Fettke and Loos 2007, p. 5) and, thus, can be effectively applied in an integrated way for decision making process support (Colledani et al. 2008, p. 260). During the development process, we thoroughly research the automotive domain, put characteristic components in order, and identify relevant relationships. To be useful for OEMs during the conception of automotive services, the CRF must be correct, the incorporated constructs

Table 1 Logic representation and co-creational practices

Logic representation	Value relationship	Perspective	Co-creation practice
Goods-dominant logic	Value-in-exchange	Supplier-centric	Value creation of product or service provider
Service-dominant logic	Value-in-exchange / Value-in-use	Customer-centric	Value co-creation
Co-creational network	Value-in-exchange / Value-in-use / Value-in-experience	Stakeholder-centric / Balanced-centricity	Value co-creation among SS actors

must be complete, and the overall arrangement as well as interdependencies must be comprehensible.

Following the development approach outlined by Rößl (1990, p. 101) (Fig. 1), we first selected the constructs based on Osterwalder and Pigneur's (2011) BMC. The BMC is a good analytical and visualization tool (Freiling 2015) and is suited for becoming acquainted with BM thinking within an investigated domain (Fielt 2013; Bilgeri et al. 2015). Following, we adapted the BMC elements by abstracting them to the SS domain from an operational point of view (Alter 2012).

After having identified the framework constructs, we substantiated them by reviewing literature of automotive SSs, following the steps outlined by Fettke (2006). We collected data regarding the latest automotive SSs, analyzed and synthesized it, and then derived construct dimensions. Based on these findings, relations between the constructs were identified by conceptually modelling a class diagram in UML. The class diagram is particularly useful in structuring the constructs and the relations between them (Gomaa 2005). From this, we were able to derive relations, integrating and ordering them, resulting in an initial CRF design. Next, the CRF was evaluated in regard to correctness, completeness, comprehensiveness, and applicability by applying a five-phase evaluation process following Frank (2007, p. 120). Thereby, we evaluated the CRF from three different perspectives by conducting five guideline-supported interviews. In addition, we ran a workshop by applying the CRF in a case scenario concerning a real problem statement. Throughout the evaluation the CRF was iteratively modified based on received feedback.

A conceptual reference framework for automotive service systems

Constructs

For the conceptualization of SSs, a framework is necessary by which organizations can effectively analyze and facilitate the communication of automotive services. Mapping the business model concept to SSs provides us with a set of constructs that "allows the representation of the customers' integration and thus the co-creation" (Zolnowski and Böhmann 2014, p. 4). In doing so we make use of Osterwalder and Pigneur's (2011) BMC, which is a framework that is widely adopted in academia and practice, aspires to be of general validity and is centered on the customer's value proposition (Ojala 2016). The BMC is advantageous for centrally capturing and delivering value creational aspects of service business development and is a useful communication tool (Coes 2014). It provides a set of essential elements that are clustered in customers (channels, relationship, customer segments,), infrastructure (key resources, key partners, key activities), offering (the value proposition) and financial (revenue stream, cost structure) categories (Widmer 2016). Thus, the elements take into account the pivotal role of the customer as an essential premise of value co-creational practices (Vargo and Akaka 2012). By abstracting the building blocks, reflecting on their meanings and applying them to the SS domain, we identify the framework constructs (Lee et al. 2011; Alturki and Gable 2014) as can be seen in Table 2. Therein, we take an operational point of view as Alter (2012) proposed, which emphasizes viewing the SS from a managerial perspective for services that are, or ought to be, in operation.

The focal point of any BM is the value proposition and the reason for customers to seek a specific service to fulfill their needs (Osterwalder and Pigneur 2011). Characterizing the CRF in this way provides the company with an outlook on the overall value per actor, i.e. consumers, partners and the organization itself. (Zolnowski and Böhmann 2014). The value proposition is created for customers (Andreassen et al. 2016) who thus determine contextually and phenomenologically a service (Vargo and Lusch 2008). Everyone participating in the SS network can be both a contributor and beneficiary at the same time, underlying a stakeholder-centric point of view (Mele and Polese 2011). For the sake of this research and the following systematization, a customer is defined as an

Fig. 1 Reference framework development procedure

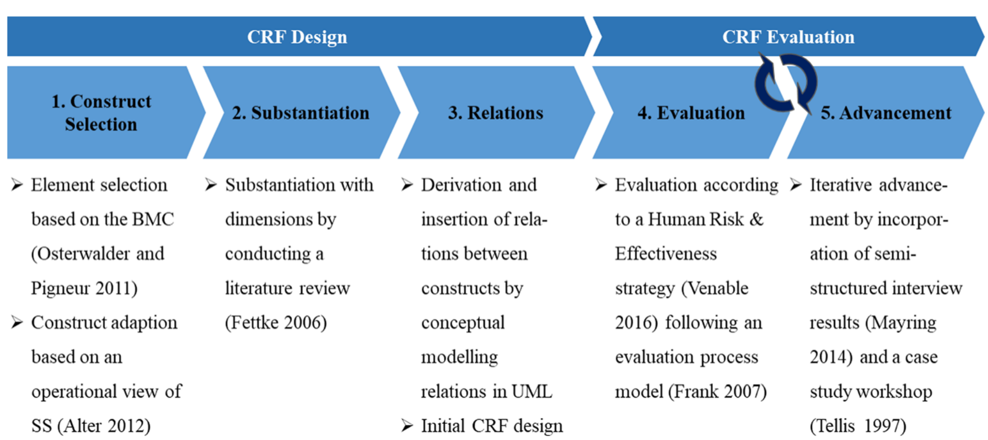


Table 2 Literature review constructs

BM categories	BMCBuilding blocks	Constructs	Description
Offering	Value Proposition	Service Value	Service value is the central element of an SS and inherent in every service (Maglio and Spohrer 2008)
Customers	Customer Segments	Customers	Customers determine contextually and phenomenologically the co-creational derivation of value (Vargo and Lusch 2008)
	Customer Relations	Customer Involvement	Value creation in an SDL involves customer participation (Vargo 2008)
	Channels	Points of Interaction	Customer points of interaction serve as the link between the service provider and the recipient (Clatworthy 2011)
Infrastructure	Key Resource	Service Infrastructure	Infrastructures are a collective investment of humans, information and technology, in other words, resources within SS (Alter 2008)
	Key Partners	Service Stakeholders	Various stakeholders are involved in service operation within SS networks that form relationships of value (Mele and Polese 2011)
	Key Activities	Service Objective	Stakeholders within automotive SS collaboratively perform distinct activities to collectively pursue one or multiple common SS objectives (Gummesson 2008)
Financial	Cost Structure	Cost Structure	The cost structure is comprised of the costs incurred from operating and delivering specific services distinguishing between cost-and value-driven costs (Osterwalder and Pigneur 2011)
	Revenue Streams	Revenue Streams	Revenue streams are generated from customers and involve transaction and recurring revenues (Osterwalder and Pigneur 2011)

individual or organization that demands a mobility-related service. Both the customers and the service value are chosen to be the central constructs as every service offering is initiated with them (Maglio and Spohrer 2008). Third, customer relations include the types of relationships a firm establishes with its customers (Osterwalder and Pigneur 2011). From an SDL perspective, "value creation always requires customer involvement" (Vargo 2008, p. 212). Thus, understanding and integrating this concept within service networks is crucial (Skålén and Edvardsson 2015). Third, key activities comprise the most important steps for a firm to successfully implement its business models (Osterwalder and Pigneur 2011). This study does not focus on the case of a single firm, but on an entire industry and their SS. Therein, stakeholders perform key activities collaboratively to pursue one or more service objectives (Mele and Polese 2011). The fulfillment of these service objectives can be seen as the driving motives upon which stakeholders ultimately create value for the service recipient. Fourth, channels demonstrate the way in which customers are reached and the value proposition is delivered (Osterwalder and Pigneur 2011). Customer points of interaction, or touchpoints, characterize the points of contact during the service provisioning process (Clatworthy 2011) and in this sense, can also be used to evaluate a service's effectiveness (Shostack 1984; Clatworthy 2011). Fifth, key partners are required to operate the business model successfully (Osterwalder and Pigneur 2011). They are stakeholders of the automotive SS and are involved in the service operation, contributing with their own resource investments (Mele and Polese 2011). The sixth element to be considered is resources. Resources are required in every step of the service fulfillment process, and include investments a company has to commit to operate a business model (Osterwalder and Pigneur 2011). Automotive SSs are collective investments of manpower, information and technology. As manpower is comprised within the construct stakeholders, the resources, information and technology can be specified as infrastructures that are shared with other SSs and are both operated and managed outside of the automotive SS (Alter 2008).

The BMC elements "cost structure" and "revenue streams" are included as constructs within the CRF but were not substantiated by the literature search. These elements are results from the previously established building blocks and are organization-specific. Revenue streams are established through the generated value proposition for the customer (value-driven or cost-driven), and the cost structure is substantiated once all the previous elements have been defined (transaction revenues or recurring revenues) (Osterwalder and Pigneur 2011).

Substantiation by means of a literature review

Following the steps outlined by Fettke (2006), the review procedure stretches over five phases, as shown in Fig. 2.

The literature review was conducted between October and December 2016 to identify relevant SS dimensions for the CRF. Five major databases were queried: Business Source Complete (EBSCO), Elsevier ScienceDirect, IEEE Xplore, Springer Link, Scopus, which represent relevant conferences and journals in the field of information systems. The goal was to substantiate the automotive SS constructs with dimensions and identify the relations. Several search phrases were tested and iteratively adjusted until satisfactory outcomes could be determined using the following search string: "(automobile OR automotive OR vehicle) AND (service systems OR information systems OR digital services)." In total, 2522 English sources were gathered comprising only peer-reviewed scientific journal articles, published between 2006 and 2016, with a focus on information systems (step 2).

The sources were evaluated (step 3) with regard to relevance of the possibilities given by the databases, which were further narrowed down by filtering out topics that did not connect with vehicle-related automotive SSs. During the first (gate I) and second refinement stage (gate II), duplicates were eliminated, and the terms were searched within keywords and title to gather a set of relevant articles in the field of focus. The articles were selected by reading the abstracts (gate III) and skimming the remaining articles (gate IV). As a result, we identified and fully read 31 relevant papers (see Fig. 3).

While analyzing the articles, we identified and extracted expressions that correspond to the identified CRF constructs. An exemplary excerpt of the analysis is listed in Table 3 and the full analysis can be viewed in Appendix Table 5.

To achieve comprehensiveness, we iteratively discussed, clarified and refined the expressions until we conceptually derived a list of dimensions. Therefore, we first aggregated and ordered the expressions with regard to their constructs: service value, service objectives, customers, stakeholders, infrastructures, customer involvement, and points of interactions. Following, we analyzed the expressions by discussing and reflecting upon them, removing redundancies and merging expressions when needed, for instance, automotive OEMs, automotive manufacturers, and electric vehicle manufacturers were merged into OEMs. Next, we proposed classes, reflected upon them and ordered the expressions accordingly before we repeatedly discussed the classes and allocation results. Subsequently, we defined categories (Given 2008, p. 72) and again discussed them as well as simultaneously refined the previous processes until an agreement on completeness and satisfactory clarity was reached. Lastly, we abstracted categories into dimensions of general validity that are meant to be mutually exclusive and collectively exhaustive (MECE) of the identified literature (see Table 4). The completed substantiation results, ordering and classification can be seen in Appendix Table 6. However, collective exhaustiveness cannot always be ensured since the literature review comprises only a selection of the entire literature on automotive services.

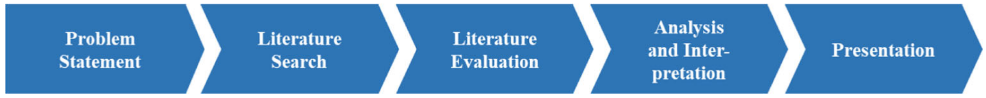
According to Juehling et al. (2010), automotive services comprise all services that provide benefit for customers over the vehicles' life cycle and can generally be distinguished between technical and non-technical services. We derived the service value based on the SS objective. For instance, Hung and Michailidis (2015) investigate the deployment of battery charging station infrastructure for electric vehicles (EVs). The service objective is to minimize the overall routing costs for EV drivers, such as travel time and distance. Hence, the perceived customer value can be increased with the accessibility of EV charging stations, convenience, and other factors. Besides safety and security, we identified resource optimization, emotion and experience, and convenience as general service value dimensions.

Most articles investigate technical services, particularly some form of assisted driving systems (e.g., Bengler et al. 2014; Mahut et al. 2015; Guériau et al. 2016). Their primary aim is to increase the carriers' safety, such as early brake support, collision mitigation, anti-lock braking systems (ABS), and electronic stability programs (ESP). The improvement of driving support and assistance in order to increase safety and security is identified to be the predominant service objective, accounting for 23 of the articles (e.g., Yeh et al. 2007; Vashitz et al. 2008; Stevens et al. 2010; Park and Kim 2015). The trigger of these technical services occurs through sensory input, and the computation takes place inside the vehicle. Technology related to driving assistance systems is progressing toward more automatic and cooperative driving (Bengler et al. 2014), upgrading the potential influence of the vehicle to semi-autonomous or autonomous driving. Other service dimensions identified were intelligent transportation, such as car sharing, maintenance assistance, and connectivity through vehicle or in-vehicle information systems (VIS or IVIS[1]) (Lisboa et al. 2016).

IVIS partly provides access to non-technical automotive services, such as navigational services. For non-technical services to be operable, infrastructures need to be in place in various fields (e.g., Wan et al. 2014; Park and Kim 2015; Olia et al. 2016). Vehicles should be able to communicate with multiple infrastructures and partly with other stakeholders

[1] VIS or IVIS – In-vehicle Information Systems - technology that provides additional information to drivers, e.g. traffic, navigation, weather, etc. (Vashitz et al. 2008)

Fig. 2 Literature review process



within complex networks (V2V,[2] V2I,[3] V2R,[4] VANET,[5] V2C[6]). Thus, the necessary telecommunication infrastructure would have to be implemented (Kakkasageri and Manvi 2014; Gao and Zhang 2016). For the service provision, backend systems need to be in place, which would have to be able to process the data that can be converted into information and fueling the value creation processes. These systems hold the identity and access management data, service context, legacy systems, vehicle master data, customer context, and application logics, and are callable via web application programming interfaces (APIs) (Frey et al. 2016). Generally, the infrastructure can be distinguished as physical stationary, physical mobile, and digital.

Accordingly, the SS stakeholders can be dimensioned as physical service providers (e.g., mechanics) and digital service providers (e.g., car sharing platforms and service recipients), which can be individuals, organizations, or the general public. Customers can be actively or passively involved in the value creation process. From an OEM perspective, customers are mostly the initiators of the service action while driving the vehicle. Even though they trigger the service, such as the intervening of the driving assistance system (DAS), they remain passive throughout the service delivery process. Digital services, however, have the potential to actively involve and engage customers during the service life cycle.

Points of interaction exist throughout various stages of the service delivery process and essentially involve stakeholders and many resources or infrastructural components being in place at the same time. Most identified interaction points are connected to the physical vehicle attributes (e.g., buttons) or vehicle environment. Further identified touchpoint dimensions are human interactions (e.g., via the service staff), the external environment (e.g., traffic signaling devices), or virtual interfaces via information system devices (e.g., smartphones).

Relations

After having identified constructs and dimensions, the relations among them were derived by conceptually modeling the constructs in a UML class diagram (see Fig. 4).

[2] V2V – Vehicle-to-Vehicle

[3] V2I – Vehicle-to-Infrastructure

[4] V2R- Vehicle-to-Road Side Unit - "Communications [...] between vehicles and roadside infrastructure" (Campolo and Molinaro 2011)

[5] VANET – Vehicular Ad Hoc Networks - "a wireless network based on short range communications among moving vehicles [...] and between vehicles and roadside infrastructure" (Campolo and Molinaro 2011)

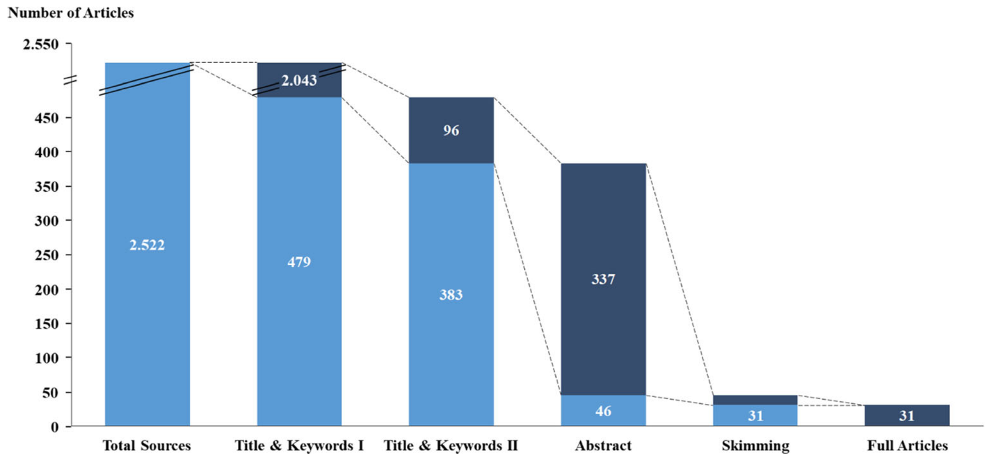
[6] V2C – Vehicle-to-Cloud services

The customer is the focal point of any SS (Vargo and Lusch 2008) and wants one or many service values to be met (Osterwalder and Pigneur 2011). One service value perception can relate to multiple service objectives, and vice versa. For instance, having enhanced collision avoidance software can serve customers' safety values and satisfy their convenience needs. In return, the service value can be related to collision avoidance systems and enhanced IVIS, which reduce driving distraction. The service objective directly influences the customer involvement in the value creation process. Customers that trigger DAS act as service actuators by moving the vehicle, but can also benefit from the service as passengers or as other traffic participants. In return, multiple forms of customer involvement are possible for the same SSs. For digital services, for instance, customers could passively participate by providing user data or by actively engaging in the product's value creation by giving feedback. Customers are engaged via points of interaction in the value creation process, which in turn are connected to stakeholders (such as the service providers) and the service infrastructure (such as the vehicle itself, mobile devices, backend systems, etc). Though services are centered around fulfilling customer needs and delivering service values, stakeholders are inherently motivated by and need to consider financial dimensions as well, i.e., revenue streams and cost structures.

Building upon the constructs, the identified dimensions, and the UML model, we developed an initial version of the CRF that we iteratively advanced and adapted. We arranged the CRF constructs, as depicted in Fig. 5, through internally discussing the automotive service delivery process and externally validating our line of thought by means of multiple evaluation phases (see Evaluation and advancement section). Therefore, we reasoned utilizing the example of an intelligent parking spot search. The customer is the central construct of any automotive SS around which the other constructs are independently layered. Thus, the notion that value creation is collaboratively pursued within the SS network is emphasized. The constructs contain the dimensions that are typical expressions of automotive SSs as identified in Table 4.

To illustrate the reasoning process (Recker 2013, p. 15), a driver (external service recipient) wants to quickly find a free parking spot while driving through a congested city. He or she is demanding a convenience value to be met by reducing the time of search. On that basis, the service objective of optimizing resources, such as time, gasoline, etc., can be derived. Therefore, the vehicle's sensors could spot and detect free spots, their range and calculate the possibility of it being an appropriate parking gap. For an OEM

Fig. 3 Article selection process



to provide the service in an engaging way, the customer could be solicited for active involvement by making the data of the free parking spot available to be shared among other drivers and ancillary service providers. To provide a holistic customer experience, the OEM ought to consider customer points of interaction, which could be physical vehicle attributes, such as vehicle buttons, and virtual interfaces, such as the IVIS, or the customer's mobile application. To successfully set up this service, a set of infrastructures need to be in place and integrated, such as a cloud and telecommunication infrastructures. In addition, other stakeholders need to co-creationally collaborate, such as telecommunication providers, the customer, mobile device providers and others. Lastly, the OEM has to balance the development costs and expected revenue stream of the provisioned service, e.g. through subscription models, referred to as recurring revenue streams.

Evaluation and advancement

Figure 6 outlines our five-phase evaluation process following Frank (2007, p. 120). First, we chose the evaluation strategy to be a Human Risk and Effectiveness Strategy for evaluating design science research suggested by Venable et al. (2016). We chose this strategy as the major design risk is user oriented and "a critical goal of the evaluation is to rigorously establish that the utility/benefit will continue in real situations" (Venable et al. 2016, p. 82). Primarily, it shall ensure that users can apply the CRF beneficially. Since naturalistic evaluations are always empirical, the artifact should be evaluated by real users in their actual context.

We specified the primary requirements to be completeness, correctness, comprehensibility, and usability. The framework was found to be correct if no objections for the selected constructs, identified dimensions, or drawn relations could be observed. By evaluating the CRF's completeness, we intended to determine whether any construct or dimension was missing. In addition, we asked whether the overall arrangement and scheme is comprehensive – that is, if the interviewees could interpret the CRF and the corresponding drawn relations. Usefulness was ensured by whether interviewees perceived the CRF to be beneficial for an OEM during the task of conceptual service planning. Next, we outlined the evaluation perspectives. For the purpose of gaining the most insights and prolific feedback, we incorporated the OEM perspectives of two industry experts and that of a leading researcher on business models and digitalization into our evaluation process. Therefore, we conducted five guideline-supported interviews, of which we analyzed and iteratively incorporated their feedback (Mayring 2014). In doing so, we improved the CRF in five evaluation phases. In addition, we applied the CRF in a workshop with an underlying real problem case (Crowe et al. 2011).

Interviews

We chose to interview three OEM employees from two different firms, who have different scope and areas of responsibility. Additionally, we interviewed one external industry expert with an extensive background in IT consultancy with a managerial position serving OEMs, contributing an external, inter-company perspective. Finally, the interviewed researcher contributes to the latest state-of-the-art knowledge about business model innovation.

The interview guideline comprises a short introduction, the interviewer's goal, open questions with regard to the evaluation criteria and the initial CRF construct. The guideline was sent to interviewees prior to the interview appointment to provide time for reviewing the material. All five interviewees reported to have read through the guideline and the CRF prior to the scheduled telephone call. The

Table 3 List of abbreviations and excerpt from the literature analysis

Abbreviations:

1. DAS – Driver Assistance System	8. IVIS – In-Vehicle Information Systems	15. APTS - Advanced Public Transportation System
2. RTIS – Real-time and temporal Information Service	9. TP - Telematics Platform	16. AVHS - Advanced Vehicle and Highway System
3. RSU – Road Side Unit	10. PSS – Product Service Systems	17. HMI – Human Machine Interaction
4. IVS – Intelligent Vehicle System	11. CAS – Computer Aided System	18. MCC - Mobile Cloud Computing
5. OBD – On-Board Diagnostic	12. RTM - Remote Technology Management	19. VCPS - Vehicular Cyber-Physical Systems
6. VIS – Vehicle Information System	13. ITS – Intelligent Transport System	20. GIS – Geographic Information System
7. ICT - Information and Communication Technology	14. ATIS - Advanced Traveler Information System	21. V2V – Vehicle-to-Vehicle

Authors	Goal of the Article	Service Systems	Service Value	Customer	Key stakeholders	Service network infrastructure	Service Objective	Customer Involvement	Points of Interaction
Bengler et al. 2014	- State-of-the art of DAS1 and future research field	- DAS	Assistance	Drivers	- Service Provider; driver; supplier; 3rd party beneficiaries; service provider for V2 V21 communication; traffic participants; OEM	- Vehicle; communication infrastructure; sensors; information, DAS	- DAS goal provide active and integrated safety; intelligent transportation for an efficiency increase	- Driver as the trigger of the DAS	- Vehicle; in-vehicle display and projections (virtual interfaces); infrastructure that provides sensor data
Bohnsack et al. 2014	- Exploration of the evolution of business model development between incumbent and entrepreneurial firms	- General consideration of movement to service-based business models by means of EVs, e.g. battery leasing etc.	Resource Efficiency	Incumbent s, End Customer	- OEM; supplier (battery provider e.g.); financial service provider; driver; dealer; swapping service station provider; charging grid operator	- Battery; EV; virtual application; mobile phone; communication infrastructure; grid	- Intelligent transportation through car-sharing and increase in mobile sustainability; comfort & convenience, when charging at home; battery swapping (technology enabler services) financial service systems	- Customer involvement in the service usage; customers may appear as service providers for grid balancing, when charging at home	- Vehicle; mobile applications; infotainment system; service personnel; financial services; dealer who can change the car; battery swapping personnel
…	…	…	…	…	…	…	…	…	…

Table 4 Abridged substantiation with dimension

	Category	Dimension
Service value	Safety Security	Safety & Security
	Resource efficiency	Resource Optimization
	Driving experience Service experience & Usability	Emotion & Experience
	Customization	
	Accessibility Comfort & Convenience	Convenience
Service objective	Transportation & Navigation	Intelligent Transportation
	Connectivity enhancement	Connectivity
	Issue Detection & Driving support	Driving Support & Assistance
	Quality improvement	Maintenance Assistance
Service network infrastructure	Stationary infrastructures Areas	Physical Stationary Infrastructure
	Mobile devices	Physical Mobile Infrastructure
	Information IT Infrastructure	Digital Infrastructure
Customers	End Consumer Business Customers	External Service Recipient
	Business Units OEM	Internal Service Recipient
Key stakeholders	Service staff Service Providers	Physical Service Provider
	Information service staff Information service providers	Digital Service Provider
	Secondary beneficiaries	Secondary Service Beneficiary
Customer involvement	Developmental Collaborators Active Participation	Active Involvement
	Service Users Information Provider	Passive Participation
	Actuator / Enabler	
Points of interaction	Personnel	Human Interaction
	Vehicle Composition	Physical Vehicle Attributes
	Physical Environment	External Environment
	IVIS Virtual interfaces	Virtual Interfaces

interviews were recorded and transcribed. Subsequently, the text passages were ordered in a category system composed of the defined requirements. Via a two-step reduction process relevant text passages were selected and subsequently clustered (Mayring 2014). Finally, the text passages were abstracted and summarized as a new statement, which are displayed in Fig. 7.

After each evaluation episode we analyzed and reflected upon the recommendations and internally discussed them. Therefore, we also looked for research evidence that supports the evaluator's point of view and suggested alteration. For instance, the first reviewer remarked to add an emotional dimension to the construct service value as many OEM customers purchase a vehicle or other products connected to the OEM's brand based upon an emotional experience. Investigating the remarked point research indicates similar behavior to be true for digital services, (Zarantonello and Schmitt 2010; Powers et al. 2012, p. 479) which is why we decided to implement the suggestion in the artifact.

Four of the five interviews resulted in CRF adaptations and were very beneficial for the CRF evaluation and its subsequent advancement (see steps 4 and 5 of Fig. 1). Over the course of the interviews the framework was simplified as dimension constructs were excluded. The CRF was generally perceived to be correct – that is no false constructs, dimensions or relations could be detected. The third interviewee, however, noted that the construct and dimension should be orthogonal to each other in order

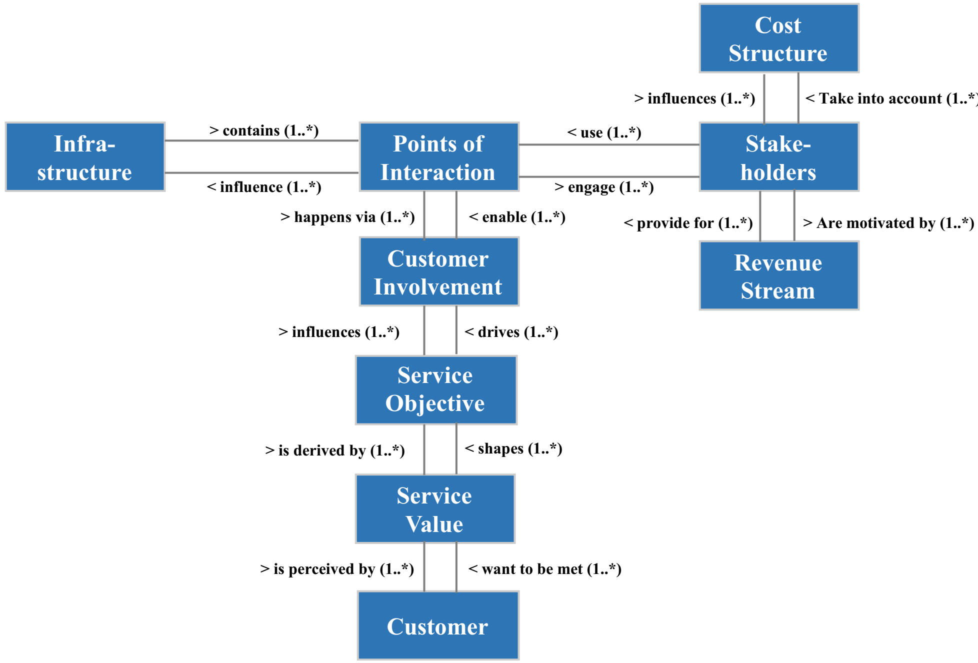


Fig. 4 Relations between constructs in UML

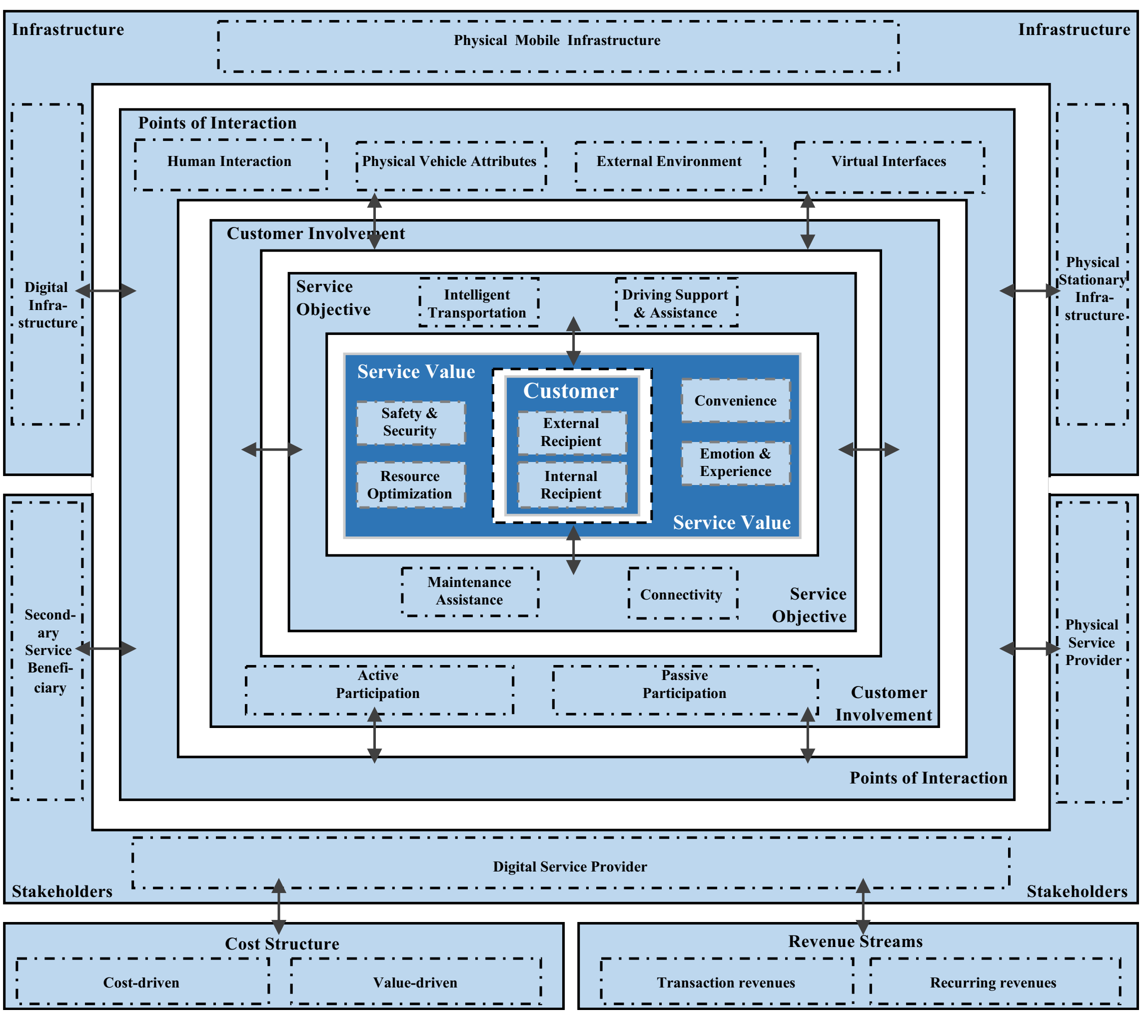
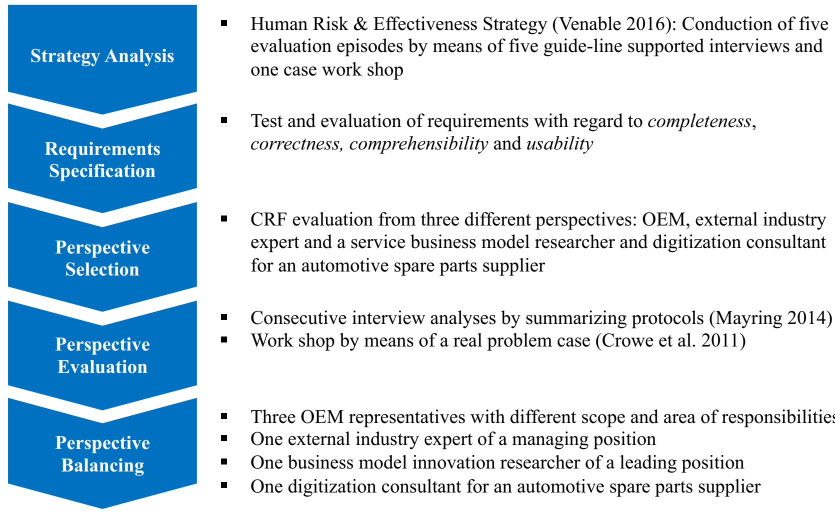


Fig. 5 CRF of automotive service systems

Fig. 6 Evaluation process



to ensure they are mutually exclusive and collectively exhaustive. For instance, it was proposed by the interviewee to merge the constructs "service value" and "service objective" as both are similar to each other and contain similar dimensions. The dimension "emotion "was added as a service value in order to complete the spectrum of individual value perceptions. Again, four of the five interviewees perceived the CRF to be complete, whereas the 3rd interviewee criticized the identified dimensions as not following the MECE principle. Not surprisingly, the CRF was not intuitively comprehensible for the surveyed practitioners. They demanded a functional explanation by means of a service example. The BM researcher, however, could interpret and comprehend the CRF representation. Although, the interviewee had received the representation after four evaluation episodes. This can indicate that the comprehensiveness of the representation improved, and by giving a practical example, the comprehensiveness had significantly increased overall. Mostly, the interviewees value the CRF for its ordering purposes. The practitioners however, implicitly demanded for a functional methodology that is more applicable in identifying and designing service business models than a classification framework.

Case workshop

In addition to the interviews we applied the CRF in a 90-min workshop with a researcher that did a PhD on the development of automotive industry in the Asia-Pacific region, who is referred to as participant hereafter (see Fig. 8). Within an extensive research project, the participant consulted a major Swedish spare parts supplier, which

	1st Interview:	2nd Interview:	3rd Interview:	4th Interview:	5th Interview:
Evaluation Episode	**OEM Representative:** ▪ Innovation and idea manager ▪ Executing position	**OEM Representative:** ▪ In-house IT Consultant ▪ Leading position	**IT Consultant:** ▪ Automotive IT management consultant ▪ Leading position	**OEM Representative:** ▪ Chief digital officer ▪ Leading position	**Researcher:** ▪ BM engineering and innovation researcher ▪ Leading position
Correctness	▪ Perceived to be correct	▪ Perceived to be correct	▪ Constructs not orthogonal ▪ Relations correct ▪ Dimensions not MECE	▪ Perceived to be correct	▪ Perceived to be correct
Completeness	▪ Generally complete ▪ Emotional dimensions are missing	▪ Perceived to be complete	▪ Perceived to be incomplete, as dimension are not MECE- could be further abstracted	▪ Constructs and dimension perceived to be complete ▪ Too few relations between the constructs	▪ Perceived to be complete, but dimension "other" in constructs problematic
Comprehensiveness	▪ CRF is very extensive ▪ General use case description helpful	▪ Without specific use case intuitively not comprehensible	▪ Without higher research question CRF purpose not intuitively comprehensible	▪ Generally perceived to be comprehensible	▪ Comprehensible
Usability	▪ Usable as a system of ordering and classification	▪ Usable as a system of ordering and classification	▪ Conditional usable to categorize and classify as dimensions are not MECE and constructs not orthogonal	▪ Assessed that CRF cannot reflect all possible autom. service cases and each BM would need an own CRF	▪ From an OEM perspective difficult to answer ▪ Pos. research contribution
Adaptation, Operationalization	▪ Dimension extension "Emotion & Experience" ▪ Explanation with regard of a specific point of view ▪ General use case description	▪ Cancel connecting line for infrastructure and stakeholder dimensions ▪ Explain CRF by means of a specific use case	▪ Dimensions abstracted to a higher degree to be MECE ▪ Format modification ▪ Deletion of dimension manifestations	▪ No adaptation	▪ Deletion of dimensions "Other" ▪ Clearly communicate perspective and CRF aim

Fig. 7 Evaluation episodes, categorized findings and derived CRF adaptations

is named case company hereafter. The case company generates the majority of its revenue via own physical shops, where they source, produce and deliver spare parts. Due to digitalization, the company faces the challenge to enhance their physical value propositions into the digital sphere. Beforehand, we sent the participant the CRF with an explanation and an exemplary case on how to apply the artifact in which an OEM intends to create a service in order to facilitate finding parking spots for its customers. While conducting the workshop, we formulated a hypothesis to expand the case company's current online activities and develop a platform to transfer and integrate physical and digital services.

We began by shortly introducing the constructs with its dimensions and clarifying their purposes as well as relations among each other. For each dimension, we formulated examples and suggested the main service value. During the process we noticed that applying categories led to the formulation of dimensions and provided further support towards more specific and relevant ideas on how to shape an online platform whilst keeping focus on the intended end-consumer. In addition, we noticed explicitly stating customer involvement possibilities and dimensions of customer interaction points helped the participant to take in, and maintain, a customer-centric perspective. The entire range of ideas as well as the structured CRF of the case workshop can be seen in Appendix III.

The participant noted the CRF as being a good framework in organizing and visualizing the relations of constructs as it provides a clear view on the objects of relevance. Further, the participant highlighted that there is a clear emphasis on customer-centric service design during the exploration phase. However, it was also noted that implementing and designing the service would require supplementary tools in order to reach completion. In general, the CRF was found to be useful for service conception and its industry-specificity was remarked as beneficial in saving resources and providing more precise results. To increase CRF applicability, we added the provision of the CRF categorization table that led to the derivation of the dimensions (see Table 4).

Discussion

Research implications

The SDL has been fundamental in the understanding of the service provision, the role of the customer, and its market consequences (Vargo and Lusch 2004; Kuzgun and Asugman 2015). Previous studies on these concepts "lack the strategic, functional and tactical directions for organizations to apply" them (Gaiardelli et al. 2015, p. 1165). Further, industry characteristics were not taken into consideration (Reim et al. 2014; Freiling 2015) and methodological applicability has been low. Within this study we intend to investigate how digital automotive services as part of SSs can be conceptualized and how OEMs can be supported in their design under consideration of essential stakeholders.

A conceptual reference framework was found to be a useful instrument for identifying and ordering automotive service system constructs and for relating them amongst each other. The CRF supports the importance of customer-centricity within complex stakeholder networks by synthesizing SS research with BM concepts. The artifact

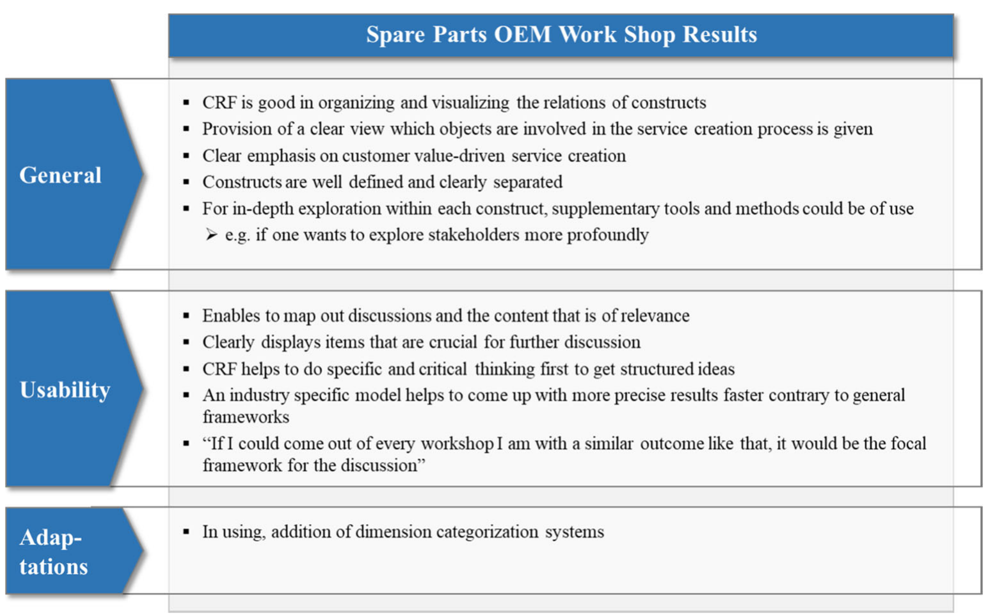


Fig. 8 CRF evaluation during case workshop

organizes and advances the knowledge of a SS as a work system. First, it demonstrates how a SS can be conceptually designed from a small amount of constructs by incorporating industry-specific dimensions. The constructs, interplaying with the dimensions, provide not only an adequate range and depth towards the understanding of the characteristics of automotive services, but also on how to use them to design services from a customer-centric perspective. Moreover, it provides a structure for organizing SSs in the automotive industry such as those which were identified through the literature search and listed in Appendix Table 5. The range of possible automotive services is expanding through ongoing digitalization. The CRF presents a particular view on SSs from a BM perspective as it is intended to support organizations and be applicable in the early service development phase. In addition, it contributes to the general knowledge on SSs (Ferrario et al. 2011; Alter 2017). Following up the discussion on how a SS can enhance value co-creation and customer interaction (Alter 2017), the present framework demonstrates that active engagement can be achieved by progressively designing interaction points that facilitate service accessibility for the stakeholders involved. The study further suggests to organize SSs around the focal point, its purpose of existence in the first place. From a customer-centric perspective, it delivers service values that can only be achieved if collaboration and interaction is optimized, which in turn, depends on an ubiquitous domain understanding of all stakeholders. As digital services "are closely related to and rely on ICT", it remains to be investigated on how these technologies can be systematically put to use to stimulate service innovation (Stoshikj et al. 2016, p. 219) and facilitate collaboration for these networked businesses (Akaka and Vargo 2014, p. 367).

In this sense, the CRF helps with gaining a fundamental understanding of the stakeholders and objects surrounding the value-creation processes of automotive SSs, contributing to the service business model knowledge. The framework endorses previous works which conclude that value creation happens in stakeholder-centric networks, where each stakeholder is both a beneficiary of the SS and a contributor to it (Mele and Polese 2011). However, the study also demonstrates, only few of the identified articles take customer involvement into account during service development, and fails to explicitly identify them as collaborators in value-creation processes. It suggests customer involvement as a theoretical concept in the automotive industry is not practically considered. We strongly support further research on how to translate service science insights on networked value co-creation and customer centricity into communicable methods and applicable tools for manufacturers that increasingly turn towards the development of digital product-service offerings.

Managerial implications

Research presumes that one of the biggest obstacles in the process of digital service expansion is the change in mindset from offering a produced good towards "an integrated product and service offering that delivers value-in-use" (Baines et al. 2007, p. 1545). To do so, the creation of value has to be seen from a customer-centric perspective (Johnstone et al. 2009), which represents a great challenge for manufacturing firms as their business logic tends to focus on product-based thinking (Ng et al. 2012). VISs are becoming increasingly important as a carrier of services and a field of differentiation among OEMs. VISs provide multiple touchpoints for service providers to interact and manage customer relationships via human machine interaction (HMI). Managing these links is essential for a company's interaction with its customers and for involving customers in the value creation process (Lee et al. 2013). From a managerial point of view, the CRF adopts this perspective as it is structured along this understanding and, at the same time, offers to be a tool by which firms can practically implement this concept.

Managerially, the CRF proved to be useful on a practical dimension for OEMs as well as automotive suppliers, as it provides industry specific concepts and enhances the practitioner's potential to communicate and design digital services themselves. Within a condensed period of time, a service proposition could be sketched and conceptually outlined within a networked system. One key challenge during conceptualization is "handling the many composed elements related to need, context, intention, possibilities, etc." (Andreasen et al. 2015, p. 33). Therefore, the CRF provides a structured framework by which to address this complexity. By practically applying it, the CRF was found to be useful in effectively organizing automotive services and formulating customer-centric service narratives. It is both a tool for saving resources, such as time and effort, and for structured, analytical thinking.

Additionally, the CRF meets the demand for an industry-specific framework (Heikkinen 2014). The construct dimensions are derived from automotive services and contain an arrangement by which automotive services can be categorized. In using an industry-specific CRF, organizations and researchers can be more effective in solution finding and more efficient in the way of getting there, as was remarked during its practical application.

General frameworks, such as the BMC are either designed for different purposes or their practical applicability is limited. The CRF in cooperation with the categorization scheme helps to generate more precise results and also highlights areas that have not been traditionally observed in the industry, most notably, customer involvement and touchpoint design. As the constructs are relevant SS objects that ought to be considered in service design independent of the domain, we support further research on other industries by developing a different set of dimensions and further advancing the framework.

It must be noted, however, that the shifting of product-centric organizations towards a focus on service value creation leads to numerous organizational challenges as well. The introduction of digital technologies accompanies growing dependencies on them and new personnel capabilities have to be established. In addition, processes have to be aligned and adapted so that the changes are adequately represented in the organization's operations. Pursuing a digitalization strategy possibly increases risk exposure due to field inexperience and the need for new technological competencies. Furthermore, as value creational activities are changed "the new digital activities deviate from the classical – often still analog – core business" (Matt et al. 2015, p. 341).

Limitations

However, this study's outcome is subject to subsequent limitations. It must be noted that only a part of the literature could be considered during the research process, therefore, the CRF is not all-embracing. The identified CRF dimensions are results of the literature review process and are subject to selection and analyses constraints. Furthermore, the CRF was evaluated by means of interviews and one case study workshop. Hence, the selection of interviewees, the number of evaluation phases and existing case could possibly influence the research results. As typical for empirical cases, not all boundary conditions could be controlled, such as the case company problem or external time constraints. Further, the chosen methods, such as conceptual modeling, the literature review approach, and the qualitative data analysis procedure may also influence the results of our findings.

Conclusion

This study proposes a CRF for automotive SSs, that was developed as part of an extensive research in which we investigate how to methodologically support OEMs during their shift from product-dominant to product-service offerings from a BM perspective taking into consideration relevant stakeholders. The reference framework constructs were abstracted from the BMC and adapted to the SS domain. In order to substantiate the constructs with dimensions specific to the automotive industry, we conducted a comprehensive literature review. By modeling the dependencies in UML, we derived the relations between the constructs and designed a CRF draft. The CRF was evaluated and iteratively improved by conducting five guideline-supported interviews. Further the CRF was applied in a case workshop underlying a real problem statement. Two specific applications were initially proposed. First the CRF shall support OEMs during the early development stage of automotive services, the idea generation and conceptualization phase, by giving a structure and a customer-centric direction. We observed the artifact to meet the requirements of correctness, completeness, comprehensibility, and usability.

The novelty of the outlined framework is the SS classification out of a business model perspective emphasizing both customer-centricity and shared participation of the various stakeholders involved in the value-creation processes. The CRF shows that customers are not merely consumers, but the focal point of any SS, as their value offering is the starting point for its development. This article provides an applicable categorization theme for the service conceptualization and is an integral component for further methodological advancements that support companies in these transitional processes. This research demonstrates that automotive SSs are networked businesses that involve the collaboration of a variety of stakeholders to meet customer demands. The artifact supports the notion that service innovation occurs in shared mobility networks involving a variety of stakeholders, who positively contribute to the service value and fulfill its objectives. Shared service networks enable OEMs to operate complex services that they cannot realize alone (Hoffmann and Leimeister 2011). The study primarily focuses on customer-oriented automotive SSs, neglecting the value of physical goods. However, vehicles themselves remain important and are ultimately the basis for services to run and be delivered to customers. As Lenfle and Midler (2009, p. 2) point out, "Servitization does not lead to an eradication of physical goods, but rather an enlargement of value, with the opportunity to monetize this by new business models."

Appendix

Table 5 Literature categorization in accordance to the identified constructs

Authors	Goal of the article	Service systems	Service value	Customer	Key stakeholders	Service network infrastructure	Service objective	Customer involvement	Points of interaction
Bengler et al. 2014	- State-of-the art of DAS[1] and future research fields	- DAS	Assistance	Society, Drivers, Road Participants	- Service Provider; driver; supplier; 3rd party beneficiaries; service provider for V2V[21] communication ; traffic participants; OEM	- Vehicle; communication infrastructure; sensors; information, DAS	- DAS goal provide active and integrated safety; intelligent transportation for an efficiency increase	- Driver as the trigger of the DAS	- Vehicle; invehicle display and projections (virtual interfaces); infrastructure that provides sensor data
Bohnsack et al. 2014	- Exploration of the evolution of business model development between incumbent and entrepreneurial firms	- General consideration of movement to service-based business models by means of EVs2, e.g. battery leasing etc.	Resource Efficiency	Society, Incumbents, End Customer	- OEM; supplier (battery provider e.g.); financial service provider; driver; dealer; swapping service station provider; charging grid operator	- Battery; EV; virtual application; mobile phone; communication infrastructure; grid	- Intelligent transportation through carsharing and increase in mobile sustainability; comfort & convenience, when charging at home; battery swapping (technology enabler services) financial service systems	- Customer involvement in the service usage; customers may appear as service providers for grid balancing, when charging at home	- Vehicle; mobile applications; infotainment system; service personnel; financial services; dealer who can change the car; battery swapping personnel
Dai et al. 2016	- Exploration of RTIS2 system between vehicles and RSU3 for vehicular networks	- Temporal information service system with RSU and RTIS; real time location-based services and routing services; autonomous intersection control; in vehicle infotainment; efficient data services; media services; vehicle-assisted temporal data service	Multiple	Drivers, Information Service Consumer	- Communication infrastructure providers; OEM; drivers; service provider; RSU provider; platform provider or providers	- Vehicular information, sensors; application layer; virtual applications; network layer; MAC layer; RSU infrastructure; communication infrastructure	- Safety of vehicular networks; efficiency and sustainability gains of intelligent transportation systems	- Driver participation in a service network through vehicle movement	- Navigation system in the vehicle, which driver interacts with
Gusikhin et al. 2007	- Overview and a sampling of AI usage, soft computing and	- IVS4 as optimal vehicle operation services; neuralnetwork-	Safety	Driver, Passenger	- Supplier; OEM; driver and / or passenger; 3rd party road user;	- Vehicle; diagnostics and prognostics information	- Increase in safety, intelligent transportation	- Driver triggers IVS actions when moving the vehicle	- Virtual interface of VIS6; service personnel for diagnostics

Table 5 (continued)

Authors	Goal of the article	Service systems	Service value	Customer	Key stakeholders	Service network infrastructure	Service objective	Customer involvement	Points of interaction
	other intelligent system technologiesin the automotive industry	based virtual sensors; speech recognition; proximity recognition; OBDs[5] and prognostics			service technician; engineer	technologies; Spare Parts; Repair space	and comfort and convenience		
Firnkorn and Müller 2012	- Investigates possible carsharing strategies through interviewing Car2Go Users	- Mobility service provider; sharing service	Resource Efficiency	OEMs, Car Sharing Consumers	- OEM; service provider; communication infrastructure provider; municipality as space provider; driver or service user	- Vehicle; Service platform; Public parking areas in cities; Mobile application	- Car sharing as a form of intelligent transportation; Economic and ecologic benefits; Comfort and convenience regarding maintenance, repair or parking	- Active participation in the service system	- Website; personnel through a customer hotline; virtual interface via smartphone applications
Frey et al. 2016	- Promotes the role of a software architect for the successful development of connected vehicles	- Telematics services such as door lock functions; in-car parcel delivery; car sharing; concierge services	Comfort & Convenience	Driver and passengers; OEM business units	- Driver and passengers; suppliers; OEMs; service operators; back end provider; software architect	- Vehicle; IT; Backend systems, e.g. cloud; mobile applications; communication infrastructure	- Connected vehicles for safety, intelligent transport, comfort and convenience, security, e.g. remote door lock function	- Not specifically mentioned, but depending on the service a spectrum of potential forms of collaboration	- Virtual interface over mobile devices (tablets, smart phones); service personnel; physical environment via the vehicle
Gao and Zhang 2016	- Business model review of the car sharing economy in China	- Car sharing or ride sharing	Resource Efficiency	Car sharing consumer	- Mobile device manufacturers platform operators (Uber); mobile network operators; governmental regulatory agency; third party partners: investors and competitors; legislators	- Vehicle; platform; ICT[7] infrastructure, mobile phones, mobile applications; stores; staff for promotion	- Car sharing for intelligent transportation	- Active participation of customers is the foundation of the service	- Virtual interface via apps on mobile devices; physical environment, e.g. supermarket stores for promotion; service personnel in the stores
Guériau et al. 2016	- Discussion of Cooperative Intelligent Transport Systems (C-IST) for traffic management	- Advanced Driver Assistance Systems (ADAS); information exchange with the infrastructure; traffic management; traffic monitoring; provision of real-time info.	Assistance	Drivers, Road Participants, Society	- Service providers; technology suppliers; infrastructure providers; driver; OEM; driver; 3rd party customer, e.g. municipality	- IT Systems; Vehicle; RSU; Real-time information; ADAS technology	- C-IST fostering intelligent transportation and navigation through traffic management; ADAS provide safety	- A spectrum of potential forms of collaboration; driver as the initiator of the service system	- Vehicle; virtual interface on traffic information systems
Harvey et al. 2011	- Review of IVIS8 in the context	- IVISs as the basis of secondary	Driving Experience Enhancement	Users of IVIS	- OEM has content sovereignty; IVIS	- Vehicle; IVIS technology;	- IVIS ensure safety by providing	- Customer interacts with the IS to	- Vehicle as the physical

Table 5 (continued)

Authors	Goal of the article	Service systems	Service value	Customer	Key stakeholders	Service network infrastructure	Service objective	Customer involvement	Points of interaction
	of task– user– system interaction; proposal of a modeling framework	functions that enhance the driver experience; article talks about IVISs functions, which can be viewed as services in some regard			builder as the supplier; software provider	Communication infrastructure; staff; mobile phones	relevant information without driver distraction, enhance vehicle efficiency and provide convenience functions	retrieve services, thus providing information to the system	interaction environment; virtual interfaces; Auditory via phones; Via staff through human beings
Hoffmann and Leimeister 2011	- Introduction of a design framework to systematically develop automotive services	- Several service systems covered: mobile software-based services; personalized news service; collection of brokerage fees for content displayed in the car etc.	Individualization	Automotive Service Providers	- Service system network partners; basic technical infrastructure for mobile business; network operators; content providers; OEM; customers as driver and passengers	- Mobile phones; Vehicle; Information (e.g. for news service); Communication Network; Software	- Software-based systems for safety and security; on-board navigation promoting intelligent transportation	- Customer actively involves when personalizing services	- Vehicle, virtual interface via mobile devices; personnel on hotline
Hung and Michailidis 2015	- Introduction of an electric vehicle service system modeling framework	- Charging station infrastructure deployment	Accessibility	Electric Vehicle Operators; Electric Vehicle Manufacturers	- Charging station operators, drivers or vehicle owners; EV manufacturers	- EVs; batteries; charging station; mobile phones; mobile application	- Minimization of the overall routing costs for EV drivers, such as travel time/distance	- Driver shares GPS real-time data of the EV location	- EV charging station; applications for real-time service information
Juehling et al. 2010	- Introduction of an integration framework of service and technology strategies	- After sales services	Resource Efficiency	End customer	- Customers; OEM; distributors; suppliers; staff; legislators	- Vehicle; Mechanic / technician performance; Legislative actions; realtime information; spare parts	- No particularly objective specified, but rather an approach for the industry to integrate services	- Customer initiates the service and mechanic order	- Via dealers; IVIS
Kakkasageri and Manvi 2014	- Review on information management techniques of vehicular ad hoc networks (VANET's)	- Distinction between driver services, passenger services, information services and public services	Intelligent Transport	Drivers, Society	- OEM; customers; sensor suppliers; communication infrastructure providers; platform provider	- Vehicle; telecommunication infrastructure; service platform; technology suppliers	- VANETs are a component of intelligent transportation systems and improve safety, convenience, commerce, entertainment, infotainment	- No specific involvement mentioned; driving enables being part of a VANET	- On-board devices
Lee and Gerla 2010	- Survey on vehicular sensor network developments and identification of new trends	- Street-level traffic flow estimation; proactive urban surveillance; vehicular safety warning services; ride	Connectivity	OEMs, OEM suppliers	- OEMs; drivers; smartphone producers; roadside communication	- Vehicle; sensors; sensory information; communication network; service platform;	- Vehicular sensing for safety increase by better predicting environmental conditions	- Customers' smart phones as sensing platforms; no active involvement	- Smartphone and virtual interfaces

Table 5 (continued)

Authors	Goal of the article	Service systems	Service value	Customer	Key stakeholders	Service network infrastructure	Service objective	Customer involvement	Points of interaction
		quality monitoring; locationaware micro-blogging			infrastructure provider			studied or focused on	
Lenfle and Midler 2009	- Case study on an OEM regarding the management of emergency / breakdown calls	- Management of emergency and breakdown calls	Safety	Automotive Manufacturers	- Service personnel; OEM; legislator; technology supplier; Communication infrastructure provider; service provider if not OEM; platform provider	- Vehicle; telecommunication technology; TP9; Service staff; Emergency infrastructure and staff;	- Emergency and breakdown calls service to increase safety as well as comfort and convenience	- Customers actively and / or directly engage with the personnel	- Directly via the phone; virtual interface on mobile devices
Lim et al. 2015	- Evaluation informaticsbased services in the automotive industry and proposition of a conceptual design framework	- Vehicle operation and health manager; ecoefficiency improvement service; driving safety enhancement; consumable replacement support service; prognostic maintenance support service	Safety	Automotive service consumers; repair shops	- Telematics platform provider; OEM; service providers; consumers; repair shops; consumable management shops; insurance companies; application developers; service designers	- Vehicle; service platform; staff for service design; communication infrastructure; insurance tariffs	- Foremost to increase safety, as vehicle operation and health manager; driving safety enhancement services for commercial vehicles; comfort and convenience gains through monitoring, diagnosis & predictions	- Degree of participation differs with the service; customers as service demanders, but rarely involved in the service creation process; customer integration through information provision, but not actively involved	- Smartphone application (Fuel-efficiency improvement); onboard device for information display (Driving safety enhancement); Email (Consumable replacement support); Phone call (Prognostic maintenance support)
Lindkvist and Sundin 2016	- Research of the information transfer in the service development process of two OEMs	- Development of service maintenance instructions	Resource Efficiency	Automotive Service Developers; OEMs	- After-sales and sales staff; legal authority; service development department; terminologist; technical informant; translator; times study technician; service designer; illustrator; editor; spare part partner; publicist	- Vehicle; handbook; service development staff; publishing staff; spare parts	- Safety as well as comfort and convenience via service maintenance instructions	- Low customer involvement in the design process; recognition of importance of utilization of information feedback	- Vehicle; handbook
Lisboa et al. 2016	- Identification of innovative IVIS through a Multi-Criteria Decision Making (MCDM) model	- Displays; augmented reality; touch screens and haptics; others digital assistants; gesture recognition;	Service Experien ce Enhancement	Automotive Service Providers, OEMs	- Suppliers; service providers; distributors; legislators; OEM; staff	- Displays; augmented technology; ICT; Software for voice and gesture recognition; vehicle	- Instrumentation to increase safety and assist driving by conveying the car's internal state; comfort and convenience	- Drivers are service consumers; driving triggers service system	- Vehicle infotainment system or buttons, virtual interface through mobile applications

Table 5 (continued)

Authors	Goal of the article	Service systems	Service value	Customer	Key stakeholders	Service network infrastructure	Service objective	Customer involvement	Points of interaction
		interactive projection; eye tracking; voice control and speech recognition					through infotainment, A/C controls and navigation (e.g. GPS)		
Mahut et al. 2015	- Exploration to the shift of PSS10 and its applications with the focus on the automotive industry	- Emphasize on service development and provision of exemplary examples, e.g. diagnostics, assisted driving, embedded communication services, personalization	Product and service integration	OEM units	- OEM; driver; service designer; service provider	- Vehicle; service development staff; communication technology; DAS	- Increased safety through assisted driving; mobility as a service as an intelligent transportation service; remote diagnostics	- Recognizes customer involvement as an integral part of the methodology for PSS (MEPSS)	- Service channel for customer interaction; virtual interfaces through mobile phones
Mitsopoulos-Rubens et al. 2011	- Investigation of the usability of three IVISs regarding a human-centric design approach within a case study	- IVISs	Usability	Automotive Service Providers, OEMs	- Drivers; service designers; OEMs; engineers	- Vehicle; service design staff; IVIS technology; ICT	- Increase in safety foremost, but also comfort and convenience with respect to usability	- Usability evaluation of the prototypes by means of 30 end users; generally, no continuous UI gathering and testing considered; customers actively engage with the IVIS	- Virtual interface; physical environment within the vehicle
Mukhtar et al. 2015	- Provision of a survey about the state-of-the-art on-road visionbased vehicle detection and tracking systems for CASs[11]	- Vision-based vehicle detection techniques; active: collision and avoidance system, automatic braking, adaptive cruise control, lane departure warning systems; passive: vehicle safety systems (seat belts, airbags, crumple zones, laminated windshields)	Safety	Automotive OEMs; suppliers	- OEM; automotive suppliers; driver; passenger;	- Vehicle; DAS technology; CAS; control software	- Vision-based vehicle detection techniques for road safety improvement	- Driver is the initiator of the service through vehicle movement	- Screens as virtual interfaces
Nybacka et al. 2010	- Presentation of a RTM[12] solution for new innovative services in the	- Remote Test Management: vehicle dynamics, vibration/noise, exhaust	Safety	OEMs	- Service providers; OEMs; test drivers; staff	- Vehicles; tires; test drivers; service team; test site facility; RTM platform	- RTM for automotive winter testing services, which benefits safety	- Customers are OEMs and suppliers and work closely together with the	- Virtual interface of the RTM; service personnel; virtual interface

Table 5 (continued)

Authors	Goal of the article	Service systems	Service value	Customer	Key stakeholders	Service network infrastructure	Service objective	Customer involvement	Points of interaction
	automotive winter testing industry	measurement, temperature and humidity measurements; audio /video communication						test service providers	
Olia et al. 2016	- Introduction of a traffic modeling framework for the interaction between vehicles and the infrastructure	- ITS[13]	Safety	Society, Driver; OEMs	- Driver; Road network providers; OEMs; Legislators; suppliers; service providers; 3rd parties such as pedestrians and residents; platform provider; infrastructure provider	- Vehicle; RSU; Traffic infrastructure; sensory information; communication infrastructure; control software	- Safety improvement and mitigation of traffic congestion by the usage of advanced ICT; environmental aspects	- Customers provide geographic information and contribute to the network, resulting in mutual benefits, e.g. fewer travel time, less accidents, fewer congestion, better environment	- Vehicle and mobile phone applications
Park and Kim 2015	- Proposition of an adaptive multimodal invehicle information system (AMiVIS)	- ITS; ATIS[14]; APTS[15]; AVHS[16]	Safety	OEM, Service Provider	- Driver; OEM; service provider; mobile technology providers; navigation suppliers; road authority	- Vehicle; communication infrastructure; IVIS; geographic information	- Increase in safety and intelligent invehicle navigation systems	- No involvement in the service development process	- HMI[17], e.g. infotainment systems etc. – physical and virtual interface
Sharples et al. 2016	- Study on dynamic electric information on motor highways and its driving decision making influence	- Dynamic information road signs	Assistance in driving decision making	Public Infrastructure Managers	- Road sign authority; technology suppliers (no active involvement); drivers	- Vehicle; highway authority agency; road signs; application; platform;	- Display dynamic info. in highway environments to increase safety and provide intelligent transportation	- Drivers participate e.g. by following the instruction, in the overall service objective	- Virtual interfaces on signs, smartphone applications and websites
Stevens et al. 2010	- Investigates the safety issues arising from an increase of IVIS through distraction	- Distraction measurement of IVIS	Safety	IVIS Display Designers	- Usability experts; drivers; human factor analysts	- Vehicle; IVIS; designer staff; Legislator actions	- Safety issues from IVIS	- Testers' responses are integrated in the evaluation process	- Virtual interface; physical attributes within the vehicle environment
Vashitz et al. 2008	- Simulation of IVIS effects on driving safety in road tunnels	- IVIS	Safety	Society, Drivers, Road Participants	- IVIS supplier; OEMs; highway traffic safety administration	- OEM; highway authority staff; road infrastructure; IVIS	- Effect of IVIs on vehicle safety	- Drivers as testers of the distraction level of IVISs	- Virtual interface of the IVIS
Wan et al. 2014	- Development of an architecture for the integration of	- Safety hazard prediction; entertainment;	Enhance service integration	Society, Incumbents, End Customer	- Driver or passenger; VCPS infrastructure	- Vehicle; VCPS infrastructure; sensors; ICT	- The overall objective is to provide the	- Not mentioned, but drivers trigger	- Virtual interfaces; road signs processing the

Table 5 (continued)

Authors	Goal of the article	Service systems	Service value	Customer	Key stakeholders	Service network infrastructure	Service objective	Customer involvement	Points of interaction
	MCC[18] in VCPS[19]	traffic aware mobile GIS20; Safety information and entertainment resources sharing; carpool services; maintenance; emergency road services; real-time traffic information; cloud-supported dynamic routing; reservation services			provider; service providers; OEM; Suppliers –sensor providers; communication infrastructure providers (internet, access points); public cloud providers	infrastructure (internet, access points); public cloud	necessary service infrastructure, where services fulfil different functions and applications	data delivery to public clouds	data representing the physical environment
Yeh et al. 2007	- Software integration framework for the use of VIS	- Vehicle box that tracks the vehicle status and has a scene reconstruction function	Usability	Drivers, Information Service Consumer	- ICT suppliers; service providers; customers; OEMs	- Vehicle; service platform; GPS sensors; Geographic information; touch sensing software; V-box	- Overall safety and convenience related service applications	- Customers can interact via a touch based GUI with the VIS	- Touchscreen based GUI; Vehicle

1. DAS – Driver Assistance System; 2. RTIS – Remote Traffic Information System; 3. RSU – Road Side Unit; 4. IVS – Intelligent Vehicle System; 5. OBD – On-Board Diagnostic; 6. VIS – Vehicle Information System; 7. ICT - Information and Communication Technology; 8. IVIS – In-Vehicle Information Systems;9. TP - Telematics Platform;10. PSS – Product Service Systems;11. CAS – Computer Aided System; 12. RTM - Remote Technology Management; 13. ITS – Intelligent Transport System; 14. ATIS - Advanced Traveler Information System; 15. APTS - Advanced Public Transportation System; 16. AVHS - Advanced Vehicle and Highway System; 17. HMI – Human Machine Interaction; 18. MCC - Mobile Cloud Computing; 19. VCPS - Vehicular Cyber-Physical Systems; 20. GIS – Geographic Information System; 21. V2V – Vehicle-to-Vehicle

Table 6 Substantiation with dimension

	Expression	Ordered expression by class	Category	Dimension
Service Value	Increased safety features; Transportation time and stress reduction; Driving experience enhancement; Navigation facilitation; Enhanced entertainment Cost reduction; Comfort; Service maintenance improvement; Optimized mobility experience; VIS usability improvement; Advanced service integration; Environmental impact reduction; Service individualization; Security improvement; IVIS safety improvement; IVIS experience enhancement; Object detection improvement; Infotainment improvement; IVIS usability enhancement; Mobility enhancement; Mobility accessibility improvement; Provision of health manager; Emergency support	Increased safety features; Emergency support; IVIS safety improvement; Improved testing conditions; Provision of health manager	Safety	Safety & Security
		Object detection improvement; Security improvement	Security	
		Cost reduction; Environmental impact reduction; Transportation time reduction	Resource efficiency	Resource Optimization
		Driving experience enhancement;	Driving experience	Emotion & Experience
		Enhanced entertainment; Service maintenance improvement; VIS usability improvement; Advanced service integration; Optimized mobility experience; Infotainment improvement; IVIS usability enhancement; IVIS experience enhancement	Service experience & Usability	
		Service individualization	Customization	
		Mobility enhancement; Mobility accessibility improvement	Accessibility	Convenience
		Traffic convenience improvement; Driving facilitation; Comfort; Transportation stress reduction; Navigation facilitation	Comfort & Convenience	
Service Objective	Carsharing; Intelligent transportation; Advanced driving assistance; Formation of VANETs; Maintenance reduction; Vehicle connectivity; Intelligent navigation provision; IVIS issue detection; IVIS driving effects recording; Routing time reduction; Reduced routing expenses; Driving decision support; Service integration; Vehicular sensing improvement; Vehicle diagnostics improvement; Maintenance instructions improvements; Enabling remote diagnostics; Visual vehicle detection techniques; RTM for testing services; Dynamic information delivery; Traffic awareness system; Connectivity enhancement; Safety software systems	Carsharing; Intelligent transportation; Intelligent navigation provision; Routing time reduction; Reduced routing expenses	Transportation & Navigation	Intelligent Transportation
		Formation of VANETs; Vehicle connectivity; Dynamic information delivery; Connectivity enhancement	Connectivity enhancement	Connectivity
		Advanced driving assistance; Traffic awareness system; Visual vehicle detection techniques; IVIS driving effects recording; IVIS issue detection; Safety software systems; Vehicular sensing improvement	Issue Detection & Driving support	Driving Support & Assistance
		Maintenance reduction; Vehicle diagnostics improvement; Provision of health manager; Maintenance instructions improvements; Enabling remote diagnostics; RTM for testing services; Service integration	Quality improvement	Maintenance Assistance
Service network infrastructure	Vehicle; Communication infrastructure; Stationary sensors; Geographic information; Environmental information; DAS; Battery; Virtual applications; Mobile communication devices; Electric grid; Application layer; Virtual applications; Network layer; MAC layer; RSU infrastructure; Data Center; Diagnostics and prognostics information; Spare Parts; Repair space; Public parking areas; Internet; Cloud infrastructure; Stores; ADAS technology; Electric Vehicle; Batteries; Charging station; Sensing platform; Emergency infrastructure; Insurance tarifs; Displays; Augmented technology; Software; Voice and gesture recognition technology; CAS;	Communication infrastr.; Stationary sensors; Electric grid; RSU; Signaling Devices; Road signs; Charging station; Emergency infrastr.	Stationary infrastructures	Physical Stationary Infrastructure
		Stores; Repair space; Public parking areas; Test site facility;	Areas	
		Vehicle; Mobile sensors; DAS; Electric Vehicle; Mobile communication devices; Spare Parts; Batteries; Tires; Displays	Mobile devices	Physical Mobile Infrastructure
		Geographic information; Environmental inf.; Diagnostics and prognostics inf.; Vehicular inf.; Insurance tarifs; Software; Voice and gesture recognition technology; CAS; Augmented technology	Information	Digital Infrastructure
		Data Center; Internet; Cloud infrastructure; Sensing platform; RMT	IT Infrastructure	

Table 6 (continued)

	Expression	Ordered expression by class	Category	Dimension
	Tires; Test site facility; RMT platform; Road signs; Mobile sensors	platform; Application layer; Virtual applications; Network layer; MAC layer; ADAS technology		
Customer	Drivers; End customer; OEMs; Business customer; Incumbents; Information service consumer; Passenger; Car sharing consumers; OEM Business units; Users of IVIS; Automotive service providers; Electric vehicle manufacturers; OEM Suppliers; Automotive service consumers; Repair shops; Automotive service developers; OEM Units; Suppliers; Service providers; Public infrastructure managers; IVIS Suppliers; Mobile cloud computing users; Application providers; VIS Software development companies; VIS Software	Driver; End customer; Information service consumer; Passenger; Car sharing consumers; Users of IVIS; Automotive service consumers; Mobile cloud computing users; VIS Software users	End Consumer	Extenal Service Recipient
		Automotive service providers; OEM suppliers; Repair shops; Suppliers; Service providers; Public infrastructure managers; IVIS suppliers; Application providers; VIS software development companies	Business Customers	
		Business customer; OEM business units; OEM units; Automotive service developers	Business Units	Internal Service Recipient
		OEMs; Electric vehicle manufacturers; Incumbents	OEM	
Key stakeholders	Spare parts supplier; 3rd-party beneficiaries; V2V communication providers; Traffic participants; Battery supplier; Financial service provider; Dealer; Battery charging station providers; Battery swapping service station operators; Charging grid operator; Communication infrastructure providers; Staff; RSU provider; Platform provider; Service technician; Engineer; Municipality; Backend provider; Software architect; Mobile device manufacturers; Mobile network operators; Governmental regulatory agency; Investors; Mechanic / technician; Staff for service design; Service development staff; Publishing staff; Test drivers; Service team; Highway authority agency; Sensor suppliers; Aftersales and sales staff; Terminologist; Insurances provider; Technical informant; Security and Privacy Provider; Translator; Time study technician; Service designer; Illustrator; Editor; Spare parts partner; Publicist; Test drivers; Road network providers; Usability experts; Human factor analysts; ICT supplier; Society; Highway traffic safety administration	Service technician; Technical informant; Time study technician; Human factor analysts; Dealer; Charging grid operator	Service staff	Physical Service Provider
		Staff; Mechanic / technician; Staff for service design; Service development staff; Publishing staff; Test drivers; Service team; Highway authority agency		
		Battery supplier; Battery charging station providers; RSU provider; Communication infrastructure providers; Mobile device manufacturer; OEM; Customer; Road network providers; Engineer; After Sales and sales staff; Terminologist; Spare parts partner; ICT supplier; Battery swapping service station operator; Spare parts supplier	Service Providers	
		Software architect; Usability expert; Service designer; Editor; Mobile network operator; Translator; Publicist; Service designer; Illustrator	Information service staff	Digital Service Provider
		Financial service provider; Insurance provider; V2V communication providers; Service Platform provider; Municipality; Backend provider; Governmental regulatory agency; Sensor suppliers; OEM; Security and Privacy Provider	Information service providers	
		3rd-party beneficiaries; Traffic participants; Investors; Municipality; Highway traffic safety administration; Society	Secondary beneficiaries	Secondary Service Beneficiary
Customer Involvement	Drivers as actuators of the DAS and IVS actions; Service usage; Service providers for grid balancing; Participation in a service network through vehicle movement; Active service participation; Feedback giver; Device carriers; Enablers for sensing platforms; Givers of sensory	Collaboration with OEMs and suppliers as test service providers; Test persons; IVIS distraction testers; Service providers for grid balancing	Developmental Collaborators	Active Participation
		Active service participation; Feedback giver; Direct/indirect engagement with service employees; Active IVIS engagement	Active Involvement	

Table 6 (continued)

	Expression	Ordered expression by class	Category	Dimension
	information; Direct/indirect engagement with service employees; Passively as service demanders; Information provision; Utilization feedback provider; Test persons; Active IVIS engagement; Collaboration with OEMs and suppliers as test service providers; Geographical information providers; IVIS distraction testers	Service usage; Passively as service demanders	Service Users	Passive Participation
		Givers of sensory information; Information provision; Geographical information providers;	Information Provider	
		Device carriers; Drivers as actuators of the DAS and IVS actions; Participation in a service network through vehicle movement; Enablers for sensing platforms	Actuator / Enabler	
Points of Interact ion	Sensor data infrastructure; Mobile applications; Infotainment system; Dealers; Battery swapping personnel; In-vehicle navigation system; Website; Customer service; Technicians; Virtual interface via mobile devices; Physical in-vehicle interfaces; Mechanics; Auditory interactions; Electric vehicle charging station; Digital interaction; Vehicle manual; Human Machine Interaction; Auto repair shop; Traffic information systems; Vehicle touchpoints	Dealers; Battery swapping personnel; Customer service; Technicians; Mechanics	Personnel	Human Interaction
		Vehicle touchpoints; Sensor data infrastructure; Infotainment system; Physical in-vehicle interfaces	Vehicle Composition	Physical Vehicle Attributes
		Electric vehicle charging station; Traffic information systems; Vehicle manual; Auto repair shop	Physical Environment	External Environment
		In-vehicle navigation system; Human Machine Interaction;	IVIS	Virtual Interfaces
		Mobile applications; Financial services; Virtual interface via mobile devices; Website; Auditory interactions; Digital interaction	Virtual interfaces	

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