

A Reference Model for the Design of Service-Dominant Business Models in the Smart Mobility Domain

Completed Research Paper

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Abstract

Initiatives in the smart mobility domain are increasingly characterized by a service-dominant mindset, focusing explicitly on the value that is created for the customer. As a result, the business models of these initiatives become more agile in nature, forcing them to be continuously and rapidly redesigned. However, given the wide landscape of potential stakeholders in the smart mobility domain, it may prove difficult to identify the stakeholders that should be considered for viable business model design. In response, this paper proposes a reference business model for the smart mobility domain which elaborates on a generic set of stakeholder categories and their characteristics to guide the design of these models. Following a design science research approach, we iteratively derived and evaluated the validity of the reference model using a set of business model design workshops. We illustrate the applicability of the reference model by means of a business model design case.

Keywords: business model, business model design, smart mobility, reference business model, stakeholder categories, design science research

Introduction

As a result of increasing population growth, especially in urban environments, cities are facing increased challenges of solving traffic problems, road safety, decreasing environmental pollution and optimizing logistics (Ning et al. 2017). To address these challenges, a vital role is present for *smart mobility* initiatives (Perera et al. 2014). In essence, smart mobility concerns the development of connected ecosystems to stimulate the effective transportation of both goods and people (Flügge 2017). It aims at establishing and utilizing interconnections between the physical and digital world to leverage traffic data to improve traffic efficiency. For example, sensors in cars or traffic lights can be leveraged using the Internet-of-things (IoT) to facilitate policy makers to generate traffic data to improve decision making (Perera et al. 2014). Similarly, IT traffic assets as road signage, vehicle detection systems and vehicle to vehicle (V2V) communication facilitate the management and dissemination of traffic data to improve traffic conditions (Ning et al. 2017). Therefore, it is no surprise that this domain has traditionally been characterized by a strong focus on

innovating traffic and mobility infrastructure and technology to find sustainable solutions for these ever-increasing challenges.

However, this emphasis on technology innovation and infrastructure development, which can be characterized as *goods-dominant* (Vargo and Lusch 2017), is slowly changing. This is because end-users are not concerned with the intrinsic technical characteristics of intelligent transport systems or applications, but rather with how these technologies can create value for them when put into practice (i.e., its *value-in-use* or *value-in-context* (Vargo et al. 2008)). As a result, smart mobility initiatives are shifting from a goods-dominant towards a service-dominant perspective, focusing explicitly on how the offered service solution creates value to the end-user (Grefen et al. 2015; Ostrom et al. 2010; Vargo and Lusch 2017). Emerging trends in the mobility domain like *car sharing* show that customers increasingly move away from a goods-dominant perspective (e.g. buying a car) but rather look at the value (e.g., the flexibility and ease-of-use) offered by car sharing applications that provide a similar mode of transportation (Cohen and Kietzmann 2014; Shaheen and Cohen 2007). As such, adopting a service-dominant perspective can enhance the value of these technology innovations and establish more sustainable solutions for smart mobility initiatives (Böhmman et al. 2014; Kley et al. 2011).

Considering this shift of emphasis, the role of *business models* to create alignment between consumer value created by the service solution and the assets deployed to create this value becomes pivotal (Al-Debei and Avison 2010). Moreover, the service-dominant nature of these business models causes these models to become dynamic and short in lifecycle, as customer demands become more volatile and complex due to the intangible nature of the offered services (Grefen 2015; Grefen and Turetken 2018; Turetken and Grefen 2017). As a result, these service-dominant business models must be rapidly constructed, reconstructed and deconstructed, placing high importance on the valid and viable design of these models (Grefen 2015). However, given the broad landscape of potential stakeholders in the smart mobility domain, which include (but not limited to) government bodies and other public authorities, traffic operators, customers (e.g., private or professional drivers and other road users, such as pedestrians and cyclists), service providers, technology providers and various other private companies (e.g. logistic companies, mobile network operators, parking operators) (Abdelkafi et al. 2013), it may prove difficult to identify the stakeholders and respective roles that should be considered, or to explore what roles are potentially missing to offer the proposed service solution. Moreover, as each stakeholder may pursue different goals, it may become challenging to ensure that all respective goals are satisfied properly.

The current literature offers methods and tools to design service-dominant business models (Turetken and Grefen 2017) and to map an appropriate value to the respective stakeholders (Bocken et al. 2015). Moreover, patterns have been proposed that focus on how financial value can be captured from a business model (Johnson et al. 2008; Osterwalder and Pigneur 2010). Some of these patterns are catered to the smart mobility domain (Abdelkafi et al. 2013; Walravens and Ballon 2013). However, there is no mentioning of a standardized template or *reference business model* in the literature that features a set of stakeholder categories expected in smart mobility business models, the characteristics of these stakeholders and what business model value outcomes they generate. Such a reference model can facilitate the design of new smart mobility business models and can serve as a basis for both practitioners and business model research to explore the configuration of smart mobility business models. It can facilitate its users in exploring the stakeholder groups that should be considered in the design of the business model, and in mapping the concrete stakeholders to these stakeholder groups. As a result, it can help its users converge more quickly to potentially valid and viable smart mobility business models. Therefore, our *main research objective* is to develop a reference business model that features a set of expected stakeholder categories including their roles and characteristics, as well as the value outcomes (costs and benefits that they will incur), with the aim to facilitate the design of service-dominant business models in the smart mobility domain.

To address our research objective, we followed a *design science research* methodology and developed the reference business model as an IS artifact (Gregor and Hevner 2013; Hevner et al. 2004). Applying *grounded theory* (Strauss and Corbin 1990), we iteratively derived the reference business model from stakeholder discussions in a number of service-dominant business model design workshops that we conducted in the smart mobility domain. For evaluating the proposed reference business model, we focused on its validity and used it to guide the design of a number of business models. We illustrate this by means of an example case.

The proposed reference model is comprehensive in nature and can serve as a basis for practitioners to derive concrete business model designs in smart mobility initiatives. Our research contributes to existing literature on business models by proposing a reference model that adopts a stakeholder (rather than a revenue) perspective, grounded on the premises of service-dominant logic. This may serve as a basis to explore generic configurations of these business models.

The remainder of this paper is structured as follows. First, we present an overview of the relevant literature and elaborate on the concepts that we refer to. Next, we describe the research design of this study, and elaborate on the derived reference business model by describing the roles and characteristics of the identified stakeholders. We illustrate the application of the reference business model by means of an example case. Consequently, we present and discuss the results of the evaluation with regards to the validity of the reference model. We finalize the paper by summarizing our contributions and findings, and discussing the limitations and opportunities for future research.

Theoretical Background

In this section, we discuss the relevant research and theoretical background to our study and elaborate on the concepts that we refer to in our research.

Service-Dominant Logic and Business Engineering

Traditionally, organizations have focused on the pursuit, capture and exchange of (physical) resources, adopting a *goods-dominant perspective* (Vargo and Lusch 2004). Economic value for organizations was considered to be present in the transfer of ownership of goods and its physical distribution (Savitt 1990). However, the last three decades characterized a shift in paradigm, for which the intangible resources (e.g. relationships, skills, knowledge) were considered increasingly more important (Vargo and Lusch 2004). Emphasis is placed on how resources are used or transformed to establish competitive advantages, rather than focusing on the intrinsic utility of the resources (Srivastava et al. 2001). This sparked the start of a *service-dominant perspective*. The transformation process of fixed resources is largely influenced by the dynamic, intangible resources or core competencies of an organization (Srivastava et al. 2001). These core competencies can be both cross-functional as well as inter-organizational. Moreover, this explicit focus on processes of transformation cannot be seen without the involvement or needs of the end-user or customer (Vargo and Lusch 2004). Customers no longer buy goods, but rather offerings as services that present value (Gummesson 1995). It is how these resources are transformed that shapes the value of the offering and allows organizations to differentiate themselves.

This change in perspective does not merely apply to marketing, but covers all functional departments in organizations (Vargo and Lusch 2008). Moreover, value creation is not merely an interaction between the organization and customer, but rather the effect of complete value constellations, which may be intra- and inter-organizational (Vargo et al. 2008). Adopting a service-dominant perspective implies reengineering business practices to adhere to consumer needs, and to cope with increasing challenges of business agility and service complexity (Ostrom et al. 2010). Moreover, these business practices should be adequately supported by IT (Al-Debei et al. 2008).

Business Model Design and Service-Dominant Logic

In essence, a business model describes how an organization functions and how its goals are achieved (Massa et al. 2016). In its broadest sense, it represents the logic of how value is created and captured (Osterwalder 2004), describes the resources, capabilities and competencies needed to enable these value mechanisms (Zott and Amit 2010), addresses the revenue model behind the business model (Johnson et al. 2008; Magretta 2002) and relates to or reflects the business strategy the organizations pursues (Casadesus-Masanell and Ricart 2010; Shafer et al. 2005).

Several methods or tools have been proposed in research for the design or representation of business models. However, not all proposed methods explicitly adopt a service-dominant perspective, and hence may not accommodate the characteristics of smart mobility business models. From an e-business perspective, Gordijn & Akkermans (2001) propose a modelling notation referred to as *e3-value methodology*. Adopting a networked perspective, the e3-value notation allows business networks to be

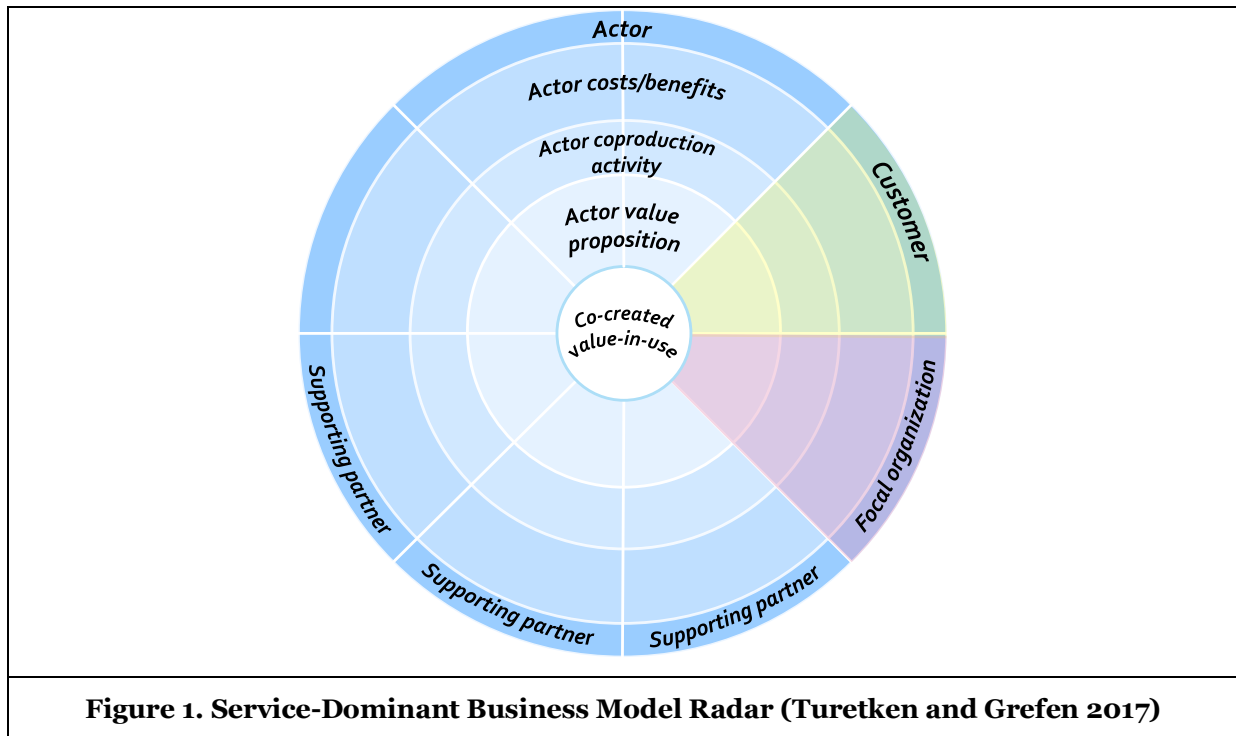
modelled, focusing on how economic values are exchanged between organizations within the network. These value networks consequently can be translated to business process models, in order to support business models through IT. However, contrasting the premises of the service-dominant perspective, value exchanges in an e3-model are only mapped bilaterally between business actors (one to one), whereas the notation does not focus on creating and appropriating value-in use. Osterwalder (2004) proposes the Business Modelling Ontology (BMO), which has served as the basis for the Business Model Canvas (BMC) (Osterwalder and Pigneur 2010). The BMC provides a visual representation of nine building blocks for designing business models. These building blocks represent the resources, capabilities, value proposition, customers, network, and revenue logic of a business model for a certain organization. Contrasting the service-dominant perspective, the BMC adopts an organization-centric view of business models and as such pays less attention to the essential role of customers and business network stakeholders for service-dominant businesses (Turber et al. 2014).

Taking the concept of service offering as a basis, Faber et al. (2003) and Bouwman et al. (2008) propose the STOF-model, which starts from establishing the value to the customer, and consequently focuses on four infrastructural domains, namely service, technology, organisation and finance, which comprise the design of the business model. An extension to this model is proposed by Heikkilä, Heikkilä, & Tinnilä (2008), which emphasizes the role of customer and supplier relationships (and as such is named CSOFT). El Sawy, Pereira, & Fife (2008) propose the VISOR framework, which decomposes business model design into five interrelated categories, namely the value proposition, customer interface, service platform, operational model and revenue model. Although these works reason from the basis of services, they do not explicitly incorporate the co-creation of value (particularly including the customer as a co-creator). Moreover, these methods propose sub-models per business model component, which may make it difficult to interpret in practice.

Grounded on the premises of service-dominant logic, Turetken & Grefen (2017) propose the *Service-Dominant Business Model Radar* (SDBM/R) for designing service-dominant business models. The layout of the tool can be seen in Figure 1. At the center of the radar lies the *co-created value-in-use*, which presents the value that is created by the service solution *for*, but also *with* the customer. Three rings encapsulate this central value-in-use, which highlight how value is created or captured in the model, whereas each ring is divided into 'slices' to represent the number of stakeholders included in the business model design. The *actor value proposition* ring describes the value that each stakeholder contributes to the central value-in-use. The *actor coproduction activity* ring describes the business activity or process a stakeholder performs in order to offer their respective value proposition. The *actor costs and benefits* ring describes the costs and benefits that each stakeholder accrues from participating in the business model. These costs and benefits can be *financial*, but also *non-financial* (for instance social or environmental benefits) in nature, and can be the result of activities of other stakeholders within the model. Note that the feasibility of the business model depends on how for each stakeholder the accrued benefits off-set the accrued costs.

Business Models and Patterns in Smart Mobility

The smart mobility domain has shown to be a promising field to enhance the value of sustainable innovations and technology through adopting a service-dominant mindset (Böhmman et al. 2014). This is also reflected by substantial research within this domain that focuses on business models that encapsulate these technologies as service systems (Kley et al. 2011). For instance, research has focused on the characteristics of sustainable business models related to electric vehicles. Kley et al. (2011) and San Román et al. (2011) have analyzed the structure of these business models, focusing specifically on the interrelationships between actors in the business model, the profitability of offering the services and the deployment of infrastructure. Similarly, Cohen & Kietzmann (2014) examine business models related to car and bike sharing, focusing on the relationships between service providers, users and governments to achieve shared objectives in creating sustainable mobility. From an IoT perspective, Perera et al. (2014) analyze business models which apply sensor technology to improve city logistics, as well as how value is distributed in the model.



Given the extent of work that has been conducted on smart mobility business models, especially focusing on the structure and characteristics of these models, it is surprising that no research has focused on the derivation of a generic set of characteristics, and how value is created and captured. Although Kley et al. (2011) provide a morphological box which includes a set of stakeholders to be chosen from, their work focuses predominantly on exploring what building blocks can be selected to define the business model, whereas their set of stakeholders is specifically catered to electric vehicle applications (and may, as such, be too limiting for more generic smart mobility initiatives). Moreover, their work adopts a *goods-dominant* view of business modelling, lacking an explicit focus on networked interactions between stakeholders to create value for and with the customer. Similarly, Abdelkafi, Makhotin, & Posselt (2013) draw from business model patterns with regards to revenue models (Johnson et al. 2008; Osterwalder and Pigneur 2010) and apply these patterns to smart mobility business models to analyze whether these patterns can be applied. However, they only examine the revenue models that may fit to these business models, and do not cover a comprehensive set of expected stakeholders and their characteristics.

Research Design

In developing the proposed reference business model, we followed the design science research methodology (Gregor and Hevner 2013; Hevner et al. 2004). Accordingly, our research process includes the following steps: *problem identification*, *definition of the objectives for the artifact*, *design and development of the artifact as a solution* and *demonstration and evaluation of the artifact* (Peffer et al. 2006). An overview of this process is depicted in Figure 2. In the next sub-sections, we briefly elaborate on each step.

Problem Identification

We discussed the research problem that drives our research in the introduction of this paper. In brief, service-dominant business models are highly agile in nature, and therefore, must be constructed, reconstructed and deconstructed rapidly. This places strong emphasis on the valid design of these business models. Given the nature of smart mobility initiatives, which typically involve collaborations between multiple stakeholders and an explicit focus on offering value through services (Böhmman et al. 2014; Flügge 2017), the emphasis on rapid design of valid models applies also for smart mobility business models. Given the wide landscape of potential stakeholders in this domain, practices of standardization (as reference

models, best practices, and patterns) can help in overcoming the challenge of rapid and valid business model design. The existing literature, however, lacks such a reference model. Therefore, in order to guide the design of smart mobility business models, which are characterized by a service-dominant perspective, we focus on the development of a reference business model.

Definition of the Requirements/Objectives of the Reference Business Model

Given the identified problem, a reference model for smart mobility business models should not only provide a generic overview of the stakeholders to be expected in the design of these models, but also their characteristics and value contributions. The service-dominant nature of smart mobility business models requires the reference model to explicitly accommodate a networked and value-centric view. Therefore, the first set of requirements with regards to the structure of the reference business model can be defined as:

R1: The proposed reference business model should accommodate a networked business model view

R2: The proposed reference business model should take a value-centric view

The primary goal of the reference business model is to provide a catalog of generic stakeholder groups that take part in the smart mobility business models. Therefore, the reference model should provide an overview of a generic set of stakeholder groups, their characteristics as well as how they are expected to obtain value (in terms of costs and benefits, which can be financial or non-financial in nature) from participation. Therefore, the second set of requirements for our artifact can be defined as follows:

R3: The proposed reference business model should describe generic stakeholder categories, their characteristics to be expected for smart mobility business models

R4: The proposed reference business model should describe per stakeholder category the costs and benefits that can be expected from participation

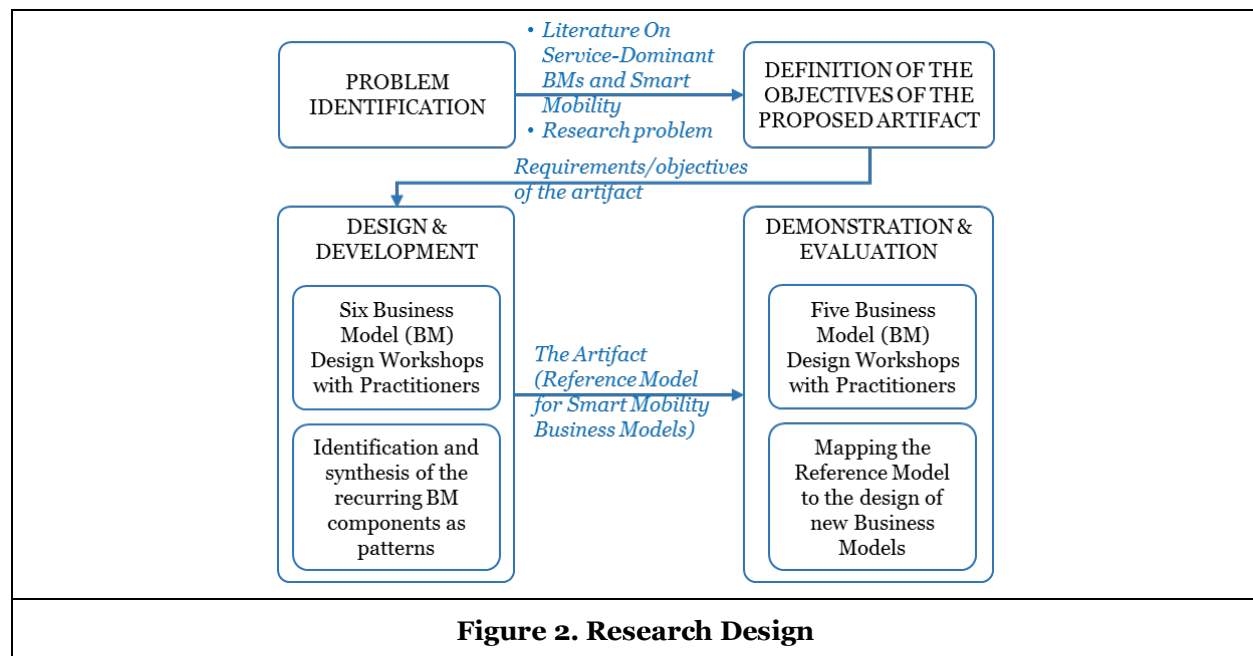


Figure 2. Research Design

Design and Development of the Reference Business Model

For developing the proposed artifact, we followed a *grounded theory approach* (Charmaz 1996; Strauss and Corbin 1990). We iteratively derived the proposed artifact from stakeholder discussions within a set of a business model design workshops that we conducted with practitioners in the smart mobility domain. These workshops focused on improving mobility in a number of cities through the application of cooperative intelligent transport systems (C-ITS) technologies and applications. The design of these business models was aimed at exploring the potential actors that would be necessary or could be involved

in the provisioning of mobility solutions that would offer value to the end-users through the deployment of C-ITS and with the involvement of appropriate business resources.

In total, 11 business model design workshops were organized, in which 15 business model designs were generated. The participants of these workshops were active in the mobility, traffic management, or transportation domains and had significant experience in the implementation and deployment of mobility solutions. These participants were active or potential stakeholders for the ‘to be designed’ business models.

Each business model workshop was orchestrated and coordinated by at least two authors of this paper. Given the service-dominant nature of smart mobility business models, we used the SDBM/R (Turetken and Grefen 2017) for the design of these models, as the tool is grounded on the service-dominant principles. The workshop participants were encouraged to think aloud and openly express and discuss their specific needs and preferences. Each workshop facilitated the design of a business model catered to the mobility challenges and needs of the city in which the workshop was held.

The first 6 workshops that we conducted (out of 11) served for the development of the reference model, whereas the remaining 5 were used to apply and evaluate the reference model for guiding the business model design process. Each workshop constituted of 2 parts. In the first part, we presented the principles of the service-dominant logic, and introduced the SDBM/R. In the second part, the authors of this paper moderated sessions where the participants collaboratively designed service-dominant business models using SDBM/R around a specific business theme (e.g., traffic management in a certain district of a city during large events). Table 1 lists these workshops, the business models that were designed, the time-location information, and the number of participants in each workshop. In total, we were able to bring together 125 practitioners collaboratively designing 15 new service-dominant business models.

Workshop	Business Models (their ‘value-in-use’)	Location / Time	# Participants (125 in total)
<i>FOR THE DEVELOPMENT OF THE REFERENCE MODEL</i>			
Ws1	Bm01- Ultimate Festival Edition in the City	Delft, NL Jun.2015	8
Ws2	Bm02- Free Event Organization for the Government Bm03- Just-in-time Presence of Elderly in Healthcare Institutions	Eindhoven, NL Jun.2015	9
Ws3	Bm04- Convenient City Visit for Shopping	Delft, NL Jul.2015	16
Ws4	Bm05- Comfortable Commuting by Bike through Traffic Light Prioritization for Vulnerable Road Users	Helmond, NL Jun.2017	17
Ws5	Bm06- Optimized Driving Experience through Green Light Optimal Speed Advisory	Thessaloniki, GR Jul.2017	20
Ws6	Bm07- Hassle-free Concert Experience with Mode & Trip Time Advice Bm08- Reliable Arrival Times through Mode & Trip Time Advice Bm09 Safe Travelling Experience by Warning Services for Vulnerable Road Users	Copenhagen, DK Aug.2017	9
<i>FOR THE DEMONSTRATION and EVALUATION OF THE REFERENCE MODEL</i>			
Ws7	Bm10- Green, Reliable and Comfortable Commuting	Bordeaux, FR Aug.2017	8
Ws8	Bm11- Safe Driving Experience with Driver Warning Services for Vulnerable Road Users	Barcelona, SP Sep.2017	20
Ws9	Bm12- Efficient and Effective Public Services via Green Priority Bm13- Fast and Safe Travel of Emergency Vehicle via Green Priority and Emergency Vehicle Warning	Vigo, SP Sep.2017	5
Ws10	Bm14- Efficient Freight Delivery in an Urban Area with Parking Availability	Bilbao, SP Sep.2017	6
Ws11	Bm15- Reliable and Efficient Transportation via Traffic Information Provisioning	Newcastle, UK Sep.2017	7
Table 1. The Workshops and Smart Mobility Business Models			

We started the derivation of the reference business model by conducting *open coding* (Charmaz 1996). Accordingly, we allowed our codes, which focused on the generic stakeholder categories to be included, to iteratively develop as our understanding of the roles of stakeholders, as well as their interactions within the business model increased. Discussions with participants were collected and noted, allowing the generated data to be coded. We also examined why certain decisions were made with regards to the design of the business model.

Next, we applied *focused* or *axial* coding (Charmaz 1996; Strauss and Corbin 1990) to establish generic categories of stakeholders. Thus, more concrete stakeholders that had similar characteristics or roles within the business model were grouped and categorized. Moreover, as our understanding of more generic stakeholder groups increased, feedback could be generated and incorporated from participants. As the stakeholder categories crystallized, we applied *narrative* or *focused coding*, aimed at understanding the characteristics of each stakeholder group as well as their respective costs and benefits that can be expected from participation. Taking into account the requirements that were set prior to the development of the artifact, the final results of our analysis were mapped to the SDBM/R to accommodate a service-dominant view (Turetken and Grefen 2017). This resulted in a comprehensive reference business model for smart mobility business models, elaborating the stakeholders to be expected, their value contribution as well as how they capture value from participation.

Demonstration and Evaluation Reference Business Model

For the remaining business model workshops, we used the derived reference business model as a basis to guide the design of smart mobility business models. Starting from the reference business model, workshop participants were able to analyze the stakeholder roles that would be needed to offer the mobility service solution, and map the concrete stakeholders for a city or mobility initiative to these generic stakeholder categories, while inheriting their expected costs and benefits from participation.

With respect to the evaluation of the artifact, the proposed reference model contrasts existing literature by focusing on generic stakeholder categories rather than generic financial patterns. Moreover, as opposed to traditional business model research, the proposed reference model is grounded on the premises of service-dominant logic (rather than a goods-dominant viewpoint). Hence, given the particularly novel nature of the artifact, for the evaluation we focused on its *validity* by means of a *proof of concept*, i.e., the extent to which it is applicable and can be used for its intended purpose of use (Gregor and Hevner 2013). This allowed us to understand whether the derived generic stakeholder categories were applicable and used. Hence, although the reference business model is comprehensive in nature and therefore may include more groups than necessary, we examined whether the stakeholder categories which were derived were actually used by participants to design new business models, and whether the characteristics described per stakeholder category matched the role of concrete stakeholders grouped under the respective stakeholder category. Feedback of participants with regards to the set of stakeholders and characteristics, and how the reference business model was applied, was recorded and used to further improve the proposed artifact.

Reference Business Model for Smart Mobility

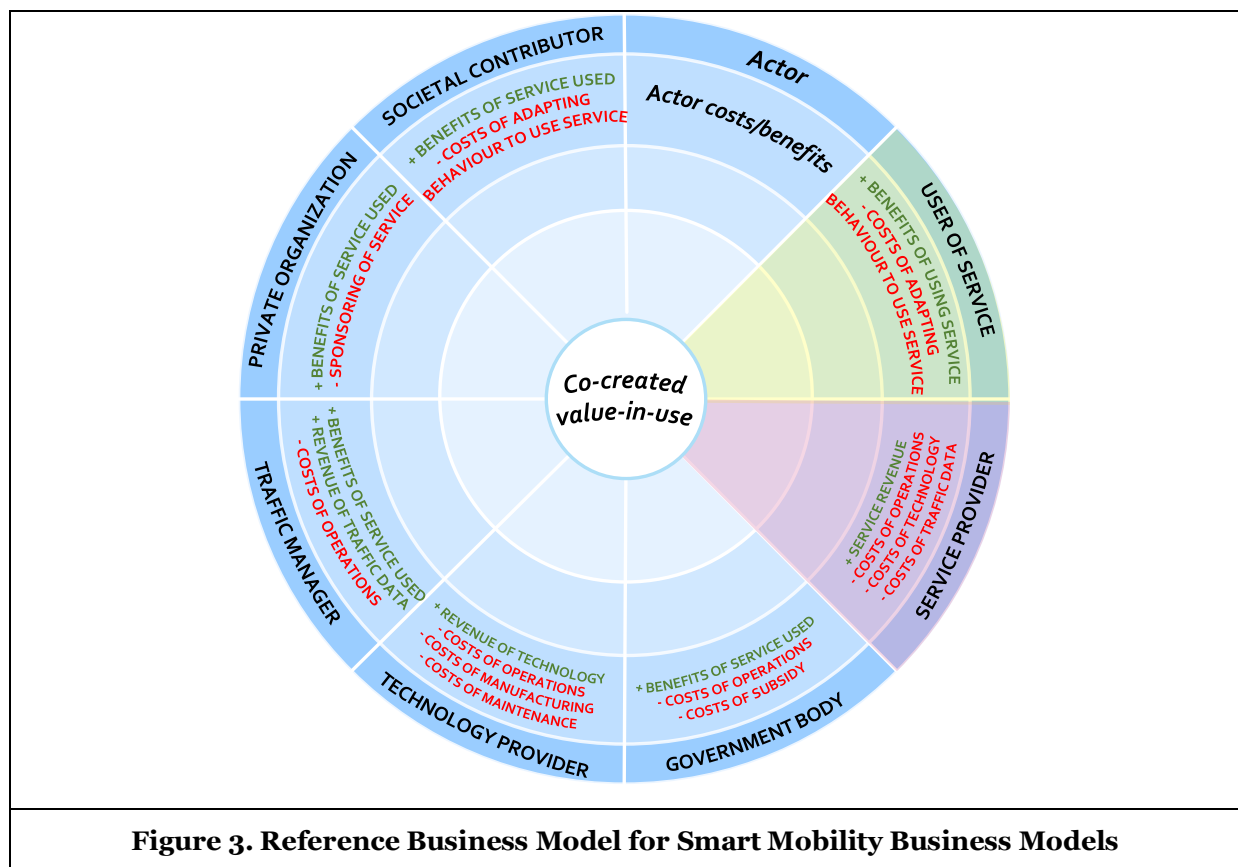
Figure 3 presents the reference business model that we propose. The model is depicted in the form of a service-dominant business model radar and provides guidance mainly for two layers of the radar: actors and the cost/benefits that each actor incurs. By using the SDBM/R, we take a networked and value-centric perspective, satisfying the *first (R1)* and *second (R2)* requirements of the artifact.

For each stakeholder category identified, we elaborate the characteristics of the associated role, and specify the generic cost and benefit items that can be expected from participating in the business model. These costs and benefits can be *financial* and *non-financial* in nature (Bocken et al. 2015; Turetken and Grefen 2017). Hence, we satisfy *R3* and *R4*. Accordingly, users of the artifact can explore what generic stakeholder categories are available and which categories they should include to provide the service solution. Moreover, examining the characteristics of each stakeholder category facilitates the users to map concrete stakeholders (specific to a city or area) to these generic roles. Similarly, given the generic costs and benefits that are expressed per stakeholder category, users can identify whether these costs and benefits are also applicable for their concrete stakeholders (or whether adjustments to the business model design should be made). Note that, because of the generic nature of stakeholder groups, in practice concrete stakeholders

may not cover the entire spectrum of characteristics or functionalities which reside in different groups, requiring the multiplicities of the groups to be changed.

The proposed set of stakeholder categories shows a certain degree of overlap with the proposal by Kley et al. (2011), which focus explicitly on electric vehicle applications. This set included the actors *manufacturers*, *suppliers*, *customers / users*, *service providers*, *government* and *substitutes* (Abdelkafi et al. 2013; Kley et al. 2011). Extending their work from a networked and value-centric perspective, and taking a focus on C-ITS services rather than electric vehicles as the core technology enabling the service, we did not include manufacturers and suppliers from the set of stakeholders (which for their categorization were strongly related to the production of electric vehicles) and rather include a *technology provider*, related to the provisioning and deployment of C-ITS. Furthermore, the category *substitutes* related to alternatives that may be present or may extent the service solution (e.g. public transport to electric vehicles). Given the nature of C-ITS services, we did not include these services under an explicit category *substitutes*, but rather encapsulate these functionalities under *traffic manager*, who is in charge of managing the traffic infrastructure (which may take various modes) and generating data.

Similarly, our discussions with participants of the workshops indicated that the smart mobility initiatives should be supported not only by government bodies or public authorities, but also by *private organizations* as a source of funding and support. This is also acknowledged within smart mobility research, for which financing structures as *public-private partnerships* are becoming more prominent and accepted to support mobility initiatives (Cohen and Kietzmann 2014; Kley et al. 2011; Perera et al. 2014). As such, we have added the category *private organization* to the set of stakeholders. Likewise, our analysis also presented the need to include an additional category related to the cooperative nature of C-ITS services, which although catered to a specific end-user, affects and may involve additional *societal contributors* as well with whom the service may communicate (Bocken et al. 2015; Perera et al. 2014).



In the subsequent paragraphs, we briefly describe each actor and its role in the reference model.

User of the Service Solution

The *user of the service solution* is a key stakeholder in any service-dominant business model and represents the party to which the value created by the service solution is appropriated. The smart mobility business models should include a user group and ensure that the service solution is catered to the end-user. The user of the service can be concretized as a car driver, pedestrian, or cyclist. Moreover, this may also be specified further to target highly concrete user groups (e.g., elderly pedestrians) or organizations which act on behalf of these user sets (e.g., transport operator). For instance, the business model design might be catered towards stimulating trucks to use outer ring-roads to reach their delivery location instead of the roads in the inner city to relieve the traffic in an urban area. In this case, the logistic company instead of the individual truck driver becomes the user of the solution.

Considering our discussions with the workshop participants, the main revenue structure for individual users for designing and implementing smart mobility business models should accommodate a ‘free’ business model for which the user does not have to *pay*. This is primarily to stimulate the adoption of service solution and is aligned with the general pattern observed in successful business models in this domain (Lu et al. 2018). In this scheme, the costs of participating in the model comprise of the actions the user has to take to use the service (the change in behavior required, e.g., using a C-ITS application, presenting and offering usage data, or adhering to instructions presented by the service). These costs should be compensated by the benefits that the service solution may provide to the user (e.g., increased comfort and safety while travelling or decreased travel times). However, in case of an organization representing these groups of users, this revenue model may be catered to a subscription or lease model, depending on the benefits that arise from the service solution.

Service Provider

The *service provider* is the focal organization and ‘owner’ of the business model, responsible for establishing the interface between the end-user and business model stakeholders, and orchestrating the service solution. The service provider is also often a platform provider (similar to organizations as Uber). The service provider operates as an information hub, collecting traffic, technology and usage data to instantiate the service or to disseminate data with regards to service or activity invocations of other business model stakeholders. From our workshops, we identified that service providers are primarily driven by financial opportunities to participate in smart mobility business models. Therefore, the benefits obtained from the business model for the service provider are in the form of revenue generated by offering the service, while the financial costs are incurred for the orchestration and internal operation of the mobility solution. Moreover, depending on whether the service solution requires data to be generated by other stakeholders within the business model (e.g., technology provider, traffic manager), the service provider can also be required to compensate the costs incurred for obtaining this data.

Government Body

Smart mobility initiatives are typically aimed at improving city management (Flügge 2017). Hence, the inclusion of a *government body* is key to ensure the success of a business model. The *government body* can be characterized as a municipality, local or national government. Its role is to support and ensure the feasibility of the business model, which may include operational support (providing the legal means to implement C-ITS technology within cities or areas), but also financial support in terms of subsidizations. As the service solution is catered towards solving or improving a city challenge, the main benefit that can be appropriated to the government body are the benefits of the service being used, which may include (but are not limited to) improved traffic conditions, increased safety of the end-user, decreased traffic emissions, and improved image of the city or a district. This is at the cost of the investments or subsidies the government body offers to the orchestrator (the service provider), and the possible initial and operational expenses to support the business model implementation.

Technology Provider

Mobility solutions can involve the deployment of advanced technology solutions including C-ITS, and related components, such as sensors, cameras, road-side units, or vehicle-to-vehicle applications. The

stakeholder category *technology provider* develops, implements and manages this enabling technology. The organizations focusing on the development of these applications can be mapped under this stakeholder category. Our discussions with workshop participants showed that the participation by the technology provider in the business model is driven by the sales of technology. Given these characteristics, costs and benefits appropriate to the technology provider are primarily of a financial nature. As benefits, the technology provider generates revenue by selling the availability of technology to the service provider (e.g. development and maintenance), whereas costs are incurred for developing, implementing and maintaining the C-ITS technology and operational costs with regards to supporting internal business practices.

Traffic Manager

The stakeholder category *traffic manager* is a rather elaborate category, encompassing the responsibility of operating the traffic infrastructure, which may include facilitating the mobility of end-users (e.g. road availability and traffic management) or actively transporting end-users. Accordingly, depending on the service solution offered by the business model, the *traffic manager* may be concretized as a road operator, but can also take the role of public transport operator. Based on how the *traffic manager* is concretized, benefits may either relate to the effects of the service being used or relate to the increase in revenue concerning the transportation of end-users. For instance, in case the stakeholder category is concretized as a road operator to manage the traffic as part of the service solution, the road operator can benefit from the effects of the service solution being offered (e.g. less traffic jams or an increased throughput of cars on the road). Similarly, if the role is concretized as a public transport operator to offer the part of the service solution, the public transport operator can benefit from an increase in user base, as end-users are stimulated to take public transport. Depending on how the category is concretized, the traffic manager incurs costs of internal operations related to supporting the service solution.

Private Company

The *private company* can be concretized by a wide group of stakeholders (including, but not limited to, insurance companies, employers, parking providers, retailers), which may support the feasibility of the business model as these organizations can potentially benefit from the service being used. The service solution can generate valuable user data, endorse traffic behavior which may benefit the organization, or is catered to a group of end-users which interests the organization. Given the potential benefits of the service solution, the *private company* can join to further stimulate the feasibility of the business model. For instance, for a service solution that allows employees to arrive timelier at work, employers also benefit from the service solution (e.g. increased productivity of workers). To ensure that the use of the service solution can be sustained (or even stimulated), the employer can actively support the business model financially. Therefore, they do not actively contribute part of the value of the service solution, but rather ensure that the business model remains feasible. Accordingly, this may be part of *public-private partnerships* schemes to improve the feasibility of the business model (Cohen and Kietzmann 2014; Kley et al. 2011). Similar to the *government body*, the effects of the service being used may prompt a private company to become an active stakeholder in the business model and invest in the service solution. As costs, the private company incurs costs of sponsoring or stimulating the service.

Societal Contributor

Although the service solution aims to improve overall traffic conditions within a certain area, the service solution cannot be catered to all customers or end-users (e.g. car drivers, cyclists, pedestrians). However, the effectiveness of the service solution might depend on how well these end-user groups interact. For instance, services which depend on detection to avoid collisions with traffic users (e.g., pedestrians) may become significantly more effective to end-users if pedestrians actively contribute behavioral data. In turn, this may also benefit the pedestrian in terms of increased traffic safety. Therefore, the *societal contributor* can be characterized as the party that enhances the service solution by supporting the service. This can be achieved through sharing data but can also be achieved by following up road instructions or traffic signage. Generalizing the previous example, the societal contributor benefits from the service being used (e.g., a decrease in collisions between car driver and pedestrian). As a cost, the societal contributor has to adapt his or her behavior (e.g., follow up instructions or actively share behavioral data).

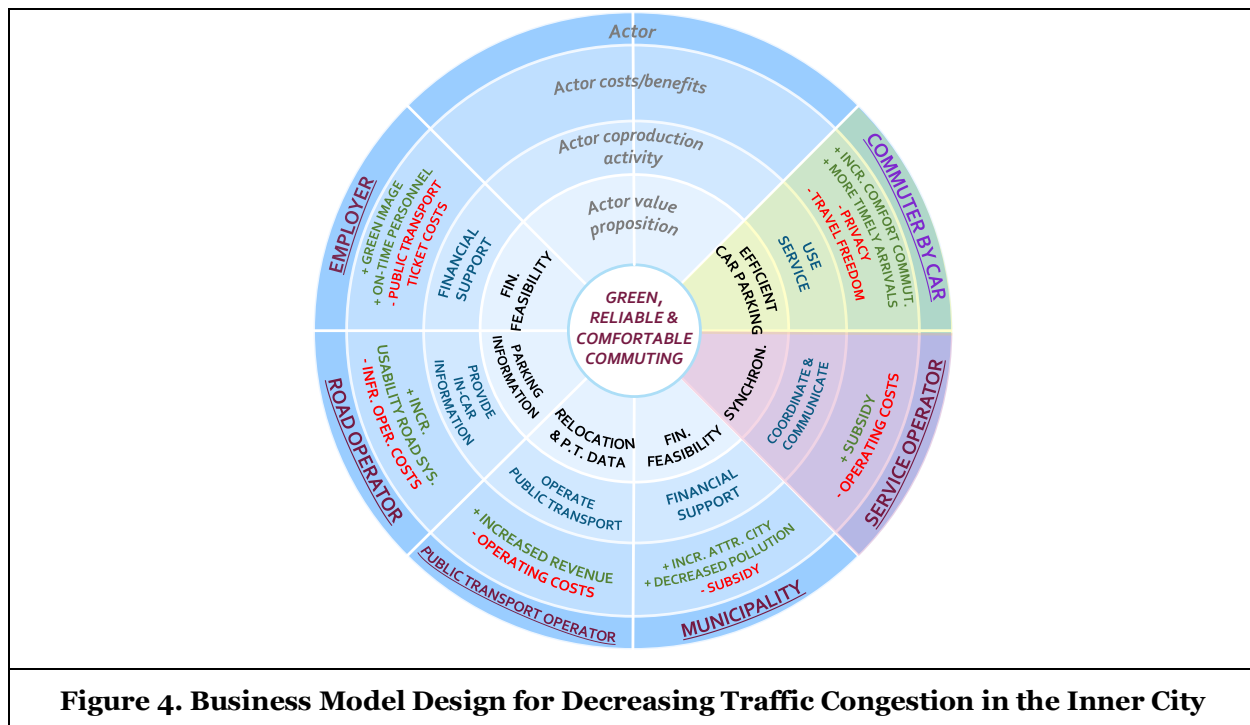
Application of Reference Model to Guide Business Model Design

As stated before, the derived reference business model has been used to guide the design of smart mobility business models in the second set of workshops. In this section, we illustrate the application of the reference business model by presenting and elaborating the results of one of the business model designs that has emerged from the workshop in Bordeaux (Table 1). We illustrate the mobility challenge that was central to the workshop and the service solution proposed. Moreover, we show how participants of the workshop used the reference business model to transition from generic stakeholder groups to more concrete stakeholders catered to the city’s mobility challenges and characteristics. For anonymity of the results, we do not provide the names of the organizations, but rather express the organizations as concrete as possible.

Example Business Model: Decreasing Traffic Congestion in the Inner City

In the workshop that was conducted in Bordeaux, the mobility challenge that the city was facing was the increasing traffic congestion in the inner-city roads, especially during rush hours. The current infrastructure for the city (which included a limited set of bridges with a high traffic profile) was unable to handle the high demand of car users during these peak moments. As a consequence, the flow of traffic would decrease considerably, causing negative externalities to logistics, employers and retailers (as car drivers could not reach to their destinations in time). Therefore, the municipality of the city sought after solutions involving C-ITS technologies which would improve the current situation.

The mobility solution which originated from the stakeholder discussions in the workshop constituted of an approach which would stimulate *commuters to work* to not travel by car to the inner city, but rather park the car at the outskirts of the city and venture to the inner city by public transport. The value created by the solution, i.e., the co-created value-in-use, is the increase in travel time reliability and a more comfortable and eco-friendly travel experience, as public transportation, specifically metros, is able to follow a more reliable time schedule, and driving through a congested city by car may cause stress and discomfort. The C-ITS services supporting this solution included *urban parking availability* and *mode and trip time advice*, which facilitate finding and directing users to a suitable parking location at the outskirts of the city, and providing users necessary and timely information on what mode of transport to take accompanied by the arrival and departure times respectively. The resulting business model design is presented in Figure 4.



Using the solution scenario and the reference business model as bases, the workshop participants first examined what generic stakeholders were necessary to offer the service solution, and to which end-user group the service solution was catered. Considering the characteristics of the service solution, which involves end-users parking their car at the ring roads or outskirts of the city and transporting these end-users to their desired destinations, the generic categories service provider, traffic manager, government body and end-user were considered. Consequently, these were translated into concrete stakeholders fitting the characteristics of the city. This mapping can be seen in Table 2.

Accordingly, a concrete stakeholder took the role of service provider, responsible for orchestrating the business model, integrating the parking data and public transport data (arrival and departure times) in order to effectively provide parking and mode-and-trip-time advice to the end-user. Considering the reference business model, the service provider should receive financial benefits for offering the service, whereas costs are incurred for internal operations. This is reflected by the business model design, in which the service operator is paid by the municipality for offering the service solution in terms of subsidization. However, the service provider incurs costs with regards to operating the service solution.

Similarly, the municipality of the city was mapped to the stakeholder category *government body*. As presented by the reference model, the municipality should benefit from the service being used. This is reflected by the business model design by an increase in the attractiveness of the city (e.g. less congestion), and decrease in air pollution by traffic. As discussed before, the municipality incurs costs for subsidization.

Considering the reference business model, the *commuter by car* (the end-user) benefits from the service being used (e.g. timely arrivals, comfortable commuting), whereas in order to allow the service to work effectively, the *commuter* is required to change its behavior. As such, the *commuter* loses some flexibility or freedom as the car is left at the outskirts of the city.

Given the characteristics of the service solution, the role of the traffic manager described in the reference model is split into two roles to include the public transport operator and the road operator as explicit actors, as public transport and road management is organized by different stakeholders for this city. Therefore, the stakeholder category traffic manager is mapped to two concrete stakeholder roles (Table 2). The road operator takes care of generating data with regards to parking availability, while the public transport operator takes care of the transportation of commuters. As described by the reference business model, the road operator benefits from the service being used (e.g., increased usability of the road infrastructure), while the public transport operator benefits from an increase in user-base and increased revenues of offering transportation (as commuters take the public transport instead).

Lastly, the use of the reference business model also stimulated participants to explore external revenue sources through including private organizations. For instance, as the commuters' timeliness potentially improves, certain *employers* (companies) located in the inner-city can also be included in the network to cover (part of) the public transport ticket costs. This can be attractive particularly for those companies that are expected to offer parking facilities to employees. Consequently, employers can benefit from green-image and on-time personnel (and can potentially cover for the expenses of public transport).

Evaluating the Validity of the Reference Model

Following the design science research methodology, the developed artifact should be evaluated in a real-life setting (Hevner et al. 2004). As stated earlier, we focused on the validity of the reference model – i.e., whether it is applicable for its intended purpose of use. We do so by assessing whether the reference model could be used to guide the design of business models, by analyzing the extent to which the concrete stakeholders could be mapped to the generic stakeholder categories in the reference model. The results of this evaluation are presented in Table 2. As shown in the table, for all workshops that we used the reference model, at least 5 out of 7 categories were used, showing that the model provided significant support towards the design of the business models. The categories *user of service*, *service provider* and *traffic manager* were used in all business models. One case did not include a government body explicitly as a concrete stakeholder. However, in this case, the road operator which was included as stakeholder acted on behalf of their municipality (and thus encompassed part of its functionalities). These categories, therefore, can be considered appropriate for the design of business models in this domain. The *technology provider*, *private organization* and *societal contributor* were not used in all business models. This was largely due to characteristics of the proposed service solution, which did not always require the functionalities or

characteristics of these stakeholders. Nevertheless, for some cases, they were selected to enhance the value of the service solution. Therefore, these categories serve to enrich the service solution. Note that, some cases featured concrete stakeholders (highlighted as underscored) which were mapped to multiple categories, as these possessed more functionalities than proposed by the category, whereas some categories include multiple concrete stakeholders.

Due to space limitations, we do not include a detailed mapping of the costs and benefits proposed by the reference model and the concrete costs and benefits included in the business model design. Despite the fact that the concrete costs and benefits proposed in the business model design were often preliminary and varied based on the characteristics of the service solution, they showed significant overlap with the generic costs and benefits proposed. This way, it facilitated practitioners to focus their attention on the feasibility of the business model by examining the costs and benefits accrued. Differences largely occurred when concrete stakeholders fall under multiple categories or when data generated by stakeholders was not billed.

		Concrete stakeholders per workshop				
		Bordeaux	Barcelona	Vigo	Bilbao	Newcastle
Stakeholder categories defined	User of service	Commuter by car	Car driver	Public transport operator / Emergency Vehicles	Truck driver	Commuter by public transport
	Service provider	Service operator	Service operator	<u>Road operator</u>	Parking operator	Service operator
	Government body	Mun. of Bordeaux	Mun. of Barcelona	Mun. of Vigo	<u>Mun. of Bilbao</u>	<u>Road operator</u>
	Technology provider	<i>Not included</i>	Software provider	Technical service provider	<i>Not included</i>	<i>Not included</i>
	Traffic manager	Public transport operator / Road operator	Traffic operator	<u>Road operator</u>	<u>Mun. of Bilbao</u>	Bus operator / <u>Road operator</u>
	Private organization	Employer	Insurance company	<i>Not included</i>	Retailer	<i>Not included</i>
	Societal contributor	<i>Not included</i>	<i>Not included</i>	<i>Not included</i>	Logistics association	Other car drivers
# categories used		5/7	6/7	5/7	6/7	5/7
Table 2. Mapping of Concrete Stakeholders to Generic Stakeholder Categories						

Conclusions

In order to cope with the growth of world population, particularly in cities, local and national governments are striving for efficient city management (Perera et al. 2014). This has sparked increasing interest in *smart mobility* initiatives by which governments aim to exploit innovative information systems and technologies to find sustainable solutions to address these issues. However, these technologies should be encompassed by a valid business model in order to be effective (Chesbrough 2007; Johnson et al. 2008). Moreover, considering the service-dominant nature of these business models (Böhmman et al. 2014), they should be designed, implemented, evolved, and deconstructed rapidly. Given the wide landscape of potential stakeholders, it may become difficult to design valid smart mobility business models. Thus, there is need for a reference model that can aid the design of these business models.

In this study, we proposed a reference business model, which elaborates on the generic stakeholder categories that are expected to take part in the smart mobility business models. We indicate the characteristics and forms that these stakeholders can take in these business collaborations, their functionalities, as well as the costs and benefits that they can expect when they participate.

The proposed artifact has contributions both to the research and practice. The literature offers methods or tools for designing business models (Bouwman et al. 2008; Osterwalder and Pigneur 2010; Turetken and Grefen 2017), for appropriating and mapping value (Bocken et al. 2015), and on the patterns to structure the revenue model of business models (Abdelkafi et al. 2013; Walravens and Ballon 2013). Complimenting these research streams our study proposes a reference model with a set of generic stakeholder categories that serves as the basis for the service-dominant business design, specifically catered to the smart mobility domain. Such a model, applicable to smart mobility business models, has not been proposed before. Although concrete stakeholders, specific for a city or area, may cover various functionalities or roles, the comprehensive set of stakeholder categories encapsulates the basic set of functionalities that may be expected for these models. Taking this as a starting point, it facilitates business model research to better explore the interrelationships that these stakeholders have in offering the service solution and how these stakeholders may create value. Therefore, the proposed artifact provides a foundation for smart mobility business model design and can be used as a reference to explore the configurations of these business models in more detail. Taking such a model as a reference and a starting point might help practitioners to rapidly design (more) complete service-dominant business models in the smart mobility domain. The reference model can also help practitioners in evaluating the feasibility/viability of these models.

This research is not without limitations. Although using a grounded theory approach facilitates the derivation of constructs from qualitative data, it is subjective in nature. We aimed to mitigate this issue by involving multiple researchers within the coding and categorization process (i.e., the authors of this paper). Still, other researchers (particularly with different backgrounds) may come to different categorizations and labels to characterize stakeholder groups. Furthermore, we only evaluated our artifact with regards to its validity with a limited number of smart mobility business models. Although the artifact is rather generic, its *utility* should also be evaluated with the potential users of the reference model, to understand the true value to its users.

Future research should explore reference business models which are catered to different domains, and to compare what differences may be present between the proposed reference models. As such, research may strive for more generalized reference models, applicable in multiple domains. This work can be combined with existing work on revenue model patterns, to examine in detail how the patterns should be applied. Furthermore, given the set of value outcomes to be expected per stakeholder, future research may also explore how the feasibility of each stakeholder (and as such the business model design) can be evaluated. This can facilitate the development of a more generalized approach for evaluating smart mobility business models.

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