TOWARD A DESIGN FRAMEWORK FOR SERVICE-PLATFORM ECOSYSTEMS

Research paper

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Abstract

The emergence of digital platforms disrupts the way we communicate, interact, and utilize services. We increasingly find ourselves in a world shifting away from Goods-Dominant (G-D) toward Service-Dominant (S-D) logic. One crucial aspect of this is the way we will use mobility in the future. In the past, we relied on goods in the form of privately owned cars to travel from point A to point B. However, platforms such as Uber, Lyft, DriveNow, and car2go change the way we use mobility from owning a car to using mobility as a service (MaaS). Although we have gathered knowledge about how to optimize production processes in the G-D world, how to design successful platform ecosystems from an S-D perspective is unclear. In this article, we took a design science research approach to developing a framework that helps scholars to systematically compare, and practitioners to design, a mobility service platform ecosystem (MSPE). First, we started with a literature review to ground the artifact in S-D and MaaS research. We then developed the framework iteratively, drawing from literature and two case studies representing a public and private mobility platform. The resulting artifact is a first step toward providing a structural, reproducible framework to design MSPEs that ensures comparability across platform ecosystems.

Keywords: digital platforms, mobility as a service, mobility platform, platform ecosystem, service-dominant logic

1 Introduction

Digital platforms have changed the way we communicate, socialize, interact, consume, and share with one another. Examples range from Social Media platforms such as Facebook, through merchant platforms such as Amazon or eBay, to the sharing economy with its recent key players Airbnb and Uber. Those companies exploit network effects by connecting two or more interest groups within an ecosystem that a digital platform mediates (McIntyre and Srinivasan, 2017, de Reuver et al., 2016). The more Uber drivers there are on the platform, the better the coverage for potential passengers. Conversely, more passengers on the platform increases the number of possible rides for the drivers. Besides network effects, platform companies offer digital services, which allows them to transmit, capture, and monetize the various data sources within the ecosystem (Evans and Gawer, 2016).

As more and more physical goods become digital, platforms continue to affect the way we live. One particular aspect is connected mobility, where the shift of mobility from Goods-Dominant (G-D) to Service-Dominant (S-D) logic is omnipresent (Lusch and Nambisan, 2015, Harrington, 2002). When traveling from point A to point B, people are no longer restricted to using their own cars. They can also access mobility as a service (MaaS) through different providers including on-demand ridesharing platforms (Greenwood and Wattal, 2017). Current platforms exhibit different aspects of MaaS. These range from sharing cars, bikes, and rides to intermodal mobility services (Spickermann et al., 2014, Firnkorn and Müller, 2011, Teubner and Flath, 2015, Willing et al., 2017).

One critical question—how should digital platforms should be designed?—remains unanswered (de Reuver et al., 2016). Neither scientists nor practitioners currently have an artifact that helps them to create transparency about how to design a platform ecosystem. Although there are well-established theories pertaining to S-D-logic service innovation and platforms (Lusch and Nambisan, 2015, Barrett et al., 2016, Benlian et al., 2015, Tiwana, 2015), none provides the necessary guidance on how to decompose a platform ecosystem. Resolving this issue entails theoretical and practical implications. On the one hand, scientists would benefit from a tool with which they can model specific parts of a platform ecosystem thereby enabling them to systematically compare different platforms. The benefits are reproducible, comparable outcomes and increased scientific rigor when modeling platform ecosystems. On the other hand, the practitioners could benefit from having a design artifact that reduces the complexity of platform ecosystems and makes dynamics between different actors within a platform more transparent.

We adopt a design science research (DSR) approach (Gregor and Hevner, 2013, Hevner et al., 2004a) to developing a design framework for a configurable mobility service platform ecosystem (MSPE). To ensure practical relevance, we constrain the scope to a concise domain that is becoming increasingly important (Greenwood and Wattal, 2017, Willing et al., 2017). Further, we increase scientific rigor by carrying out a systematic literature review (SLR) to establish a knowledge base pertaining to MSPEs. We also engage in closely interlinked relevance, rigor, and evaluation cycles within two mobility service platforms (private and public) when creating the artifact (Hevner et al., 2004a, Hevner, 2007). In the remainder of this article, we start with the theoretical background as the basis for the artifact to be developed. We next explain the methods used to increase scientific rigor and the case studies to ensure practical relevance. After that, we describe the artifact in the form of three morphological boxes to design a configurable MSPE. We then demonstrate the artifact on the example of two case studies involving a private transportation operator operating in the field of floating carsharing services and a public transportation authority administering an intermodal mobility platform. Lastly, we discuss theoretical and practical implications, show avenues for future research, and highlight the research's limitations.

2 Theoretical Background

In this section, we describe the fundamental theories we use to develop a design framework for configurable MSPEs. We summarize S-D logic to emphasize the shift from tangible producer-consumer to intangible value-creation relationships and introduce S-D logic's three dimensions: service ecosystems, service platforms, and value co-creation. We then present the context from the MaaS perspective.

2.1 Service-Dominant Logic

Researchers have heretofore explained the institutional logic of how organizations and entrepreneurs interpret, learn, and advance mostly from a G-D-logic perspective (North, 1994, Vargo and Lusch, 2004, Vargo and Lusch, 2008). G-D logic elucidates effects, such as specialization and standardization, on tangible products or goods to benefit from control and efficiency (Vargo and Lusch, 2004, Vargo and Lusch, 2008). S-D logic focuses instead on the exchange of services during which one actor uses a set of skills and capabilities to benefit another actor. S-D logic focuses on services instead of products. As we are investigating the development a framework to design MSPEs, we apply S-D logic. Lusch and Nambisan (2015) made a remarkable contribution by conceptualizing S-D logic along three dimensions: service ecosystem, service platform, and value co-creation. Each dimension addresses different issues and concepts from the S-D-logic perspective.

2.1.1 Service Ecosystem

A service ecosystem is a community of interacting actors organized in an actor-to-actor (A2A) network (Orlikowski, 1992). Actors within the A2A network co-evolve their skills and roles, depending on each other to strive for effectiveness (Moore, 1993). Accordingly, we adopt the definition of service ecosystems proposed by Vargo and Lusch (2011) as a somewhat self-adjusted, self-contained system of regularly loosely coupled economic and social actors. A service ecosystem connects different actors through an exchange of services via mutual value creation and shared institutional logic. Lusch and Nambisan (2015) identify three issues that scholars and practitioners need to consider along this dimension. First, the ecosystem needs to provide structural flexibility and structural integrity. Structural flexibility is the ease with which actors can collaborate within an ecosystem; it governs business agility (Tilson et al., 2010). Structural integrity describes the relationship between the actors within an A2A network and their degree of coupling, fostering engagement within the ecosystem (Lewicki and Brinsfield, 2009). Second, service ecosystems need to offer a shared worldview to bridge the cognitive distance between two actors (Hendriks-Jansen, 1996, Weick, 1995). A shared worldview in the form of mutual standards or mental frameworks can ensure that actors mutually interpret the integration of resources and that they come together more quickly to exchange resources (Lusch and Nambisan, 2015). Third, the service ecosystem needs to provide an architecture of participation. This architecture facilitates the coordination and engagement of actors with the help of transparent rules and provides transparency vis-à-vis the actor's contribution.

2.1.2 Service Platform

A service platform liquefies resources and enhances resource density to facilitate efficient, effective service exchange in a service ecosystem. Resource liquefaction in this context refers to the decoupling of information from a physical good, form, or device (Normann, 2001). Resource density describes the speed with which resources can be effectively and efficiently mobilized for an actor (Normann, 2001, Lusch et al., 2010). A layered-modular structure facilitates either functional designs leading to different core value propositions or cross-design hierarchies creating completely new value propositions (Baldwin and Clark, 2000). Such an architecture also enables more scalable coordination of service exchanges, thus leading to more opportunities for value co-creation (Lusch and Nambisan, 2015). The modular architecture engenders the need for platform governance or protocols. The associated rules define the way interactions in the A2A network are governed, ranging from an open policy to closed, restrictive rules (Lusch and Nambisan, 2015, Hein et al., 2016, Schreieck et al., 2018, Schreieck et al., 2016a). We adopt the definition of Lusch and Nambisan (2015) for a service platform as a modular structure that combines tangible and intangible resources or components and coordinates the interaction of resources and actors.

2.1.3 Co-Creation of Value

The platform facilitating actors' interaction in a service ecosystem determines the co-creation process. From the S-D-logic perspective, actors can assume different roles and integrate a variety of resource types to create value. Accordingly, the definition provided by Lusch and Nambisan (2015) incorporates actors able to play different roles within the service ecosystem and relying on processes and activities needing resource integration. S-D logic differentiates ideator, designer, and intermediary actors. The ideator distributes knowledge about specific (customer) needs in a unique context, which he/she can then integrate into existing market offerings. The designer incorporates the ability to mix and match existing resources or knowledge to develop new services. The intermediary distributes and shares knowledge across multiple service ecosystems and serves as an intermediary. Each role integrates existing resources and knowledge with peers in the ecosystem, resulting in new service opportunities. However, uncertainty about who ecosystem actors are, what and whom they know, and what they can do negates potential opportunities. Lusch and Nambisan (2015) describe three issues that scholars and practitioners should address. First, they assert, the more actors interact, the more they learn from one another, which in turn determines what they can do as actors. The same is true for the communication channels. The more interactive the channels, the more plentiful the opportunities for resource integration and service exchange. Second, internal processes also need to foster value co-creation within the service ecosystem. Third, clarifying and communicating the platform's rules and protocol is essential to resolving intellectual-property issues (Lusch and Nambisan, 2015).

We structured our configurable-MSPE artifact along these dimensions to ensure that it rests upon the meta-theoretical foundations of S-D logic (Lusch and Nambisan, 2015).

2.2 Mobility as a Service

MaaS is a relatively new concept intended to characterize mobility in terms of new behaviors aided by technology and new transportation solutions (Jittrapirom et al., 2017). Hietanen (2014) provided one of the first definitions of MaaS. It defines MaaS as a mobility-distribution model for a service provider to satisfying users' transportation needs through a single interface. The model associates various transportation modes to offer a customized mobility package. New elements and characteristics have emerged over the years (Sochor et al., 2015, Atasoy et al., 2015). In this article, we draw on the work of Jittrapirom et al. (2017), who reviewed the literature on MaaS concepts and derived nine core characteristics from it (see Table 1).

Core characteristic	Description
1. Integration of transportation modes	Bringing together multi-modal transportation, which allows users to choose and facilitates their intermodal trips. Transportation modes: taxi, public transportation, carsharing, bike-sharing, ride-sharing, car-rental, on-demand services, long-distance buses, trains, flights, and ferries.
2. Tariff option	The MaaS platform distinguishes two tariffs for accessing mobility services. Mobility package: various transportation modes are bundled with a certain number of minutes/km/points for a monthly payment. Pay-as-you-go: users are charged for actual use of the service.
3. One platform	Digital platform facilitates the provision of mobility services to the end-user. Services: booking, trip planning, payment, ticketing, and real-time information. Additional services: weather forecasting, synchronization with personal-activity calendar, travel-history report, invoicing, and feedback.
4. Multiple actors	A MaaS ecosystem connects various actors through a platform. Actors: demanders of mobility, supplier of transportation services, and platform owners Additional actors: local authorities, payment clearing, and telecommunication and

	data-management companies
5. Use of technologies	Different technologies are combined to enable MaaS. Technologies: mobile computers, smartphones, mobile internet, GPS, e-ticketing, e-payment systems, database management systems, and internet-of-things technologies.
6. Demand orientation	MaaS reflects a user-centric design paradigm, which seeks to offer a transportation solution that fits the customer's perspective and context.
7. Registration requirement	Registration acts as a barrier to platform entry and is a prerequisite for offering personalized services.
8. Personalization	MaaS ensures personalization so that the system meets the customer's needs more effectively.
9. Customization	The customers' ability to modify offered mobility services according to their needs.

Table 1. Core mobility as a service characteristics (Jittrapirom et al., 2017)

In summary, the theoretical background covers S-D-service logic as the theoretical basis and core MaaS characteristics as the mobility context. The combination provides the theoretical foundation for the configurable-MSPE design framework.

3 Methods

Methods for building a configurable-MSPE framework are broken down into two phases. First, we conduct a structured literature review (SLR) identify the current theoretical perspective from which important characteristics are viewed when designing an MSPE. Second, we adopt a design science research (DSR) approach to developing the MSPE design framework based on those findings and two case studies.

3.1 Structured Literature Review

The SLR was approached as described by Webster and Watson (2002). Based on the research question about how to design a configurable-MSPE framework, we looked for publications covering platform- as well as mobility-service characteristics. We queried the Scopus and EBSCOhost databases using the search string "Platform" AND "Service" OR "Mobility" AND "Service." As the unfiltered combination of both search terms would yield an unmanageable number of research papers, we limited the results to top journals included in the IS Senior Scholars' Basket of the Association for Information Systems and ranked conferences: ICIS, ECIS, HICSS, PACIS, and WI. By imposing this restriction, we ensured that only peer-reviewed articles served as the basis for the artifact to be developed. Further, we balanced out high-quality journals' long review cycles of with the immediacy of conferences. The focus on IS literature is deemed appropriate because MSPEs are a common socio-technical phenomenon. Within the platform and mobility categories, we used the theory of Lusch and Nambisan (2015) to decide whether the publications cover the dimensions service ecosystem, platform/mobility services, and value co-creation. If we were able to associate a particular publication with one or more of those dimensions, then we included it in the resulting set of articles. We obtained 363 publications in an initial set of articles. During the first iteration, we scanned the titles and abstracts for the dimensions of Lusch and Nambisan (2015) and identified them as being either platform or mobility specific. During a second iteration, we searched forward and backward (Webster and Watson, 2002). During the last step, we allocated each paper to one of the two categories and the relevant dimensions. The result was 24 articles covering platform services and eight publications for mobility services.

3.2 Design Science Approach

For the design science approach, we adopted the methodology proposed by Hevner et al. (2004b) and Gregor and Hevner (2013). The resulting artifact aims to address the issue on how scholars and practitioners should design digital platforms in the context of mobility services. As guidance for scientific rigor, we followed the seven guidelines of Hevner et al. (2004a) for effective DSR in the field of information systems.

(1) *Design as an Artifact:* The artifact is going to be designed as a morphological box, allowing platform owners to individually configure different platform ecosystems in the context of mobility services (Zwicky, 1967). A morphological analysis captures the multidimensional, non-quantifiable character (Ritchey, 2006) of the MSPE design.

(2) *Problem Relevance:* Digital platforms are going to penetrate more and more aspects of our daily life (Evans and Gawer, 2016, Parker et al., 2016). Examples such as the mobility-service-platform Uber show that the disruptive potential also penetrates into how we use mobility as a service. Thus, reconstructing a blueprint on MSPEs provides valuable information about how platform ecosystems utilize mobility services.

(3) *Design Evaluation:* To show the artifact's usefulness, we draw on an observational evaluation method in the form of two case studies (Hevner et al., 2004a, Yin, 2014). The first case study involves a major carsharing-platform company. We complement the observations with the second case study based on a public-transportation platform in Germany.

(4) *Research Contributions:* We contribute with the DSR artifact in two ways. First, we build on the S-D logic of service innovation (Lusch and Nambisan, 2015) to develop a tangible artifact that helps to model different MSPE configurations. The model, represented by three morphological boxes, matches the key dimensions of Lusch and Nambisan (2015) and provides additional information in the context of mobility services. Second, the configurable MSPE offers practical contributions by allowing platform owners to model aspects of their platform to create transparency and to show potential for improvements.

(5) *Research Rigor:* The main theory for this research is grounded on the S-D logic of Lusch and Nambisan (2015). From there, we build on a structured literature review (Webster and Watson, 2002) combining aspects of platform-ecosystem research with mobility-service research to ensure scientific rigor.

(6) *Design as a Search Process:* We designed the DSR process in iterative steps to alternate between a theoretical and a practical lens (Gregor and Hevner, 2013). Starting with the initial framework as the result of the literature review, we cycle between interviews and theory within each case to create new artifact knowledge. If one case reaches theoretical saturation (no additional knowledge gain), the second case, with another context, is used the same way.

(7) *Communication of Research:* Like the contributions, communication of the research is also two fold. On the one hand, we express the findings for S-D logic, mobility service, and platform researchers. On the other, we provide a design framework for configurable MSPEs to practitioners (i.e., platform owners).

3.3 Case Study Research and Evaluation

For artifact creation, we follow a case-study research strategy. The method is particularly suitable as it captures and describes the complexity of environments and real challenges (Yin, 2014, Stake, 1995). The cases put the development process into the context of the qualitative interviews, their respective environment, and firms to provide relevance, boundaries, features, and limitations (Stake, 1995, Merriam, 1988). We use the theories represented in the theoretical background combined with the results of the SLR as prescriptive knowledge and a starting point for the DSR process. The case studies describe the application environment, where we derive descriptive knowledge in the form of an artifact (Gregor and Hevner, 2013). To ensure relevance and rigor, we execute three design cycles proposed by (Hevner, 2007, Sein et al., 2011). In the first iteration, we conduct a relevance cycle with the prescriptive knowledge by putting it into the context of mobility platforms through semi-structured interviews on the platform-owner side. Semi-structured interviews provide room for improvisation and exploration on the underlying phenomenon. The interviews adapted the dramaturgical model of Myers and Newman (2007). Regarding the sampling, we analyzed cases featuring mobility-platform ecosystems from the S-D logic perspective of service platforms, ecosystems, and value co-creation, as well as MaaS. Both case companies offer their mobility service in a variety of large cities in Germany with the target group of commuters, tourists, and local residents. For the interviewees, we were looking for technical and strategic employees representing the platform-owner perspective. We used MAXQDA software to code each transcript according to the grounded-theory coding process of open, axial, and selective coding (Strauss and Corbin, 1994) from the S-D-logic perspectives (Lusch and Nambisan, 2015). After that, we continued with a rigor cycle by grounding the new insights into our underlying theory in comparison with the current state of the artifact. Lastly, we updated the artifact within the design cycle (Hevner, 2007). We reran those cycles for every new interview partner, thereby iterating the building, intervention, and evaluation phase several times (Sein et al., 2011). The evaluation according to industry experts also satisfies the need for a cross-consistency assessment of the morphological boxes (Ritchey, 2006). Lastly, we described the final artifact that we grounded in the application environment, ensuring relevance and a continuous evaluation, as well as in the literature, increasing the scientific rigor.

Table 2 provides an overview of the two mobility-platform cases that we used to develop and evaluate the configurable-MSPE framework. In each case, we conducted six face-to-face interviews, transcribed, anonymized, and returned the results to obtain additional comments and to correct misunderstandings.

Case	Description	#	Role	Duration
Alpha	The private transportation operator is a market leader in providing mobility services as free-floating carsharing and value-added services for its customers in cities worldwide. The private transportation operator's main role is integrating parts of its existing mobility services and offering them to customers on the mobility-service platform. Customers use an application to allocate, reserve, book, and pay the free-floating car service.	1	Autonomous carsharing	00:52 h
		2	Mobility services, market development and rollout	00:59 h
		3	Mobile technologies in carsharing platforms	01:03 h
		4	CEO	01:09 h
		5	Project lead: embedded software platform carsharing	00:57 h
		6	Project lead: backend system carsharing	00:58 h
Beta	The public transportation operator runs the public transportation system in the city. It offers different mobility services and a wide range of transportation modes such as subway, bus, or bicycle to its customers. Moreover, in the specific case of the mobility-service platform, the public transportation operator's main role is platform provider. The public transportation operator offers access to the mobility-service platform for its end-customers via mobile applications and integrates private transportation operators.	7	Project lead: platform conception	00:38 h
		8	Project lead: transport and mobility management	00:53 h
		9	Manager urban planning and traffic management	00:38 h
		10	Manager in traffic economics	00:48 h
		11	Manager business development and strategy	00:30 h
		12	Project lead: mobility platforms	00:18 h

Table 2. List of interviewees for the design science research approach

4 Results

This section summarizes our final artifact: a configurable-MSPE design framework. The artifact is represented by three morphological boxes. The boxes (see Table 3, Table 4, and Table 5) correspond to the three main dimensions of Lusch and Nambisan (2015). Further, the boxes divide the dimensions into factors that summarize MSPE categories for the respective dimension. Each category consists of several concrete attributes covering several entities. The source in the last row indicates where each of the attributes originates. All attributes originate either from the literature or from the interviews. We marked new attributes and entities originating from the interviews with an asterisk (*). We also highlighted attributes that allow multiple selection with a superscript "x" (^{x}).

4.1 The Service Ecosystem

The service-ecosystems dimension includes different sets of actors participating in an MSPE. The actor category helps to determine the attributes of one or many actors placed into the service ecosystem to be created. Each actor has several attributes. The interviews reveal that the actor belongs to a *segment* represented by the entities *business*, *government*, and *consumer*. Furthermore, each actor plays a *role*. An actor can be a *platform sponsor*, a *platform provider*, a *complementor* (complementing products and services in the ecosystem), a *customer*, or a combination of roles. The attribute *motive* elaborates the actor's reason for joining the service ecosystem. Key *motives* are *access driven*, *ethical*, or *financial motives*. Finally, each actor plays a *MaaS role* that is specific to the context of MSPEs. According to the interviews, actors play mobility-specific roles such as *passenger*, *driver*, *owner*, *provider*, or *authority*.

Characteristics	Attributes	Entities							Source
Actor	Segment*	Business*	Government*	Consumer*					Interviews: 11
	Role^{x}	Platform Sponsor	Platform provider (Intermediary)	Complementor (Designer)	Customer (Ideator)				(Kuebel and Zarnekow, 2014, Levina and Kranich, 2017, Jittrapirom et al., 2017) Interviews: 8
	Motive^{x}	Access to customers	Access to resources	Financial benefits	Product/service based benefits*	Platform based benefits	Ethical benefits	Other*	(Frow et al., 2015, Pagani, 2013, Giessmann et al., 2014, Barrett et al., 2016) Interviews: 12
	MaaS Role*^{x}	Passenger*	Driver*	Owner*	Provider*	Authority*			Interviews: 7

Table 3. *Morphological box for the service-ecosystems dimension within MSPEs*

4.2 Value Co-Creation

The next dimension is value co-creation. It covers the categories of mobility services, value creation, and value capture. The mobility-service category provides the mobility context and connects two or more actors in an *MSPE*. Within the morphological box, the first attribute defines the service's *geographical scope*. The different forms describe whether the service applies to a *neighborhood-wide, citywide, region-wide, countrywide, company-wide* or *global* scope. Next, the service conforms to a *service pattern* indicating the timeframe *deferred*, *immediate*, *recurrent*, or *ongoing*. The *nature* attribute adds the context of mobility. Forms of this attribute are *navigation* or *location-based information services*. Lastly, the service exhibits a certain degree of *openness* ranging from *public*, available for everyone within the service ecosystem, to a *private*, not publicly available service. The value creation category covers resource integration. It includes attributes such as the *form* of value co-creation. Entities range from *co-design* (collaborative design of intermodal transport modes) or *co-production* of transportation services (collaborative production of autonomous cars with partners) through *co-consumption* (shared transportation modes) and *co-promotion* of services to *co-pricing* (e.g., pay-what-you-want) and *co-integration* (including own resources such as cars) describing the value-co-creation outcome. The *cooperation channel* and *intensity* describe whether the partnership features *physical* or *digital* interaction in a tightly coupled *strategic alliance* or a *loose cooperation* fostered through boundary resources. Subsequently, the *business field* describes whether the service is vertical to the value chain or *complementary*, horizontal in the case of *substitutive* or a mix of both with the attribute *substitutive*. The *activity type* attribute defines how the actors integrate the resources into the value-creation process. Lastly, the *duration* indicates whether a *one-off* to a *continuous* service is involved. The value-capture category connects the mobility service to the platform by showing how the platform captures value. The *value source* indicates the actor from which the platform captures value. Subsequently, the attributes follow the same pattern as that of the *actor roles* on the platform. The *value stream* clarifies whether it is either *indirect* or *transaction*/*subscription-based*.

Characteristics	Attributes	Entities								Source
Mobility Service	Geographical Scope	Neighborhood-wide	Citywide	Region-wide	Countrywide*	Company-wide	Global			(Plenter et al., 2017, Täuscher and Laudien, 2017) Interviews: 12
	Service Pattern	Deferred	Immediate	Recurrent	Ongoing*					(Andersson et al., 2013, Plenter et al., 2017) Interviews: 7
	Nature[x]	Trip planning	Navigation	Smart logistic	Parking	Sharing*	Location-based	Transportation*	Other*	(Schreieck et al., 2016c) Interviews: 8
	Openness	Public	Private							(Schreieck et al., 2016b, Leimeister et al., 2010, Benlian et al., 2015) Interviews: 8
Value Creation	Form	Co-Design	Co-Production	Co-Consumption	Co-Promotion	Co-Pricing	Co-Integration*	Other*		(Frow et al., 2015, Karpen et al., 2012, Jittrapirom et al., 2017) Interviews: 4
	Cooperation Channel*[x]	Physical*	Digital*							Interviews: 7
	Cooperation Intensity	Ecosystem	Strategic alliance	Loose cooperation	Purchase					(Labes et al., 2013) Interviews: 6
	Business Fields	Complementary	Similar	Substitutive						(Labes et al., 2013) Interviews: 7
	Activity Type[x]	Production	Aggregation	Comparison & Categorization	Integration	Consulting	Other*			(Leimeister et al., 2010) Interviews: 5
	Duration	One-off	Recurring	Continuous						(Frow et al., 2015) Interviews: 6
Value Capture	Value Source*	Platform Sponsor*	Platform provider*	Complementor*	Customer*					Interviews: 5
	Value Stream	Transaction-based	Subscription-based	Indirect*						(Täuscher and Laudien, 2017, Jittrapirom et al., 2017) Interviews: 5

Table 4. Morphological box for the value-co-creation dimension within MSPEs

4.3 Platform

Lastly, there is the platform, capturing value and connecting two or more actors within the service ecosystem through mobility services incorporating value-creation mechanisms. The categories *governance* and *architecture* describe different configurations within MSPEs. First, the governance *structure* shows whether the platform takes an *authority*-, *contract*-, or *trust-based* approach. The *control mechanisms* provide transparency about which forms of interaction are controlled. These are ranging from *input*, *output*, *behavior*, *social*, or *access* to some combination thereof. Under the *architecture* characteristic, *resource type* indicates the resources on which the platform is built. Entities are *hardware*, *software*, *data*, *know-how*, *human*, or *infrastructure* resources. *Focus* characterizes how the platform focuses on using those resources. The focus, for example, can be on building a *scalable infrastructure* or on providing an *extensible codebase* as a breeding ground for innovation. Lastly, the platform incorporates different *modules* to achieve the *focus*.

Charac-teristics	Attributes	Entities							Source
Governance	Structure[x]	Authority-based	Contract-based	Trust-based					(de Reuver and Bouwman, 2012) Interviews: 5
	Control Mech-anisms[x]	Input	Output	Behavior	Social	Access*			(Manner et al., 2013) Interviews: 12
Architecture	Resource Type[x]	Hardware resource	Software resource	Data resource	Know-How resource	Human resource	Infrastructure resource*		(Labes et al., 2013, Plenter et al., 2017) Interviews: 12
	Focus*[x]	Modularity	Flexibility*	Scalability*	Extensibility*	Availability*	Performance*		(Pagani, 2013) Interviews: 7
	Modules*[x]	Ticketing and billing	Analytics	Monitoring	Filtering*	Matchmaking	Fleet-manage-ment*	Complemen-tary Modules	(Schreieck et al., 2016c, Jittrapirom et al., 2017) Interviews: 12

Table 5. Morphological box for the platform dimension within MSPEs

5 Application and Discussion

The combination of all three dimensions provides a framework to design configurable MSPEs. Below, we discuss implications for theory and practice, limitations, and future research based on two concrete MSPEs resulting from the case studies: Alpha and Beta. Figure 1 and Figure 2 illustrate a simplification of the two MSPEs. They summarize the relationship between morphological boxes or dimensions. The most intuitive way to build an MSPE is to start with the actors from the platform owner's point of view. A service ecosystem is constrained to consist of at least two actors. The set of actors within a service ecosystem then relates to one or more value-co-creation services. Each value-co-creation service relates to one platform representing the center of an MSPE. Conversely, each platform can form the basis for several service ecosystems. All those instances combined result in an MSPE.

5.1 Case Alpha: Carsharing Ecosystem

Figure 1 illustrates a simplified MSPE for Alpha's carsharing platform. The carsharing ecosystem consists of the three actors: the carsharing-platform owner, the carsharing user, and an insurance company. Their motives are either to provide access to resources in the form of cars, to benefit from using the service via driving, or to insure drivers for monetary return. Two value-co-creation services connect the carsharing ecosystem. One of them incorporates the carsharing ride, which is immediately available globally and provides free-floating cars to offer private transportation from point A to point B. From the platform owner's perspective, the service co-integrates the ride data through a one-off loose cooperation (registration within the MSPE, but no further involvement) by data aggregation. In this value-co-creation service, the customer is the value source and is charged on a transactional basis. The platform facilitates interaction through a contract-based governance that controls access (who is allowed on the platform), output (where did the driver go and what does the car look like after the ride), and input (which resources in the form of cars does the platform accept). Regarding the infrastructure, the platform consists of hardware in the form of sharable cars, software, data, and know-how aimed at providing modularity (flexible on and off boarding of cars), availability, and performance through modules such as those for ticketing and billing, car filtering, analytics, and matching vehicles with drivers.

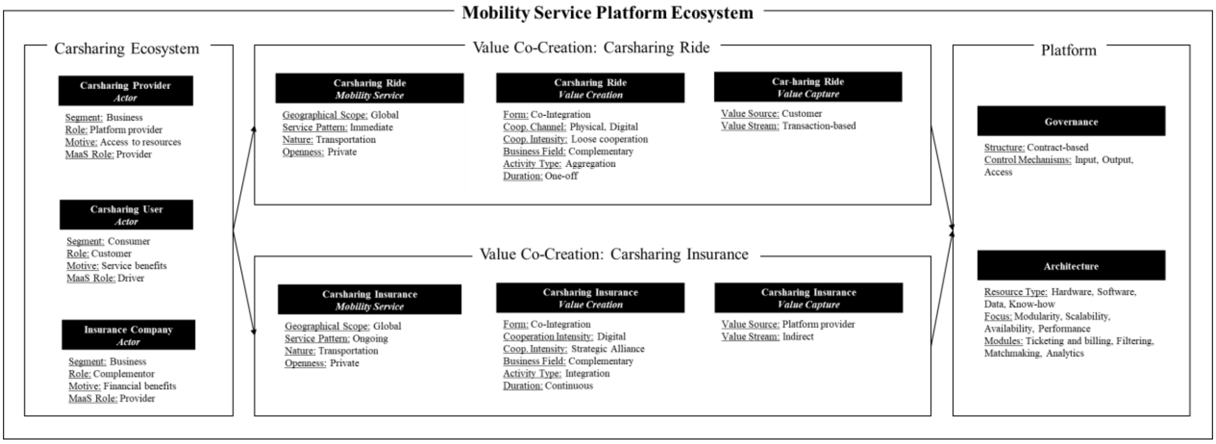

Figure 1. Application of the configurable mobility service platform ecosystem in the Alpha case study

5.2 Case Beta: Public Transportation Ecosystem

Figure 2 shows a similar MSPE for the public transport operator case, Beta. Within the service ecosystem, the platform owner operates a public transportation platform providing customers with access to its mobility infrastructure. A bike-sharing company incorporates its resources in the form of bikes to get access to the platform customers. One possible value-co-creation service is the integration of the bike-sharing company. The platform integrates the bike-sharing provider citywide, provides additional transportation services to customers, and parking possibilities for the bikes within the municipality. The platform owner co-integrates the bikes physically (ride) and digitally (booking) into their ecosystem, thus offering substitutive mobility services. The value source is the bike-sharing company, which is charged on a transaction basis. The platform's governmental character implies that authority-based governance mechanisms control the public-transportation infrastructure resources and that contractual mechanisms manage third parties on the platform. The platform furthermore controls input resources in the form of public-transportation infrastructure, third parties, and accessibility through a ticketing system. The platform's architecture consists of hardware (trains, buses), software, data, and transportation infrastructure (rails, roads) aimed at providing availability and performance. In the example illustrated, the platform uses the ticket and billing, monitoring, and filtering modules.

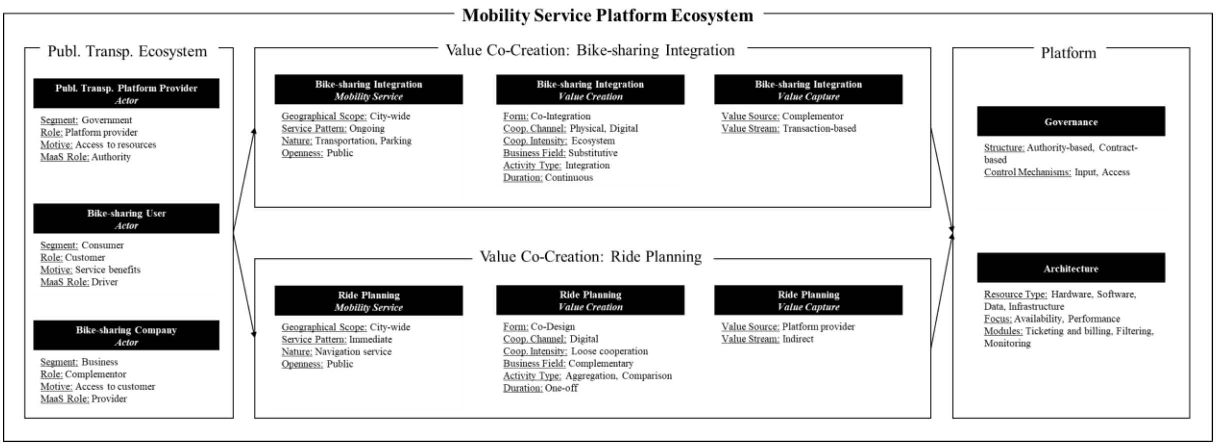

Figure 2. Application of the configurable mobility service platform ecosystem in the Beta case study

5.3 Implications, Limitations, and Future Research

During the continuous design and evaluation cycles between the interviews, we realized that the majority of interviewees still refer to producers and consumers from the G-D-logic perspective. Although Lusch and Nambisan (2015) provide a well-established theoretical framework from the S-D perspective, the approach is too theoretical, and thus too intangible, for building configurable MSPEs. We found that one way to shift the mind-set toward more S-D-logic-driven thinking was to provide a particular perspective (e.g., platform owner) and simplified MSPEs. With a concrete perspective, we wanted to solve the problem that actors within an ecosystem can be seen from various perspectives contributing all kind of resources. An actor other than a customer can be the value source in the example of carsharing rides in the Alpha case and the value-capture services. From the customer's perspective, the resource on the platform in the form of a car can also be a value source that offers a potential value, imparting mobility and flexibility by travelling from point A to point B. The same applies to value creation processes, where perspective influences the attributes within the service. One way to mitigate this situation is to purposely build the MSPE from a unique perspective. Accommodating all perspectives would increase the MSPE's complexity with each new actor in the ecosystem, leading to intransparency. Thus, we designed the two sample MSPEs from the platform owner's perspective to build on the platform companies' expertise. Moreover, MSPE simplification helps to increase understanding of the interaction within a limited set of actors connected via mobility services on a platform. In summary, focusing on a unique perspective and starting with a simplification have proven valuable for tackling MSPEs' complexity. The artifact reveals relationships and the systemic character of MSPEs thereby increasing ecosystem transparency—including that of the actors, services, and underlying platform.

The artifact could help advance theoretical understanding of platform ecosystems on three different levels. First, de Reuver et al. (2016) point out that researchers need to shed light on the question of how digital platforms should be designed. By differentiating successful from unsuccessful platform-ecosystem designs, researchers can decompose the designs into necessary and nice-to-have features. In this case, the artifact provides a systematic approach to building a platform ecosystem in the context of mobility services. Researchers can thus compare the fit of different designs or configurations through deviation within a similar context to show why some platforms survive whereas others fail (Venkatraman, 1989). Our simplified examples show similarities according to the A2A network and differences in value-creation mechanisms. In the Alpha case, the insurance company and the platform co-integrate the complementary insurance service, whereas the public-transportation company integrates substitutive mobility services in the form of bike-sharing into its ecosystem or city. Researchers can also use the artifact to document deviations within a specific ecosystem from a temporal perspective to examine the evolution over time (Moore, 1997). Because it ensures comparability, the artifact is also a first step toward enabling the conscious design of MSPEs (de Reuver et al., 2016). A second limitation of existing research is that platform ecosystems consider the availability of complementary services or products as being an exogenously triggered fact rather than a construct that can be strategically manipulated (McIntyre and Srinivasan, 2017). Practitioners and scientists can use the artifact to design, analyse, and modify a platform ecosystem to foster the integration of complementary goods and services. Returning to our examples, output control might reveal that customers can destroy cars, demonstrating the need for an additional co-creation process with insurance companies as actors.

The article also highlights practical implications. The design framework allows platform owners to configure their individual MSPEs, creating transparency and disclosing relationships between actors, mobility and value creation/capture services, as well as the facilitating platform. Thus, they can implement new actors, services, and platform functionalities to discover new solution spaces. Furthermore, platform owners can adjust the created ecosystem in response to key issues in the service ecosystem, platform, and along value-co-creation dimension (Lusch and Nambisan, 2015). As an example, the platform provider might identify weak structural integrity between the public transportation platform provider and the public transportation user. Based on that finding, the platform owner could design new value-co-creation services fostering structural integrity. Despite the implications, we want to highlight the limitations facing the study. We developed the design framework in the very specific context of mobility services to ensure practical relevance. The downside of this approach is the artifact's lack of generalizability. Some categories, such as the mobility services, are too context specific for application to other fields. One way to sort out this problem for future research might be to apply our artifact in another platform context like IoT or healthcare, where researchers need to take a similar approach to identifying specific attributes for the morphological boxes. Those findings would enhance the artifact's robustness and could lead to a more generally applicable framework for platform ecosystems. Future research could also address the need of practitioners for a guided process that helps them to apply the framework. This could also include integrating the framework into a comprehensive toolset for platform business-model development using methods such as the business model canvas (Osterwalder and Pigneur, 2010) or e³-value ecosystem modelling (Gordijn, 2002). Interfaces to these tools would improve the practical value of the MSPE design framework.

6 Conclusion

The shift from producing companies' taking a G-D-logic perspective, to a more S-D approach is indisputable (Lusch and Nambisan, 2015, Harrington, 2002). The concept of service platform from this development brought together different actors within an ecosystem and gained importance as a disruptive phenomenon (McIntyre and Srinivasan, 2017, de Reuver et al., 2016, Hein et al., 2018). One example is the platform company Uber, which uses network effects within an ecosystem of drivers and passengers to create and capture value. This and other examples, such as car- and bike-sharing platforms, illustrate the shift from using cars as products to a world in which we can use mobility as a service. However, how to design such a service-platform ecosystem has been unclear until now (de Reuver et al., 2016). Building on a design science research approach (Gregor and Hevner, 2013, Hevner, 2007, Hevner et al., 2004a), we developed a design framework for mobility service platform ecosystems (MSPEs). We started with the S-D-logic perspective of Lusch and Nambisan (2015) and mobility as a service (MaaS) concepts (Jittrapirom et al., 2017, Hietanen, 2014) as a theoretical backbone in the form of prescriptive knowledge. We then conducted a systematic literature review (Webster and Watson, 2002) to uncover additional knowledge pertinent to building the MSPE design framework. We developed the artifact through three recurring relevance, rigor, and design cycles (Hevner, 2007) according to the two cases, Alpha (carsharing platform) and Beta (public-transportation platform), drawing upon twelve interviews. Through the approach of building, intervening, and evaluating (Sein et al., 2011), we increase the scientific rigor and practical relevance of the resulting artifact. The developed artifact constitutes of three morphological boxes conforming with S-D logic (Lusch and Nambisan, 2015)—first, the service ecosystem containing two or more actors. Each of the service ecosystems relates to one or more value-co-creation services, which include a mobility, value creation, and value-capture service. Lastly, the platform facilitates the interaction of one or more service ecosystems and their connected value-co-creation services. The resulting MSPE framework provides a structural and repeatable approach to comparing different service ecosystems according to success or failure patterns.

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