Transforming into a platform provider: strategic options for industrial smart service providers

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Received 3 March 2020
Revised 30 June 2020
Accepted 31 July 2020

Abstract

Purpose – The purpose of this paper is to identify strategic options and challenges that arise when an industrial firm moves from providing smart service toward providing a platform.

Design/methodology/approach – This conceptual study takes on a multidisciplinary research perspective that integrates concepts, theories and insights from service management and marketing, information systems and platform economics.

Findings – The paper outlines three platform types – smart data platform, smart product platform and matching platform – as strategic options for firms that wish to evolve from smart service providers to platform providers.

Research limitations/implications – Investigating smart service platforms calls for launching interdisciplinary research initiatives. Promising research avenues are outlined to span boundaries that separate different research disciplines today.

Practical implications – Managing a successful transition from providing smart service toward providing a platform requires making significant investments in IT, platform-related capabilities and skills, as well as implement new approaches toward relationship management and brand-building.

Originality/value – The findings described in this paper are valuable to researchers in multiple disciplines seeking to develop and to justify theory related to platforms in industrial scenarios.

Keywords Smart service, Platform, Interdisciplinary research, Manufacturing company, Smart service provider, Platform economics, Information systems, Multi-sided markets, Business-to-business (B2B) markets

Paper type Conceptual paper

Introduction

Many firms in industrial markets such as the capital goods industry are undergoing a fundamental transformation from sellers of machines to service providers, offering their customers integrated solutions that consist of goods and services as integrated value propositions (Tuli *et al.*, 2007). The ongoing trend for digitalization (Legner *et al.*, 2017) accelerates the reach and pace of this development, profoundly transforming businesses and societies around the globe (Vendrell-Herrero *et al.*, 2017). Driven by synergies between technological advances and the widespread adoption of mobile devices, data science and the internet-of-things, the possibility to connect remotely to physical devices has enabled radically new service types (Wünderlich *et al.*, 2015). Smart products have become enablers for smart service provision. They can not only gather and analyze field data but also make

The research leading to these results received funding from the Ministry of Economics, Innovation, Digitalization and Energy, State of North Rhine-Westphalia, as part of the cluster of excellence it's OWL (project Digital Business, funding no. 005–1807-0106). This work was partially supported by the German Research Foundation (DFG) as part of the Collaborative Research Centre On-The-Fly Computing (GZ: SFB 901/3), project number 160364472.

1757-5818
DOI 10.1108/JOSM-03-2020-0066

decisions and act autonomously, considerably altering the design of services and business models (Wünderlich *et al.*, 2013; Allmendinger and Lombreglia, 2005). As this "industry 4.0 is the new source of sensational productivity gains" (McKinsey, 2017, p. 2), some leading-edge manufacturers – including the aircraft engine company Rolls-Royce (Smith, 2013) and the IT solution provider IBM (IBM, 2009) – have been reported to have successfully mastered the transition from producers to smart service providers (Porter and Heppelmann, 2015). While especially small- and medium-sized companies are still struggling to take advantage of the digital transformation (Schröder, 2016), more elaborate business models, such as smart service platforms, have now emerged, offering companies even more excellent opportunities to transform and grow their business models.

Establishing a platform business model presents itself as a particularly promising strategy for reaching market leadership. Platforms fundamentally challenge the pipeline business model – creating "value by controlling a linear series of activities" (van Alstyne *et al.*, 2016, p. 4) – traditionally implemented by many producers. At the same time, platforms go further than establishing value co-creation with customers, as advocated in service science. Beyond co-creating value-in-use with clients or groups of clients, platforms leverage (digital) two- or multi-sided marketplaces that allow different types of users to interact and transact with each other. In 2019, seven of the ten most valuable companies globally had implemented a platform business model; with this model, global leaders such as Alibaba, Alphabet, Amazon and Apple have grown exponentially and grabbed significant market shares from established firms (Schenker, 2019). Given the success of platform business models, it is not surprising that manufacturing companies with product-focused business models as well as manufacturers that have evolved into smart service providers, consider establishing platform business models. They wonder whether it will pay off to be at the forefront of the platform economy – a trend that is evidenced by many discussions and workshops we performed with manufacturing companies that operate in B2B markets. The interest in this topic by manufacturing companies also stems from the observation in some well-documented B2C settings that competition between platforms in the same market can lead – under certain conditions – to a "winner-takes-all" outcome (Eisenmann *et al.*, 2006) and that early movers may have a considerable advantage (Park, 2004).

Our paper starts by identifying three generic options that manufacturing companies can seize in response to the platform trend. The first would be choosing not to engage in platform business models at all and continuing to address a single-sided B2B market. This strategy might be appropriate for specific industries/market constellations, for instance, if there is only a limited number of high-volume customers. Second, if a manufacturing company has developed capabilities in smart service provision that might apply to other producers' smart products, the firm could opt to offer services on another platform provider's smart service platform (even while maintaining its smart service system approach). This approach might be an excellent strategy to become acquainted with platform business models. This strategy might be tied to fewer investments and risks than transforming into a platform provider itself, which is the third strategic option, and the one on which this paper focuses. Platform providers establish a digital multi-sided marketplace that enables service providers and their customers to directly interact and co-create service, fueled by data/information stemming from smart products. As establishing an installed base of smart products is a prerequisite for offering smart service and a smart service platform, the third option might only be open to companies that have already mastered their transition towards becoming a smart service provider. Still, for them, it seems like an obvious step.

To date, only very few firms – most of them operating in B2C markets – have established platforms on top of their smart products and services. For instance, Nike has launched its Nike+ platform, connecting 18 million athletes around the world with mobile application providers. They offer services based on activity tracking data and vital parameter data from

Nike's digital sport products or third-party devices such as wearable fitness trackers (Nike, 2013). However, in B2B markets, the *successful* implementation of smart service platforms has not yet been documented. Some firms even had mixed experiences with establishing smart services (Yu *et al.*, 2016), shedding doubts on their successful implementation (Paluch and Wünderlich, 2016; Ehret and Wirtz, 2017) that might also impede their willingness or ability to establish platforms.

One reason for the reluctance of smart service providers to establish platforms is the lack of research and case studies that illustrate or quantify benefits and pitfalls. To date, research on platforms has explored economic principles and strategies (e.g., van Alstyne *et al.*, 2016), but not platform business models in B2B markets that augment smart service systems. However, we argue that the emergence of *smart service platforms* may challenge and disrupt theories and artifacts in the service discipline, requiring us to understand and integrate theories that originate from platform economics.

This paper is the first to address the phenomenon of establishing smart service platforms in B2B markets, taking a multidisciplinary research perspective that integrates concepts, theories and insights from service science and platform economics, to delineate the need for developing new theory and IT artifacts in an integrated service discipline. In particular, we conceptualize three different types of platforms as strategic options for companies that wish to evolve from smart service providers to platform providers – *smart data platform*, *smart product platform* and *matching platform*. Based on revisiting literature on platform economics, we conceptualize and discuss challenges that smart service providers must overcome when venturing into the platform economy. We illustrate that a successful transition requires significant investment in IT, platform-related capabilities, and skills, as well as new approaches toward relationship management and brand building. The paper concludes by calling for interdisciplinary research on the emerging phenomenon of smart service platforms.

Related research

To fully understand the phenomenon of smart service platforms and the challenges emerging for manufacturers and smart service providers that aim to become a platform provider, one must combine knowledge from different research areas such as service marketing and management, information systems and (platform) economics. A brief review, summarized in Table 1, highlights these research fields' perspectives on smart service platforms and enumerates selected core concepts applied in each research stream. Research in *service marketing and management* has explored industrial customer–firm relationships that center

Research fields	Perspectives on smart service platforms	Selected concepts and key references
Service marketing and management	Value co-creation and service offerings; customer-firm relationships in industrial smart service contexts	Service ecosystems (Edvardsson *et al.*, 2011); solution selling (Tuli *et al.*, 2007); B2B relationships (Doney and Cannon, 1997); firm's smart service acceptance (Paluch and Wünderlich, 2016)
Information systems	Design, adoption and utilization of platforms as IT artifacts that foster co-creation of value in smart service (eco) systems	IT artifact (March and Smith, 1995); service system (Maglio *et al.*, 2009); smart service system (Beverungen *et al.*, 2019b); service systems engineering (Beverungen *et al.*, 2018), system design (Viana and Patricio, 2012)
Platform economics	Economic principles of exchange on digital multi-sided markets	Direct interaction, affiliation (Hagiu and Wright, 2015); network effects (Gawer, 2014); openness (Ondrus *et al.*, 2015)

Table 1. Different research fields' perspectives on smart service platforms

around the provision and co-creation of product/service bundles, solutions and smart service. Insights from this literature stream offer an assessment of the radical changes in relationship management that smart service providers have to undergo when transforming into platform providers. *Service marketing* and *information systems* research both focus on understanding service in the context of service (eco)systems, including people, technologies and other resources. In particular, service research in the *information systems* field focuses on the design, adoption and utilization of IT artifacts to co-create service in service systems (Beverungen *et al.*, 2019a). Platforms are viewed as a means to foster actor engagement, combining dispersed resources for value co-creation. The research field of *platform economics* identifies economic principles that apply to firm and consumer behavior on multi-sided markets, such as smart service platforms. In particular, this literature stream provides concepts such as direct interaction, affiliation, network effects and openness that build the foundation of smart service platform economics, but also illustrate the attractiveness of the respective business models.

We draw from the three different research areas to provide the theoretical background on smart service platforms in the following chapters and focus on smart service systems, smart service business models and customer relationships as well as on the economic properties of digital platforms.

Smart service systems as a framework for value co-creation

A service system is "a configuration of people, technologies, and other resources that interact with other service systems to create mutual value" (Maglio *et al.*, 2009, p. 395). As a "basic unit of analysis" in service science, service systems denote the socio-technical setting in which service customers and service providers co-create value for mutual benefit based on accessing each other's knowledge and skills. Service systems are nested structures, such that each actor participating in value co-creation is a service system of its own, while the actors constitute higher-order service systems to co-create value-in-use. Importantly, service systems can neither be traded nor bought, in contrast with earlier definitions that conceptualize product-service systems as sales objects that provide value-in-exchange (see Becker *et al.*, 2010 for a discussion). Instead, service systems are socio-technical systems that can be developed in purposeful acts of service engineering to network and reconfigure resources contributed by the actors involved in value co-creation (Beverungen *et al.*, 2018).

A smart service system is a service system in which a digitally networked device – a smart product – takes the role of a boundary object (Star, 2010; Star and Griesemer, 1989), which networks service provider(s) and service customer(s) (Beverungen *et al.*, 2019b). Smart products feature a set of properties (Figure 1), including a unique identity, location, connectivity, sensors and actuators, data storage and data processing capabilities, and interfaces that enable them to interact with other actors, including humans, other smart products or information systems (Beverungen *et al.*, 2019b). For instance, a washing machine might be a smart product, if it satisfies all (or at least, most, depending on how rigidly or inclusively one defines a smart product) of these technical features. It might have microprocessors and data storage, be able to store its unique identity and location, be connected to the vendor's information systems allowing it to order new washing detergent on demand, it might feature sensors to identify the weight of its payload, actuators to heat and turn, and provide user interfaces for washing laundry. As boundary objects, smart products implement a shared identity among service providers and customers, as well as local usefulness for each of the actors involved in value co-creation (Beverungen *et al.*, 2019b). Thus, while we can assume that customers use their smart washing machine for cleaning their laundry, its local usefulness from a provider's perspective is to document and analyze data retrieved from customers, which can be analyzed, for instance, to improve the technical

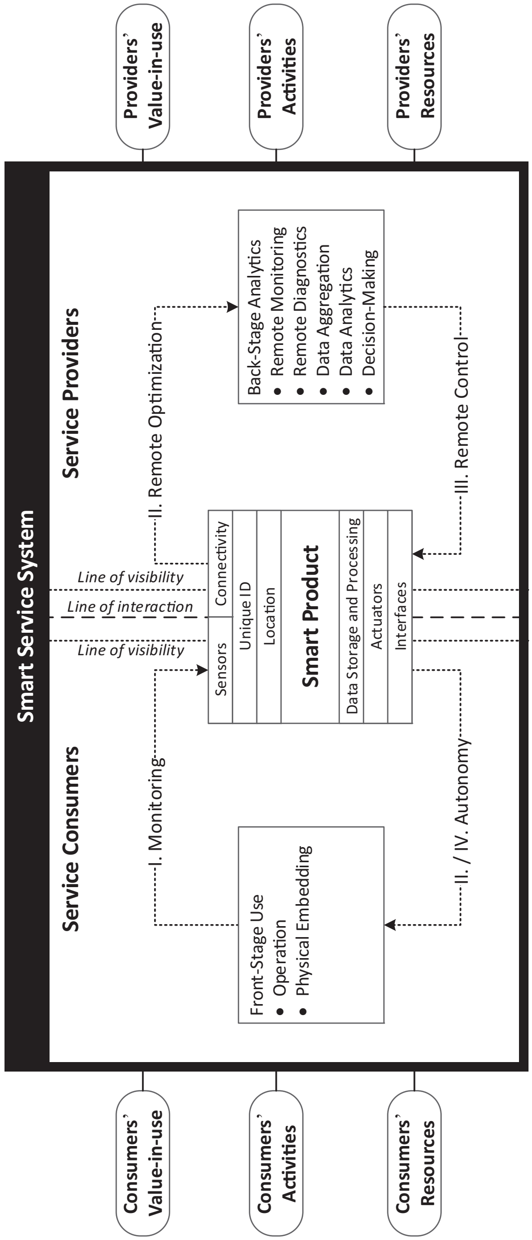

Figure 1.
Concept of a smart service system (Beverungen *et al.*, 2019b)

specifications of washing machines or to cluster customers based on their washing habits. In terms of a shared identity, a smart washing machine enables customers and providers to network their resources and capabilities to co-create value-in-use.

A *smart service system* explicitly includes a smart product – a physical object that is networked digitally – that is applied by a beneficiary to create value-in-use, based on connecting the smart product with his/her resources. In contrast, a *digital service system* can be established with an information system, such as a database, without any smart products present; for instance, parcel location services (e.g., offered by DHL or UPS) are enabled by querying a database with a parcel's ID code, even if the parcel itself has no sensors, data processing capabilities, or connectivity. The distinction between smart service and digital service is far from trivial. The point is that in smart service systems, a service customer might use a smart product only for its physical affordances, without being aware of the data collection, analysis, connectivity and optimization capabilities that reside in the product or the smart service system's backstage. For instance, few owners of a smart washing machine know (or care about) what data are stored, analyzed, transmitted and acted upon by their washing machine and to what extent these data are valuable to machine vendors. This lack of awareness about a smart product's form and function for constituting a smart service system is one reason why smart service systems and smart service platforms challenge current theory on smart service system design (e.g., Viana and Patricio, 2012).

Smart service business models and customer relationships

Firms, mainly in B2B markets, such as energy, health care, transportation, information technology and manufacturing, have started offering services to leverage their revenues, to fulfill customer expectations better, and to build competitive advantage with services that their competitors cannot imitate (Oliva and Kallenberg, 2003). However, most smart service providers in manufacturing still pursue a "pipeline" business model: they sell their products to business customers and offer them complementing value-added services. Products and services might also form integrated value propositions – sometimes called "integrated product-service offering" (Baines *et al.*, 2009) or "solution" (Tuli *et al.*, 2007). Value-added services often relate closely to physical value propositions, to augment or complement product features such as monitoring and maintenance services. Customers often view value-added services offered by manufacturing companies as free add-ons, which limits the services' value propositions and profitability (Backhaus *et al.*, 2010).

Other manufacturing companies have already established smart service systems based on networking their products digitally and utilizing them as boundary objects that augment their interfaces with service customers. In this way, they can capitalize on the data they retrieve from their machines, enabling them to offer entirely new services to their customers. A case in point for technology-driven servitization is the renowned case of Rolls-Royce's TotalCare® value proposition, which provides airlines and the military a power-by-the-hour (or pay-per-use) access to aircraft engines, based on retrieving massive data from the engines directly (Smith, 2013).

While pay-per-use business models are still the exception in manufacturing industries, the relationship between service customers and providers in smart service systems has only been explored to a limited amount. Smart service providers' relationships with their customers typically follow the characteristics of buyer–seller relationships in industrial markets. They are subject to long-term orientation, high investments, a high level of commitment and trust (Friman *et al.*, 2002). While these factors are essential in most professional relationships, they take on particular importance in industrial settings, in which firms must deal with a smaller customer base and in which each customer represents a relatively high proportion of the total revenue and customer base (Anderson and Narus, 1990; Tsiros *et al.*, 2009). Also, customer relationships are often based on personal relationships with key account managers caring for their customers during extensive pre- and post-purchase phases (Salojärvi *et al.*, 2010). The value of a smart service is typically difficult or impossible for the customer to ascertain before consumption. While a smart product itself might be observable to customers, a smart service usually is unobservable, and customers are often unaware that they are consuming a service at all. One example are predictive maintenance services, which – in the best of cases – are intended to go unnoticed by customers. Yet, a smart service profoundly challenges the relationship building between smart service customers and providers in two ways. First, the service's invisibility hampers customers' recognition of the value provided by the service. Second, customers might perceive smart services as risky and tend to reject them mainly driven by their fear of privacy violations and concerns about data security (Keh and Pang, 2010; Paluch and Wünderlich, 2016). This skepticism holds especially true for smart services that feature a high level of automated decision-making and enable service providers to access sensitive customer data (Wünderlich *et al.*, 2015). In traditional dyadic settings, smart service providers can counteract customers' elevated risk perceptions based on the trust they developed during the long-term relationships with their customers (Doney and Cannon, 1997; Pavlou, 2002). Smart service platforms may challenge this pillar of relationship building as the development of trust might be hampered due to changing interaction partners on digital platforms.

Economic properties of digital platforms

The development of the internet has contributed significantly to the study of platforms and enhanced the economic analysis of markets generally (Spulber, 2019). Since the early 2000s, scholars from different disciplines, including economics, strategy, information systems and marketing have begun to develop theory on platforms, which have also been referred to as "two-sided markets," "multi-sided markets" or "multi-sided platforms" (Rochet and Tirole, 2003, 2006; Evans, 2003; Eisenmann *et al.*, 2006; Rysman, 2009). Platforms can be viewed as particular kinds of markets that play the role of facilitators for an exchange or a transaction between different types of stakeholders that could not otherwise, or only with great difficulty, transact with each other.

A market may be an online (digital) or an offline (physical) market. Offline markets have existed for millennia as ordinary village markets, on which sellers and buyers exchange goods under the supervision of the village chief who may levy a tax for the use of the physical space provided (Martens, 2016). The prime reason for establishing a village market is that it reduces transaction costs among user groups. The advent of the internet has enabled not only the tremendous amplification of the potential to reduce transaction costs in online markets (Strader and Shaw, 1997) but at the same time opened up opportunities for designing innovative business models (e.g., Timmers, 1998; Teece and Linden, 2017).

We define a digital platform as a mediating entity operating in two- or multi-sided markets, which uses the internet to enable direct interactions between two or more distinct but interdependent groups of users (e.g., in the case of a two-sided market: buyers and sellers) to generate value for at least one of the groups (Rochet and Tirole, 2004; Rysman, 2009; Hagiu and Wright, 2015; Weyl, 2010) (cf. Figure 2 for an illustration of a digital platform and core concepts for a two-sided market). Each group of users represents a side of the market and is affiliated with the platform. Network effects arise between at least two sides of the market. Two roles are directly associated with the digital platform, namely the "platform provider" (providing "interfaces for the platform") and the "platform owner" (controlling intellectual property of a platform and deciding "who may participate and in what ways") (van Alstyne *et al.*, 2016, p. 6). There are four concepts that are associated with this definition of a digital platform: direct interaction, affiliation, network effects and openness. We discuss these concepts in the following.

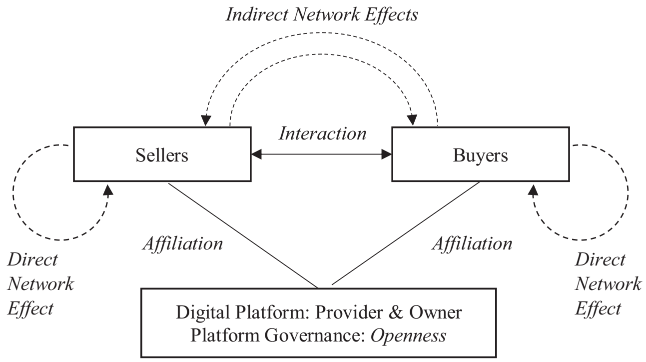

Figure 2.
Selected roles and core concepts of digital platforms

By *direct interaction* we mean that the distinct user groups "retain control over the key terms of the interaction, as opposed to the intermediary taking full control of those terms. Where the interaction involves trading, the key terms of the interaction could be the pricing, bundling, marketing, and delivery of the goods traded [. . .]" (Hagiu and Wright, 2015, p. 163). Marketplace sellers on the digital platform provided by Amazon.com are virtually free to set any price for their products and may choose to deliver these products from their warehouses, for instance.

By *affiliation* we mean that "users on each side consciously make platform-specific investments that are necessary in order for them to be able to interact with each other directly. The investment could be a fixed access fee (e.g., buying a videogame console), an expenditure of resources (e.g., spending time and money on learning how to develop applications using the iPhone's APIs), or an opportunity cost (e.g., driving to a shopping mall, joining a loyalty program)" (Hagiu and Wright, 2015, p. 163). These platform-specific investments bind the users to the platform and make leaving the platform costly (i.e., users have both nonzero entry and nonzero exit costs).

Network effects are the effects that additional users of a good or service have on the value of that good or service to others. If more buyers on a digital platform will attract more sellers, and vice versa, this is called an indirect network effect. More sellers on the Amazon Marketplace, for example, increase the breadth and depth of the assortment available on Amazon.com and also boost the competition among sellers. Both effects make it more attractive for buyers to register with Amazon.com instead of other online retailers. Vice versa, each additional buyer makes the platform more attractive for third-party sellers, leading them to choose Amazon.com instead of rival platforms. There may also be direct network effects within each group of users. In case of positive direct network effects, users feel attracted by the presence of other users on the same side of the market because it offers them opportunities for social interaction (e.g., on the online social network Facebook or the messenger service WhatsApp) and for drawing benefits from the transactions or experiences of others. For example, book buyers can benefit from recommendation lists on Amazon.com that have been compiled based on analyzing previous purchases made by similar customers.

Network effects may trigger a self-reinforcing feedback loop that magnifies early movers' advantages. Strong network effects can – under certain conditions – even drive competition between platforms to a "winner-takes-all" outcome (Eisenmann *et al.*, 2006). Platform competition in economic models is driven by the adoption of the platform by multiple groups of users, which is itself fueled by network effects (Gawer, 2014). As the value of a platform stems primarily from the access of one side to a different side of the platform, the crucial question of platform adoption is how to bring multiple sides on board (Evans, 2003;

Rochet and Tirole, 2006) while avoiding the chicken-and-egg problem (Caillaud and Jullien, 2003). In the straightforward two-sided case (see Figure 2), this problem describes the need for a critical number of sellers (or volume of supply) to attract buyers (or volume of demand); however, sellers will only adopt and affiliate with a platform if they expect a sufficient number of buyers on the other side to join (Armstrong, 2006; Caillaud and Jullien, 2003; Eisenmann *et al.*, 2006). Once a digital platform reaches a critical user mass on each side of the market, the effects of network externalities turn positive and stimulate platform growth (Hagiu and Rothman, 2016). In many instances, however, this critical mass cannot be reached, with the Dell Marketplace being one of many examples. Dell Marketplace was launched as a B2B exchange in late 2,000 to provide buyers access to items across multiple product segments from a variety of suppliers (Evans and Schmalensee, 2010). Only three suppliers had signed up until February 2001 to sell their products directly to customers in the four months Dell Marketplace had been open; likewise and self-reinforcingly, there was a lack of interest from potential buyers (Mahoney, 2001).

Besides designing a viable business model and appealing value propositions, a significant challenge for platform owners is to establish conditions in terms of platform governance that generate positive network effects, eventually leading to critical mass. If, by design, a platform permits only restrictive participation of small user groups (i.e., limited *openness* and a high degree of control), the platform's market potential is likely to be too small to generate sufficient network effects (Ondrus *et al.*, 2015). To achieve platform growth, therefore, requires it to have sufficient market potential as represented by the maximum number of users who can potentially join a platform on any side (Bass, 1969). Openness can be achieved at different levels of the platform (Ondrus *et al.*, 2015), such as on the level of demand-side users (i.e., buyers), on the level of supply-side users (i.e., sellers), on the technology level, or on the level of platform providers. At the user level, openness is concerned with making the platform accessible in indiscriminate ways to new buyers and sellers. Google Play Store, for instance, is easily accessible for all users of Android phones; the bar for developers striving to launch a new app to be presented in Google Play Store is low, too. At the technology level, openness hinges on how interoperable or incompatible the platform is with other (digital) platforms and related technologies (Ondrus *et al.*, 2015).

Three strategic options for smart service providers to establish a platform

We revisit and extend the smart service system concept to identify three strategic options for establishing a platform. We illustrate three different types of platforms that vary based on core concepts that originate from platform economic research – openness, affiliation, direct interactions and network effects – thereby extending existing knowledge on smart service systems with economic principles of digital multi-sided markets.

A key element of this re-conceptualization is introducing the "platform provider" as a new actor [1]. Unlike on platforms that form an "asset-light" two-sided market (e.g., Airbnb and UBER, who do not produce, sell, or maintain accommodations or cars, respectively (Evans and Gawer, 2016)), we stipulate that on platforms in a smart service setting, platform providers will still supply physical core products (i.e., a smart products). However, besides co-creating value with their customers – as in a smart service system without a platform – they invite other companies to offer their knowledge and skills, making complementary value propositions through the platform.

Extending the concepts of service systems and smart service systems, we view a smart service platform to enable service providers and service customers to co-create value for mutual benefit, while it is not intended to benefit one group of stakeholders alone. This conceptualization is more rigid than related views on digital platforms, allowing benefits to be generated for one group of stakeholders only. While a smart service system is a particular form of a service system that builds on using smart products as boundary objects, a smart service platform is a digital boundary object that builds on a smart product to augment a smart service system with platform properties. Table 2 summarizes the definitions of all three core concepts.

We argue that a smart service provider has three fundamental options to venture into the platform economy. Two of these options relate to different smart service platform types – *smart data platform* and *smart product platform* – and another option to a *matching platform*. While the smart data platform and the smart product platform types both rely on a smart product and/or its data, the matching platform has no immediate connection to smart products and the data they might supply. While all three options implement the economic features of platforms, they differ in terms of (1) the degree of openness of the platform and the platform providers' control of the customer interface, respectively, (2) the fees, expenditure of resources, and opportunity costs required for affiliation, (3) the vehicles for direct interactions, and (4) the resulting network effects [2].

Consider the example of the fictitious company *FutureIndustries*, a machine tool manufacturer that supplies sophisticated machinery (exhibiting properties of smart products) to its business clients, enabling them to manufacture their products. *FutureIndustries* has already established smart service systems with its industrial customers, based on utilizing their machines as boundary objects. They can now implement three types of platforms (Table 3) to stand beside or augment their smart products.

In the following, we summarize and contrast all three strategic options based on the assumption that the company has already constituted itself as a smart service provider, such that the smart service system can serve as a common point of reference for starting the transformation to become a platform provider.

Option 1: establish a smart data platform

Smart service providers might decide to provide a data platform, on which field data retrieved from their installed base of smart products – used by their customers – are stored and made accessible to external stakeholders (Figure 3). This "smart data platform" stores data sent by the machines, enabling the platform provider to access raw data on the level of individual devices, while data might be prepared (e.g., aggregated or anonymized) before being made available to outsiders. Third-party service providers can then *access* the smart data platform to retrieve cleansed and aggregated field data, on which they apply specialized data analytics methods to identify, amongst others, general usage patterns, error codes or preconditions of failure for components included in smart products. Both platform provider and customers can be beneficiaries of these services. However, we posit that third-party service providers cannot use the data to identify, trace, or analyze condition data on the level of individual machines.

Table 2.
Definitions of core concepts

Service system	Smart service system	Smart service platform
"A configuration of people, technologies, and other resources that interact with other service systems to create mutual value" (Maglio *et al.*, 2009, p. 395)	A service system in which a digitally networked device—a smart product—takes the role of a boundary object, networking service provider(s) and service customer(s) (Beverungen *et al.*, 2019b)	A digital boundary object that builds on a smart product to enable direct interactions between two or more distinct but interdependent groups of users to create mutual value

Property	Option 1: Establish a smart data platform	Option 2: Establish a smart product platform	Option 3: Establish a matching platform
Openness	As a platform provider, *FutureIndustries* has full control over field data retrieved from machines. They enable (third-party) service providers and customers to access and use aggregated data to co-create value, augmenting their value propositions	As a platform provider, *FutureIndustries* controls what data are streamed and made available by their machines; customers and (third-party) service providers access data on a machine level to co-create value, augmenting their smart product with platform functionality	Service providers access customers directly. As a platform provider, *FutureIndustries* controls the customer interface and facilitates these interactions; the platform is a digital boundary object that stands alone, not interfacing with smart products to retrieve, analyze or use field data
Affiliation	Customers need to buy or rent the machine and allow *FutureIndustries* to retrieve field data. Service providers need to establish information systems and interfaces to analyze data retrieved from the platform, which enables them to provide value propositions to service customers and/or to *FutureIndustries*	Customers need to buy or rent the machine and allow *FutureIndustries* to retrieve field data. Service providers need to establish information systems and interfaces to retrieve data from machines, analyze data, control machines and provide value propositions. They must signal *FutureIndustries* complying with the rules that govern access to the data	Interactions are market-based, with low investments in IT. Investments focus on relationship building, brand management, and on signaling the quality and complementarity of value propositions to all parties involved. Value is co-created besides strong relationships maintained between customers and *FutureIndustries*
Direct Interactions	Customers and service providers interact directly, co-creating value (e.g., data-driven production planning) based on utilizing aggregated data provided on the platform	Customers and service providers interact directly, to co-create value (e.g., predictive maintenance of individual machines). Service providers might reconfigure or update devices remotely if permitted by *FutureIndustries*	Service providers and customers interact directly without explicitly building on machine data (e.g., to certify processes for using a machine, or for training personnel), mediated by *FutureIndustries*
Network Effects	Direct and indirect network effects emerge from the amount of data provided on the platform, and from value propositions that service providers offer (both attracting additional sellers and buyers). Additional value propositions leverage the attractiveness of *FutureIndustries*' solutions and vice versa	Direct and indirect network effects emerge from the amount of field data provided on a machine level, and from specific value propositions that service providers offer (both attracting additional sellers and buyers). Additional value propositions leverage the attractiveness of *FutureIndustries*' solutions and vice versa	Direct and indirect network effects emerge with the number and diversity of customers and service providers that join the platform and actively engage in value co-creation. Additional value propositions leverage the attractiveness of *FutureIndustries*' solutions and vice versa

Table 3. Summary of strategic options, building on the economic properties of platforms

With this setup, a smart data platform can establish the right degree of *openness*, protecting data that are of strategic importance to platform providers, while also enabling third-party service providers to access, analyze, and capitalize on field data. Likewise, service customers might also be empowered to access their own data on the platform, e.g., as a self-service for condition monitoring. *Affiliating* with the platform would require third-party service

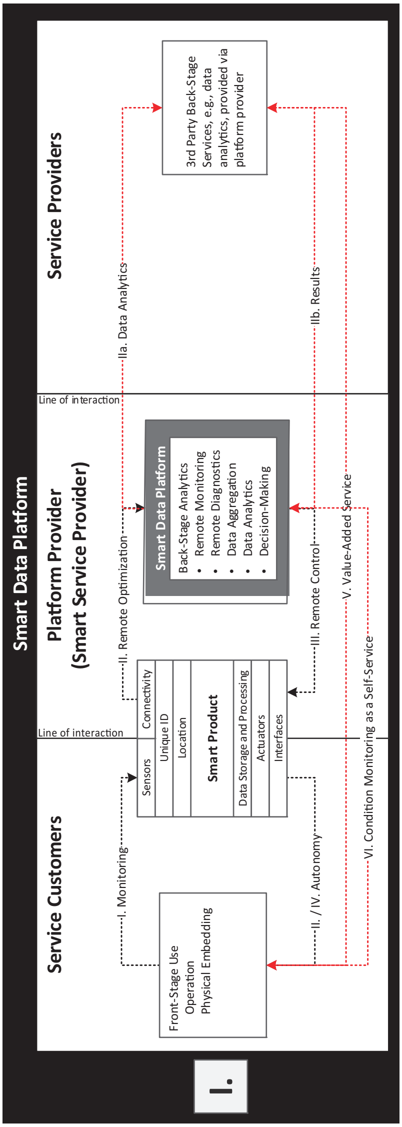

Figure 3.
Establishing a smart data platform

providers to establish information systems and interfaces to retrieve and analyze data and to provide value propositions. Based on data analytics, they might offer services that complement the core value propositions rendered by a platform provider. Service providers and customers could *interact directly* based on the aggregated data provided by the smart data platform. For instance, consultants might access a machine's smart data platform and apply sophisticated data analytics to identify general usage patterns of a machine or of components that cause downtimes across the customer base or to cluster customers. Direct and indirect *network effects* are subject to the amount and quality of field data provided on the platform and stem from the additional value propositions that service providers can offer based on analyzing these data. An illustrative case is the *teamplay digital health platform* that is provided by SIEMENS Healthineers (Siemens Healthcare GmbH, 2020). The platform enables service providers and clinics to access data and tools to advance their health services, while the company also supplies smart products for medical diagnostics (e.g., computer tomographs).

Option 2: establish a smart product platform

Beyond supplying aggregated field data, a platform provider might grant third-party service providers access to smart products directly. The platform provider might still collect, analyze and configure smart products based on the data retrieved (cf. Figure 4).

While providing field data on a machine level exhibits more *openness* as opposed to establishing a smart data platform, the platform provider needs to make smart choices on what data their smart products will transmit and how often they will transmit these data. These rules for data provision are inscribed into the hardware and/or software of their smart products, e.g., by collecting and pre-processing data inside the machines. Thus, while offering external stakeholders access to more specific and granular data, platform providers would still own the platform and determine what data are transmitted by their machines in the first place. If, however, service providers are not complying with the terms of using machine data, the platform provider might disconnect them from the stream of data that is issued by its machines. *Affiliating* with the platform would require third-party service providers to establish information systems and interfaces to retrieve data from machines, analyze data, control machines and provide value propositions. However, due to the more intimate relationship, they would also need to signal that their analysis and use of the data complies with the rules issued by the platform provider. In return, accessing data from individual machines will enable service providers to establish *direct interactions* with customers to offer much more sophisticated and specific value propositions (compared to Option 1) that are tailored to individual machines, customers' needs, or specific machine components. Direct and indirect *network effects* emerge from the amount of field data provided on a machine level, and from additional value propositions that service providers offer. Service providers might also control the machine's behavior remotely. The WAGO Cloud (WAGO Kontakttechnik GmbH, 2020) is a typical smart product platform that provides access to individual machines. Based on Microsoft Azure, this Internet-of-Things platform enables stakeholders in the machine tools industry to retrieve, analyze, and visualize data from individual machines, perform maintenance and provide updates remotely.

Option 3: establish a matching platform for value propositions that complement the core business

A third strategy is to implement a matching platform that has no immediate connection to smart products and the data they might supply (cf. Figure 5). Instead, such a platform matches requests issued by service customers with value propositions offered by third-party service providers. For instance, a service customer might request a financial service that the platform provider is unable to fulfill.

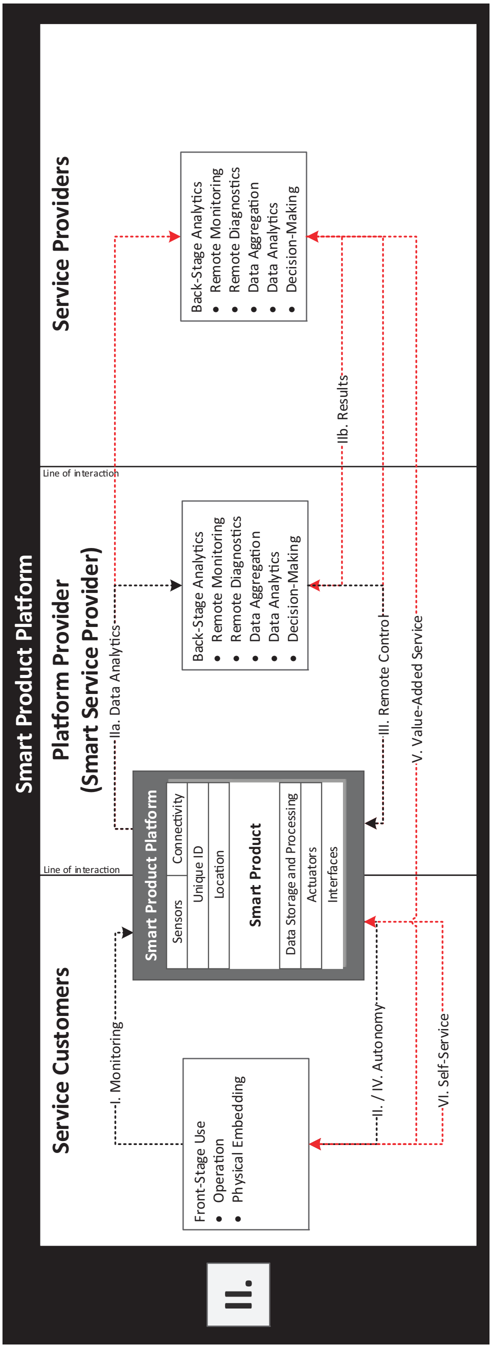

Figure 4.
Establishing a smart product platform

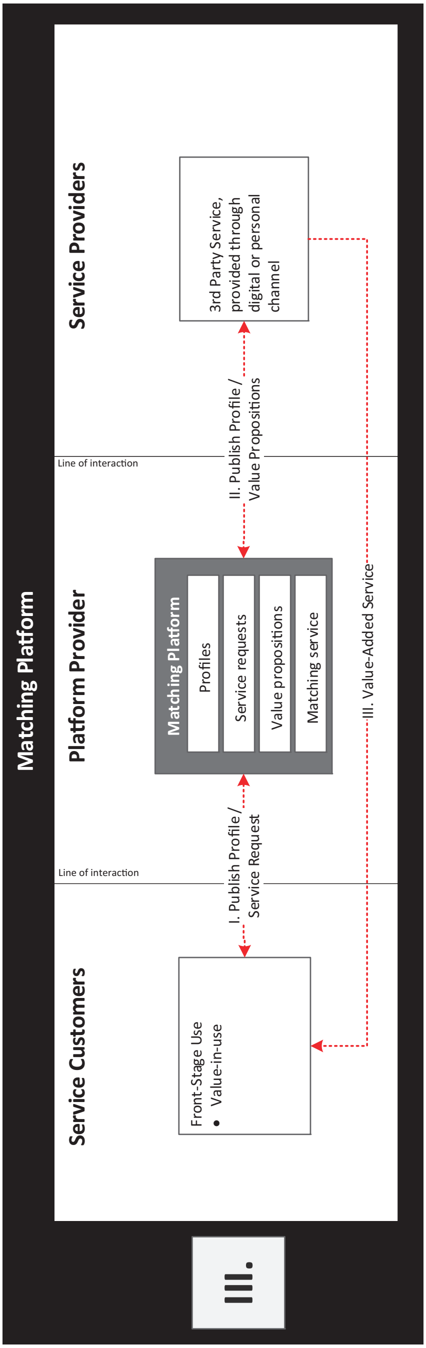

Figure 5.
Establishing a matching platform

On the platform, third-party service providers offer value propositions that are then matched with customers. Although the interactions are market-based and no machine data need to be accessed, *affiliating* with a matching platform requires specific investments from service providers, including relationship building, and signaling the quality and complementarity of their value propositions. After the matching is complete, service providers and customers will *interact directly*, while the platform provider might claim a matching fee. Direct and indirect *network effects* will then emerge with the number of customers and additional value propositions offered by service providers that join the platform.

Establishing a matching platform in the B2B sector might differ conceptually from their counterparts in the business-to-consumer (B2C) or consumer-to-consumer (C2C) sectors. Examples of the latter types include platforms for matching retailers with customers (e.g., matching so-called Marketplace Sellers with customers on Amazon.com), tourists with hotels (e.g., Booking.com) or private apartments (e.g., Airbnb), passengers with drivers (e.g., UBER), or consumers with consumers. Many B2C platform providers focus on matching stakeholders on either side of the market, while not making value propositions (e.g., hotel rooms or transportation) beyond the matching itself. In stark contrast, providers of a matching platform in B2B markets might still sell smart products to their customers, while using the platform to promote complementing value propositions from third-party service providers.

Platform providers implementing this configuration must either implement a degree of *openness* that enables them to offer smart service while also matching additional stakeholders, or they must give up selling products to evolve into a pure platform provider. Due to their radical differences compared with current business strategies implemented in many industries, both approaches seem rather hazardous to develop and run, even if they might generate superior returns.

An example of a matching platform is StaffNow (Lufthansa Technik AG, 2020a) – a platform that matches aircraft maintenance contractors and maintenance, repair, and overhaul (MRO) companies to allocate staff flexibly for resolving maintenance events.

StaffNow is part of the AVIATAR platform, which is provided by Lufthansa Technik to enable airlines and other stakeholders to access data from their aircrafts in real-time, to monitor their aircrafts and troubleshoot errors, to predict and avoid delays, to optimize operations and maintenance, and to automate their value chain (Lufthansa Technik AG, 2020b). While Lufthansa is not an aircraft manufacturing company, this platform strongly builds on aircrafts as smart products, manifesting properties of all three platform types. Thus, AVIATAR evidences that all three platform types might be intermingled, providing complex interactions among stakeholders to foster value co-creation on smart service platforms.

Challenges related to implementing a smart service platform successfully

For current research and management, we identify five fundamental challenges that smart service providers need to consider when establishing a platform. We discuss how the transformation from a pipeline business model to a platform business model – subject to the change of the underlying economic principles – poses significant challenges for service system design and business relationship management. By debating smart service platform strategies from these two lenses, we span boundaries between *service management and marketing* and *information systems*.

First, the platform economy challenges concepts that focus on relationships as dyads, since platform providers need to serve (at least) two sides of a market instead of one, which will result in a substantial increase of relationship complexity. Beyond dyads, platform providers need to manage networks of relationships, recognizing third-party service providers as additional actors that become entitled to co-create value with their customers. While developing the smart service customer market relates to traditional customer relationship management, establishing the service provider market might pose a substantial challenge to the platform provider's culture, since it might mean allowing former competitors to interact with the customers. The platform provider has to foster openness to attract and retain at least a critical mass of both service customers and service providers to allow network effects to kick in (Stummer *et al.*, 2018). Network effects operate on both sides of the market, such that neither side can be managed without considering the effects emerging on the other side; instead, the platform provider needs to adopt a holistic management approach – including a coordinated pricing approach that emphasizes interdependencies between both sides of the market (Parker and van Alstyne, 2005). The pricing approach also needs to consider the investments that customers and third-party service providers must make to affiliate with the platform. On an operational level, platform providers need to establish structures that promote network effects, for example, by offering direct channels for market participants to communicate and interact, or even interface with online social networks to promote recommending behavior.

Second, with the introduction of platforms, a smart service system is extended with a (large) number of additional actors participating in value co-creation, which – according to general systems theory (Luhmann, 2013, p. 124) – will significantly leverage the system's complexity. Platform providers are required to establish additional structures in a service system to deal with the system's new level of complexity. They need to design the service system in a way that enables transactions between at least two different groups of clients to be performed effectively and efficiently. To do so requires providing platform functionality that is restricted to a platform provider while granting other participants access to data and processes. In the case of smart data or smart product platforms, this includes enabling access to aggregated data, or even direct access to machines themselves. Beyond means of customer relationship management, the platform provider needs to design a smart service platform as a socio-technical system to increase the likelihood of receiving contributions from either side of the market, e.g., by developing and implementing distinctive interfaces for different groups of users.

Third, the role of the platform provider in value co-creation differs significantly from a dyadic view of value creation. Value is co-created in direct interactions between service providers and customers, both of whom use the platform as an infrastructure. Compared to dyadic relationships, the platform provider is not directly involved in value co-creation besides providing the infrastructure on which the participants interact. While platform providers' control of these interactions is limited to platform governance, the participants on the platform control critical terms of their direct interactions, such as pricing, quality, and terms and conditions. Some business models may even enable third-party service providers to access (e.g., download condition data), update (e.g., perform software updates) or even reconfigure a smart product itself (e.g., setting parameters in a machine). Taking actions remotely does not only challenge the ownership claim of a producer but also presupposes sophisticated management concepts to maintain high-security standards. The degree of openness of a platform reflects the trade-off between retaining and relinquishing control over a platform. Platform providers need to define governance mechanisms and inscribe them into the platform's design to foster market participants' compliance with the platform's regulations. These rules need to be flexible enough to attract attractive market participants to a platform. At the same time, there is a need to restrict access for other users or even repel participants that turn out to be unattractive.

Fourth, ensuring the commitment of many different market participants might prove challenging for a platform provider. Due to the multi-party setting on platforms, market participants experience varying levels of service quality when interacting with different partners. Especially in the case of smart product platforms, security risks and privacy concerns might arise if multiple service providers access a device that is located at a customer's facilities. Security and privacy issues might hamper the formation of platform loyalty and call for measures to be implemented that can counteract risk perceptions on the smart service platforms. Smart service providers need to develop strategies to build and sustain multi-party trust. Appropriate measures differ significantly from traditional personal relationships and trust-building actions in B2B markets (e.g., key account management, customized discounts and incentives). To signal credibility and trustworthiness, smart service platform providers should invest in developing a strong brand with sufficient market reach. This could also entail shifting a brand position, e.g., emphasizing individual relationships, to a new position that reaches multiple market participants.

Finally, the investments necessary to transform towards the platform model might be unknown when starting the transition. Market participants on both sides need to make platform-specific investments to affiliate with the platform – e.g., buying or renting a smart product and other hardware, integrating processes and applications, defining roles, and transforming their organization. While participants on matching platforms may not need to invest in tangibles or software, they still need to perform marketing and communication activities. Likewise, the platform provider needs to make substantial investments in IT architecture and in governance mechanisms for launching and operating the platform. Beyond hardware, smart service providers who want to enter the platform market need to acquire a new skill set to master these challenges. Manufacturing companies not only need to develop new operational structures and IT-capabilities – e.g., data science methods, platform architecture and governance mechanisms – that were not necessarily required for manufacturing smart products, but will also affect the firm's culture and its employees, making organizational change management a critical part of establishing a smart service platform.

A call for interdisciplinary research on smart service platforms

Since the abovementioned challenges go beyond the state-of-the-art in service theory and practice, we postulate that analyzing and designing smart service platforms requires bridging boundaries that currently separate service marketing and management, information systems, and platform economics. Bridging these boundaries is far from trivial. While service science is envisioned to be a multi-disciplinary research field – including service marketing and management, information systems, computer science, economics, and mechanical engineering – each community still seems to perpetuate its idiosyncratic theories, journals and conferences. Table 4 displays how the phenomenon of smart service platforms connects to multiple concepts that originate from different research areas. We argue that the advent of smart service platforms boosts service phenomena to an unprecedented degree of complexity that can no longer be mastered by any of these subdisciplines alone. Thus, in the following, we will demonstrate how service management and marketing, information systems, and platform economics might bridge boundaries to streamline further research on smart service platforms.

In particular, service science needs to take up economic theories to analyze phenomena related to service platforms and to design IT artifacts and management structures if it wants to deploy platform strategies and operations successfully. (Micro)economic theories offer essential concepts to understand and develop a platform provider's interfaces with stakeholders on either side of the market and manage their interdependencies. In turn, service science can provide a fresh lens on how value is co-created in (eco)systems that include platform providers, customers, and service providers, instantiating economic theory with concepts that are specific to value co-creation, as focused on in service science (Beverungen *et al.*, 2019a).

Table 4. A summary of disciplinary and inter-disciplinary research directions for smart service platforms

Core theme	Disciplinary research directions	Interdisciplinary research directions
Service Marketing and Management Perspective: Relationship building among market participants interacting on a smart service platform	(1) What role does interorganizational trust play for establishing a platform and how can platform providers establish trust and commitment in other market participants? (2) Which types of value are co-created on each platform type? (3) Do the three different platform types require different sets of instruments for relationship management? How could these instruments be integrated? (4) Which means and instruments can counteract customers' high-risk perceptions, especially on smart product platforms that allow interactions with external parties? (5) Which role does brand image play on platforms? How should a platform provider brand be positioned to attract loyal market participants? (6) How can platform providers transform dyadic relationships into networked relationships, considering interactions among relationships?	(1) What effects do technical features (e.g., data storage, data access, data analytics, recommendations) of a platform have on the market participants' behavior and loyalty? (2) How does integrating third-party service providers affect the structure and dynamics of smart service systems, as well as design and utilization of smart products? (3) How can a platform provider successfully deal with complexity in platform settings? Can information systems be used to manage complexity on a platform, or will they increase a smart service system's complexity instead? (4) How can an appropriate degree of openness and control be determined for a platform, to foster actor engagement while not sacrificing control of the customer interface? (5) How do and how can different types of platforms intermingle? (6) How ought information systems be designed to level information asymmetries, e.g., lowering the risks of hidden actions and moral hazard on platforms? (7) What external restrictions, including compliance with legal regulations and ethical requirements impact on platform business models of smart service providers? (8) How can market participants be incentivized to share their data with platform providers and third-party service providers? (9) How can benefits generated on platforms be divided fairly among stakeholders, to foster a platform's sustainable success? (10) Can different platforms coexist in the same industry, or will platforms consolidate, establishing a winner-takes all market? (11) Is the decision of establishing a particular type of platform reversible, and can companies shift among platform types? (12) How does a smart service provider's business model change if smart services are offered on another firm's platform? (13) Will successful smart service platforms in the long run be owned by one specific smart service provider or jointly by several producers of smart products?
Information Systems Design Perspective: Designing platforms as IT artifacts that constitute socio-technical service systems	(1) How ought information systems be designed to (1) balance openness and control on a platform; (2) lower the participants' expenditures required to affiliate with a platform; (3) retain stakeholders and provide long-term commitment of the stakeholders involved; (4) foster direct interactions among participants from either side of the market; (5) leverage network effects; (6) interface with smart products in the field (2) How do different IT artifacts for platforms impact on service systems, in particular regarding interactions performed on the platform, the success of platform business models, and the structure/evolution of service systems?	
Platform Economics Perspective: Organizational challenges related to implementing, transforming, and sustaining a platform business model	(1) What business model works best for each platform type? (2) How can a platform business model be established, e.g., with a radical change from former business model to platform provider, a step-wise transition, or by keeping the old business model in addition to the platform? (3) How can companies develop the required capabilities to manage the provision of smart service platforms? (4) How can managers change the corporate culture to embrace the platform business model? (5) How can smart service platforms attract competitors as market participants? (6) What impact will the transition have on the company's sales force?	

In this conceptual article, we presented three archetypes of platforms and discussed their challenges to smart service providers striving to transform into platform providers. While this paper is a first step towards conceptualizing smart service platforms, much remains to be discussed. In what follows, we highlight possible avenues for future research, organized around three core themes with a summary of specific research questions provided in Table 4. Additionally, we suggest overarching cross-disciplinary research questions to encourage researchers from related disciplines to jointly perform research on smart service platforms.

Relationship building on smart service platforms (service marketing and management perspective)

As trust has been shown to be a critical factor in dyadic online and offline B2B-relationships (Doney and Cannon, 1997; Pavlou, 2002) and on consumer platforms (Teubner and Dann, 2018), the role of trust on smart service platforms warrants further exploration. Most importantly, researchers should address, which strategies and instruments platform providers can use to establish trust and commitment to and between market participants.

In our analysis, we find that the three identified platform types vary significantly in terms of the level of control exerted by the platform provider. Market participants perceive different types of value and benefits on platforms (Lamberton and Rose, 2012), yet the value perception of smart service platforms have not yet been explored, so far. Future research should identify different value categories that relate to the three platform types as well as various sets of relationship management instruments geared to attracting loyal market participants for each platform type. Especially on smart product platforms, customers that own a smart product might have elevated risk perceptions (Paluch and Wünderlich, 2016) as other market participants access a product that is located in their facilities. Exploring risk mitigation strategies in these contexts is not only a fruitful research avenue but also critical for business practice.

At the same time, more research is needed on the role of brands in a smart service platform context. While brands have been shown to be a signal for credibility and reliability (Erdem and Swait, 2004), their impact on market participants of smart service platform has yet to be explored. A structured analysis on how a smart service provider should (re-)position their brand to ideally attract a different group of market participants in each smart service platform type could vigorously advance our knowledge of branding in a platform context.

Smart service platforms (information systems design perspective)

Design conceptualizes how human-made objects – so-called artifacts – *ought to be* (Gregor and Jones, 2007) to leverage desired effects and prevent undesired effects in an artifact's context (Alexander, 1977; Simon, 1996). The information systems discipline focuses on designing IT artifacts, including constructs, models, methods, and instantiated software (March and Smith, 1995).

As IT artifacts, smart service platforms need to be designed to foster engagement of and interactions among different groups of stakeholders involved in a service system, enabling them to co-create value. More specifically, we stipulate that the platform needs to be designed with respect to the economic concepts that impact on the success of platforms, including openness/control, affiliation, direct interactions and network effects. As *context*, the platform economy yields requirements that shape how a platform as a *form* ought to be designed to enable a platform smart service system. On the other hand, the design and use of a platform as a form will also constitute and re-constitute the business model as well as the entire social system as context established on the basis of the stakeholders' interactions. In terms of a mutually constitutive duality (Giddens, 1984), further research must identify how the context (e.g., a smart service system that involves a platform) impacts on the form and function of a platform as a piece of software, as well as how different designs of platforms impact on the service system, respectively. Of particular interest is to identify how the right degree of openness for a platform is facilitated, enabling desired interactions among different groups of stakeholders, while preventing them from interacting in undesirable ways. Also, platforms must connect to smart products used in the field, which are operated and controlled in plants that might lack access to the internet.

Organizational challenges (platform economics perspective)

This study identifies three strategic options for companies that wish to transform into platform providers. Future research needs to identify business models that sustainably support this transformation. Also, the transformation process itself warrants further investigation to ascertain whether the appropriate action to take is either a radical transition to becoming a platform provider, a step-wise transition process, or even keeping the business model unchanged.

The transition to becoming a platform provider requires performing an organizational change process that needs to be managed on a strategic and operational level (Burnes, 2004). This begs the question of how companies develop the required capabilities to manage the provision of smart service platforms. How can managers transform the corporate culture to embrace a platform business model? Research is needed that explores the intra-organizational changes following the transition, for example, its impact on a traditional sales force.

The change in culture also involves building relations with former competitors that join a platform as third-party service providers. We need guidance on how companies can transform their relationships from dyadic constellations to complex "networked" relationships.

Interdisciplinary research directions involving all three perspectives

Smart service platforms concern various research disciplines – including service marketing and management, information systems, and economics – necessitating research efforts that build new theory at the intersections of these disciplines.

For instance, further research is needed to identify if and how the inner workings of software platforms (e.g., recommender systems, online ratings, machine learning, data aggregation) impact on value co-creation (e.g., market behavior, types of value co-created) and the success of a service system (e.g., customer lifetime value, customer attrition and retention, customer loyalty, brand value). While previous research has established a connection, much needs to be done to unbox further the technology and its detailed effects on service systems. Also, more research is needed to identify environmental regulations and ethical guidelines that might enable or constrain the analysis of data as well as the design of new value propositions in service systems.

Another interesting question is how platform providers can deal with the quantum leap of complexity that is caused by including third-party service providers in their platforms. While general systems theory identified strategies on how systems can deal with complex environments, technology can lower as well as increase the complexity of a system. Further research needs to identify how technology impacts on the structure and dynamics of a service system and what guidelines managers need to follow to manage the transition towards a smart service platform provider successfully. As systems, platform service systems evolve dynamically, while the path and workings of this evolution are partially beyond the control of both the designer and the platform provider. Long-term empirical studies are required to trace the evolution of platforms and explain how decisions made by the involved stakeholders shape the evolution's course.

Economic theory reminds us that information asymmetries can lead to adverse effects, including hidden action and moral hazard (Arrow, 1986), which can be disruptive for platforms. Management and information systems need to identify ways to level information asymmetries, while at the same time limiting the resources to be spent on affiliating with a platform. Once actors have joined a platform, it is desirable to establish long-term partnerships and create exit barriers, maximizing network effects that can be realized with platforms. A crucial aspect here is motivating customers to provide data on their machines that can be analyzed to offer convincing value propositions with the platform. Dividing the value-added by introducing platform business models fairly will be another prerequisite for ensuring a platform's long-term success.

Notes

1. While the "platform provider" and the "platform owner" can be different legal entities (e.g., a platform owner may outsource the operation of its platform to an IT service provider), we posit here that the manufacturing company takes both roles. Hence, we refer to the manufacturing company only as "platform provider" in the remainder of the paper and do not discuss the interactions of these roles further.
2. Note that we order these concepts from the point of view of a platform provider here. In the section "Related Literature" the focus is on platforms as phenomena, which led us to ordering the concepts differently.

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