

Linking Service- and Capability-Driven Design – Towards a Framework for Designing Digital Businesses

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Abstract

The digitization of the economy and society requires enterprises from all industries to revisit their business models and prepare their organizations for the digital age. The design of “smart” products and services, the involvement of prosumers, and the intensifying interconnection of supply chains are signs of this transformation. Each of these scenarios builds on improved availability and interchangeability of data. In order to successfully transform their business and be able to develop valuable new services, companies require methodological help. To address this need, this paper proposes a service-capability design framework for digital businesses. The framework is developed theoretically based on the literature and earlier research. It consists of a meta-model and a high-level reference model. The framework is retroactively applied to a real-world digital use case to demonstrate its validity.

1 Introduction

The digitization challenges companies to consider data as a new valuable resource. From a volume perspective, this resource seems to be growing towards infinity, with more and more new data sources like social media data or data from “smart” products extending the current data pool consisting of core business objects data, operational transactions data, or internal documents. Before actually benefitting from this vast amount of data, however, companies need to make it technically available for use and to create organizational structures that welcome data-driven insights. This requires a tight integration of IT and Business, which needs to go beyond the “Business-IT alignment” that has always been a central topic in information systems research (Proper and Lankhorst 2014). On the technical side, new “big data” technologies address challenges like integration of heterogeneous data sources, improving data quality, and delivering complex analytics results in an understandable manner to business users (Agrawal et al. 2012; Labrinidis and Jagadish 2012; Ammu and Irfanuddin 2013). On the organizational or business side, several additional

challenges arise. These are reflected by the growing research interest in the digital transformation of business models and business strategy (Bharadwaj et al. 2013; Keen and Williams 2013; Otto et al. 2015).

So far, research in the various related fields of (digital) service systems (Leimeister et al. 2014; Barrett et al. 2015), digital business modeling (Keen and Williams 2013), digital organizational capabilities (Bärenfänger and Otto 2015; Bērziša et al. 2015), and big data management (Agrawal et al. 2012; Chen et al. 2012) has existed separately of each other. This paper suggests an integration of these fields by proposing a “service-capability” enterprise design paradigm that combines service systems design and capability modeling. The goal is a theoretically sound and practically useful framework that may help companies address the challenges of digitization.

Methodologically, the paper belongs to the domain of design-oriented research, which strives at developing “IT artifacts intended to solve identified organizational problems” (Hevner et al. 2004, 77). The model is developed theoretically based on the results of an earlier design science research (DSR) project and on ongoing consortium research. For the academic community, the contribution of the service-capability model lies in highlighting the connection of different theoretical concepts in the context of digitization. For practitioners, the model helps to structure digital initiatives and to understand the enablers of digital business services.

The remainder of the paper is structured as follows. Section 2 establishes the necessary background on services science and capability research. Section 3 presents the service-capability meta-model and its high-level reference model. Section 4 then applies the model to a real-life case to demonstrate its explanatory power for completed projects in the context of digitization. Section 5 discusses the theoretical and managerial implications and limitations of the research. Section 6 concludes the paper.

2 Background

The theoretical background for this paper is given by two main streams of research, service science and capability modeling. Special attention is paid to current research related to digitization.

2.1 Service science

Service research (or its related concepts service systems, service engineering, service science, or service management) is gaining increasing attention in information systems research (Fielt et al. 2013; Böhmman et al. 2014; Barrett et al. 2015). Generally, offering a service means “to organize a solution to a problem [...] which does not principally involve supplying a good.” (Gadrey et al. 1995, 5). The goal of a service is therefore to create value for a service user by a standalone intangible solution or by one that is delivered alongside a physical good. The authors further explain service provisioning by stating “It is to place a bundle of capabilities and competences (human, technological, organizational) at the disposal of a client and to organize a solution, which may be given to varying degrees of precision” (*ibid.*). Service provisioning therefore requires a combination of several organizational resources, for example technological resources as well as organizational capabilities (Den Hertog 2000). A relevant question to ask is how these different capabilities should relate to each other for successful service provisioning. The contemporary service understanding grounded in service-dominant logic adds that value is frequently co-created between service provider and service user by collaboration and contextualization (Lusch and Nambisan 2015). The resulting relation is sometimes referred to as “service ecosystems” (Barrett et al. 2015). This implies

that resources and capabilities for service delivery may be distributed or shared between different actors. Moreover, the intangible nature of services favors personalized, user-specific solutions as opposed to conventional mass-produced physical goods. This explains the appeal of services to many companies in the digital age, as personalization promises higher revenues and long-term customer relationships.

Consequently, Böhmman et al. (2014) recently proposed “service systems engineering” as an information systems research perspective, which focuses on developing entire “service systems” of enterprises (opposed to the design of single services), calling for more research dedicated to service architectures, service systems interactions, and resource mobilization. They encourage the creation of more “evidence-based design knowledge” for service systems (Böhmman et al. 2014, 73). In another recent publication, Barrett et al. (2015) reviewed several streams of IS research with respect to their implications for service innovation. They stress that information and communication technology (ICT), digitization and information are in the center of innovation in service ecosystems. Examples of the growing body of information systems research related to (digital) services include both service value and practical use case-oriented research like the ones on consumer-oriented digital services (Leimeister et al. 2014) or industrial service innovation (Chew 2014; Krueger et al. 2015). Others pivot more towards the technological aspects (Delen and Demirkan 2013; Demirkan and Delen 2013).

Regarding the latter, digitization increases the need for setting up light-weight and flexible IT infrastructures providing access to information from various data sources. Current IT-systems and databases are not able to handle data sharing in complex IT-landscapes and cross-company environments. Therefore, the service-oriented architecture (SOA) is currently experiencing a renaissance in approaches like the so-called data-service oriented architecture (DSOA) and the microservice architecture (Newman 2015). The goal of a DSOA is to provide data as-a-service. Light-weight technologies like HTTP (RESTful) and simple data structures like JSON replace the traditional SOA technologies SOAP (Simple Object Access Protocol) and WSDL (Web Service Description Language). A traditional SOA principle means putting the functionality of each service into the focus, but encapsulating the implementation behind interfaces (Starke et al. 2007). Another important aspect of a SOA is the loosely coupled design for avoiding dependencies between services (Maier 2009). Today, these two aspects – encapsulation and loose coupling – are two important aspects of a DSOA and of microservices, too. The fields of application of service-oriented design therefore reach from higher-level business design to actual IT implementation.

2.2 Capabilities

Organizational capability research is an established research domain going back to the resource-based view of the firm (RBV). Its goal was and still is to explain the roots and whereabouts of sustainable competitive advantage (Barney 1991). An IS capability is defined as “a firm’s ability to acquire, deploy, and leverage its IT-related resources in combination with other resources and capabilities in order to achieve business objectives” (Zhang et al. 2013, 423). Others define capabilities from a general business perspective as “the ability and capacity that enable an enterprise to achieve a business goal in a certain context” (Bērziša et al. 2015, 16). Put differently, capabilities can be regarded as core building blocks of an organization that are configured to reach business goals. They describe *what* a company *does* – or rather what it *should be doing* considering its objectives. In view of constant environmental change, the need to continuously develop further ones’ capabilities is acknowledged in the “dynamic capability” notion, which focuses on “a set of

capabilities [...] that help reconfigure existing operational capabilities into new ones that better match the environment” (Pavlou and El Sawy 2011, 239).

To become useful in a the real world and to justify their place besides classical enterprise modeling approaches, capabilities need to relate to other elements of enterprise architecture, such as processes, resources (both system-related and human resources), and key performance indicators. Bērziša et al. (2015) proposed a comprehensive meta-model illustrating these relationships. In recent years, capability modeling has also been recognized by practitioners as a potential bridging concept between Business and IT architecture (cf. Ulrich and Rosen 2011, The Open Group 2015). One example is its use in TOGAF, an enterprise architecture framework (The Open Group 2015). The mere fact that capabilities do relate to classical elements of enterprise modeling of course does not yet prove that they should be preferred over traditional modeling paradigms like process modeling. Process orientation with its research domain Business Process Management (BPM) has been the dominant enterprise modeling paradigm of the last decades of the “information society” (Leimeister et al. 2014). In the new “digital age” or “digital society”, however, requirements for business modeling change: for example, there is a need for greater flexibility to empower lower-level actors than the one offered by traditionally restrictive process models. Moreover, software (service) implementation could benefit from an organizational design made up of well-capsulated, modular business capabilities and services, whereas the chain-of-activities logic of processes does not support this equally well. While more research is needed on the issue of how capability modeling compares to process modeling, these arguments lend first theoretical support to the claim that capability modeling is a promising addition to process modeling in light of digitization and that it could combine well with services.

2.3 Related work in service and capability research

Capabilities and services have been combined in existing research. For example, Storbacka (2011) proposed 69 capabilities for a “solutions business model”, which is an industrial business model focusing on selling solutions (product-service bundles). His capabilities relate to the “business capabilities” of the model in this research. In contrast to Storbacka’s list of capabilities, we also formalize the meta-model of services and capabilities and explicitly model the information systems management level, which is only implicitly included in a capability category called “infrastructure support” by Storbacka (cf. Storbacka 2011, 704). Gebauer and colleagues (Gebauer et al. 2012) studied three different paths to service business development in small- and medium-sized enterprises and analyzed the differences across paths in dynamic and operational capabilities. They find different manifestations of the high-level capabilities across the different paths, supporting this paper’s argumentation that capabilities are a valid construct to characterize service-oriented business. Furthermore, Den Hertog et al. (2010) proposed six dynamic capabilities for service innovation and argue which types of innovations they support. Regarding practical design support for new services and a corresponding enterprise modeling perspective, the “service-innovation based business model design method” by Chew (2014) has a similar goal as the one of this research. His approach begins with understanding customer needs and proceeds to four more design practices called service concept design, service activity system design, service architecture design, and customer experience design. However, the details of these design practices are not yet specified. We complement Chew’s approach by proposing capability configurations as elements of service architecture and (to some degree) of service activity systems.

3 The service-capability design framework

3.1 Research approach

The service-capability design framework presented in this research is based on literature research, a completed DSR project (Bärenfänger and Otto 2015), and ongoing exchange with a community of practitioners. This community forms a research consortium (Österle and Otto 2010) meeting five times per year for two-day workshops to discuss the latest needs and developments regarding data and information management in the industry. The participants are experienced information managers from more than 15 companies, of which most are large international firms from various industries such as automotive and automotive supply, pharmaceuticals, fast moving consumer goods, and telecommunications. These managers are therefore adequate experts for a focus group, which is one of the recommended methods to evaluate DSR artifacts (Österle and Otto 2010).

We presented our service-capability methodology at consortium workshops in January and June 2015. Each time after the presentation and a general feedback session with the whole audience of 45 to 50 participants, details were discussed in focus groups of 10 – 20 participants, which lasted half a day, respectively. The focus group session in January refined the relation of the modeling elements and discussed “digital use cases” and valuable industrial services. The session in June was used to test the information service and capability methodology with example cases coming from the companies. This research is the outcome of these iterations and the ongoing literature work.

3.2 Meta-model

The basic service-capability meta-model is shown in Figure 1 and has four elements, which are defined below.

- *Business service*: A business service is an IT-enabled service that enterprises provide for their internal customers (e.g. employees) or external customers (e.g. B2B, B2C or B2G customers and consumers). It may be created collaboratively with the customer, delivers a specific value proposition or benefit for the customer (by satisfying a customer need), and contributes to at least one measurable business goal of the enterprise.

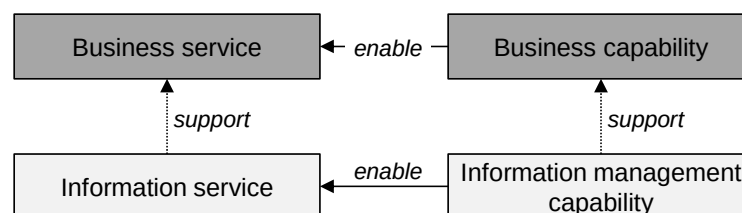


Figure 1: Basic service-capability meta-model

- *Business capability*: A business capability is the dedication of a resource set (or bundle) for a specific business goal in a certain context. This resource set may comprise a combination of both intangible resources (e.g. knowledge, skills, time) and tangible resources (e.g. money, tools, systems). Business capabilities specify the most important, stable functional goals of the enterprise. Multiple business capabilities are instantiated and configured to enable a business service. A *digital* business capability is a capability relevant for digital business models. Business capabilities imply an ongoing renewal and re-definition of the underlying resources to

be able to continuously satisfy the business goal in view of changing external and internal context (cf. *dynamic capability*).

- *Information service*: An information service is an IT-enabled information-transferring service that satisfies the information processing requirements (the information needs) of a business service. A business service may require multiple information services to have its various information processing requirements satisfied. Furthermore, the same information service can be used in multiple businesses services. Information service users may be human (e.g. an employee or customer) or non-human actors (e.g. an information system that further processes the output or result of an input information service).
- *Information management capability*: An information management capability is the dedication of a set of tangible and/or intangible IS/IT-related resources for a specific information management goal in a certain context. Multiple information management capabilities are instantiated and configured to form information services. A *digital* information management capability is a capability relevant for information management in view of the challenges of digitization and big data management.

3.3 High-level reference model

Whereas a meta-model tells the modeler (here: the information manager or enterprise architect) *how to model* something in a particular domain (here: her digital business), a reference model offers *content* that may be re-used in a practical application (Vom Brocke 2007). As reusability is the ultimate goal of reference models, it should aim for universal validity for a certain type of problem situation or certain type of company (Becker et al. 2002).

Figure 3 shows the high-level service-capability reference model for digital businesses. Its goal is to provide methodological assistance for companies that need to design their future business in the digital economy. It is called “high-level” because it only presents the general service types and capability categories, respectively. It does not show the complete lists of detailed capabilities that are subsumed under these capability categories because of the limited space available. For illustrative purposes, the four elements’ quadrants have been numbered in Figure 3. The left-hand side, quadrants I and III, shows the service perspective and contains a collection of reference service types, whereas the right-hand side shows the capability perspective.

- *Quadrants I and II*: The reference digital business services from quadrant I are based on a growing case database of “big data” or “digitization” use cases taken from the literature (e.g. BITKOM 2015) and on own empirical work with the research consortium. “Predictive maintenance” is one of these typical digital business services. The digital business services consist of a configuration of several digital business capabilities, whose categories are presented in quadrant II. They are based on the dynamic capabilities for digital business described in Bärenfänger and Otto (2015).
- *Quadrants III and IV*: Quadrant III lists four generic types of information services for digital businesses which can be distinguished by their different levels of information richness or intensity. Support for this classification comes from the business intelligence, decision support, and analytics literature (Kiron et al. 2011; Chaudhuri et al. 2011; Chen et al. 2012; Delen and Demirkan 2013; Holsapple et al. 2014). A “data-as-a-service” type information service could for example be a single quality-assured master data value, whereas “information-as-a-service”- or “analytics-as-a-service”-type outcomes require more context and logic being applied to basic

data. Consequently, information services consist of configurations of several information management capabilities, whose categories are presented in quadrant IV and which were also based on Bärenfänger and Otto (2015). These capabilities cover the entire “data value chain” or “data analysis pipeline” (cf. Agrawal et al. 2012, 2).

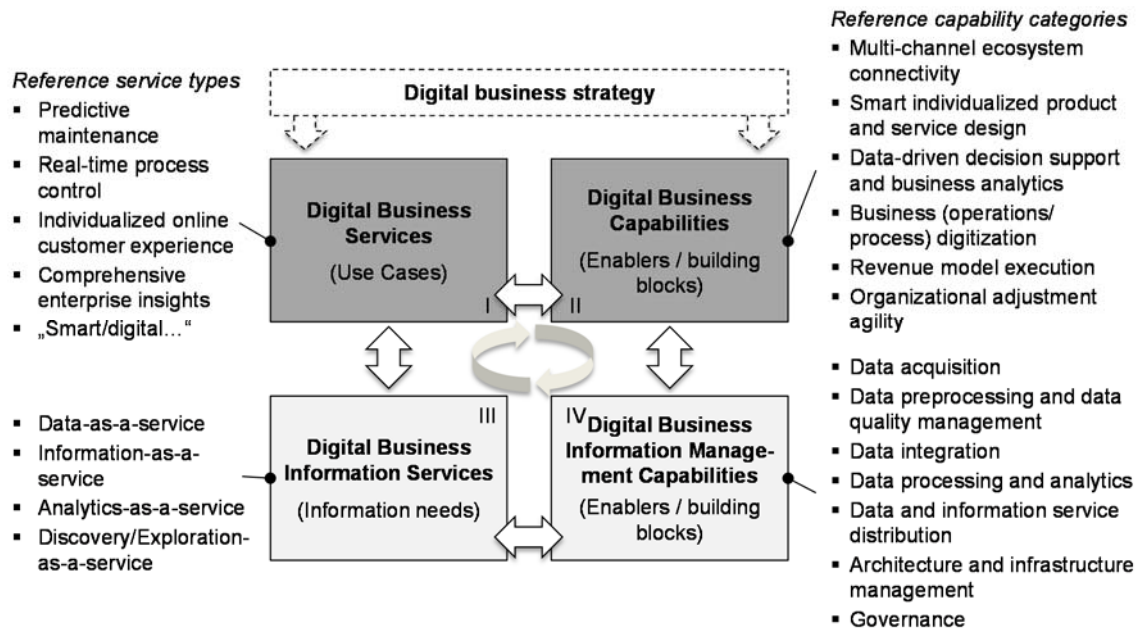


Figure 3: High-level service-capability reference model for digital businesses

4 Case example: project smaRTI

In order to evaluate the practical usefulness of the framework for real-world cases, we retroactively applied it to the industrial use case “SmaRTI”. This is a common way for an early evaluation of new research frameworks, which has for example been used by Chew (2014) or Krueger et al. (2015).

4.1 smaRTI

The goal of the smaRTI (smart reusable transport items) research project was to increase the intelligence of material flows in logistics networks by developing a service for real-time tracking and tracing of reusable transport items (RTI). We chose this case because it features a data-enabled solution based on current technology for a typical transparency and control problem in a business ecosystem. It is therefore an adequate illustrative example for a use case in the digital economy, which is the targeted scope of the service-capability framework.

The inability to keep track of the exact number and location of shared transport structures is a challenge for many companies, for example in the consumer goods supply chain. This leads to frequent losses of transport structures (in the worst case along with the handling units they were carrying), to insufficient transparency of the actual material flows, and to high working capital costs. The smaRTI solution was based on Auto-ID technologies like RFID for the identification and localization of RTIs and on a cloud software architecture for data integration. The project was completed 2013 with a pilot implementation for a candy supply chain with 18 read points shared between a manufacturer, a retailer, and an RTI service center. The implementation tracked 600

pallets in a loop between the three companies, which created around 90.000 read events per week. The loop is initiated from the RTI service center. The outcome of the pilot implementation was a transparent RTI flow between the three participants (Wrycza et al. 2014).

4.2 Framework application

The smaRTI solution is described in terms of the service-capability framework in Table 1.

Element	SmaRTI
Business Service	- Value proposition: gain full transparency and control of shared transport structures in a consumer-goods supply chain by monitoring the material flow in real-time. - Measurable business goal: reduce high inventory levels and avoid out-of-stock situations in stores. - Stakeholders: participants of a consumer-goods supply chain (manufacturer, retailer, pallet pooling provider). - Geographic scope: cross-country within Europe.
Business Capabilities	Configuration of digital business capabilities for the business service: - Multi-channel ecosystem connectivity by sensing internal resources and by digital communication with business partners. - Service design as information-enabled service on top of physical goods. - Data-driven decision support for collaborative logistics, inventory management and for internal financial planning. - Business digitization by transparency of collaborative material flows and internet-of-things- connectivity of resources of production. - Organizational adjustment agility by reduction of lead times. - Revenue model optimization by cost control, enabled by transparency and cost-efficient scalability.
Information Service	- Information Service goal: real-time intercompany pallet traceability. - Contribution to business service: identify locations of transport structure losses and create inventory cycle-time transparency (on pallet level). - Relation to “big data”: large data volumes, near real-time data access, ubiquitous service availability, high velocity of data processing.
Information Management Capabilities	Configuration of information management capabilities for this information service: - Data acquisition and integration from multiple sources: The solution acquires and integrates Auto-ID data as defined by the GS1 standard <i>EPCIS</i> from read points from all supply chain participants. A read point creates events containing an ID, a timestamp and location information and sends it to a centralized cloud service. RTIs and the transported goods are mapped via IDs. The supply chain participants use this information for a near real-time tracking not only of the RTIs, but also of the transported goods, based on the centralized stored Auto-ID events. - Data preprocessing: Incomplete read events are automatically detected to ensure information quality. - Information service distribution: The tracking data is offered in multi-channel, user-specific manner (web delivery for end-users, and an API based on RESTful interfaces for IT-system usage). - Scalable architecture and infrastructure management: The solution uses a micro service architecture building on a No-SQL document store in a cloud environment. This satisfies requirements for an easily scalable and fast service. - Governance: Roles and responsibilities are divided between supply chain partners and the solution is embedded in their operational processes.

Table 1: Framework application to SmaRTI project

This retroactive application of the framework to the smaRTI case shows that the reference model is generally suitable to describe the essential elements of a digital use case and its implementation. More detailed knowledge of the sub-level capabilities could thus facilitate information service development and business service implementation in the digital economy.

5 Discussion

5.1 Theoretical and managerial implications

The service-capability framework can provide value to researchers and managers. For researchers, it contributes to the growing understanding of the nature of digital businesses. It suggests that the new information services and their associated capabilities of a business are important to conceptualize businesses in the digital economy. To achieve this conceptualization, we combined service and capability research streams, which had been rather unrelated areas so far.

For managers, the framework may firstly speed up use case implementation by more closely aligning business requirements and information systems design. A condition for this is that information services are documented in such a way that information management capabilities' characteristics can be inferred easily.

Secondly, organizational governance and responsibility planning may benefit from a structured analysis approach of both new and existing services with respect to their required capabilities. In its pure form, capability modeling does not specify *who* should deliver a capability, thus leaving the option of either developing the required capability in-house or acquiring it externally. For example, German sports gear manufacturer Adidas recently announced the acquisition of the company owning the popular running app "Runtastic". Adidas thereby ensures the capability "multi-channel information service distribution" by integrating an external provider (Hofer 2015).

Thirdly, information managers can use the service-capability methodology to highlight their department's contribution to overall business goals. If they modeled all their outputs as "services" and established the links to (quantifiable) business goals (i.e., specific business services), this could help to justify the department's position within the organization. Furthermore, transparency of the involved capabilities for creating any information service can help gain transparency about the "price tag" of every information service, even if it is only a single high-quality data record.

5.2 Limitations

Despite being a reference model that strives for a degree of universal validity for a particular domain (Vom Brocke 2007), the model needs more empirical testing to evaluate and complement its current contents. So far, it was mainly derived theoretically from the literature and has only been retroactively applied to one real-life case. Another limitation is that the research domain of digital businesses is subject to many new technological innovations and dynamic market developments. Any set of reference capabilities will therefore only be "universally valid" for a limited period of time. Because of the apparent need for methodological and conceptual support in the industry, this should however be no excuse *not* to attempt to address this field from an information systems research perspective.

6 Conclusion

This paper presented a service-capability design framework that can help companies with enterprise modeling for the digital economy. It combines service systems design and capability modeling in a new way, thereby connecting two research streams that are currently subject of intensive research. Building on prior research and literature in these domains, the framework was presented as a meta-model introducing the core modeling elements and as a high-level reference model for service-capability design. A retroactive application of the model has demonstrated its applicability to complex digital real-world use cases. Future research will test the reference model on other real-world use cases. Two action research projects are currently underway that will validate the methodology and help develop the detailed reference models. More precisely, the goal is to develop representative business service and capability catalogs and verify the information management capabilities required to implement these services. These case studies can furthermore be used to derive design principles (Vom Brocke 2007) as to how the reference model can be applied in different companies.

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