Service Innovation: Sensing with Information Systems

Full Paper

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Abstract

Dynamic capabilities (DC) Theory highlights the need for organizations to constantly innovate their service offerings. With growing digitalization, service innovation processes (SIP) are particularly reliant on sensing capabilities of the organization, as they allow a firm to derive and disseminate the necessary insights for the development of more compelling value propositions. In this respect, contemporary research often highlights the role of information systems (IS) for innovation success. However, so far little effort has been made to understand this role more precisely. Drawing on the results of a systematic literature review, we investigate the relationship between IS and the SIP and present seven application areas for IS that support sensing capabilities. In this way, we bridge the prevailing gap between DC theory and IS research. Our results shine the light at potential application areas for the use of IS, thus allowing practitioners to improve the sensing capabilities of their organizations.

Keywords

Service Innovation Process, Information Systems, Dynamic Capabilities, Sensing Activities.

Introduction

In the modern economy, the tertiary sector produces most of the gross domestic product in developed economies (Den Hertog et al., 2010). Driven by the globalization, deregulation and technological developments in communications and information technology, even traditional manufacturers are newly introducing their own services (Lay et al., 2010). In order to satisfy the increasingly individualized customer demands and thus remain competitive in the long run, ongoing service innovations are necessary (Gebauer et al. 2005; Kleis et al. 2012). However, currently, there is a lack of understanding of the actual service innovation process (SIP), both amongst academia and practitioners (Menor and Roth, 2008). Although service innovation is not a new research area (Miles 1993), innovation research in general still tends to focus on innovation of material goods (Toivonen and Tuominen 2009). Similarly, while research and development departments in many companies are dedicated to the innovation of material goods, whereas the systematic and IT-supported development of services seems to be not yet established and fully understood (de Jong and Vermeulen 2003; Gebauer et al. 2005; Tether 2005). It is also unclear, how the use of information systems (IS) and the integration of internal and external stakeholders influences service innovation. In particular, while the supportive features of IS are seen as valid in general (Kleis et al., 2012), the mechanisms and effects of the IS remain largely unfounded and have not been allocated to any single activities within the SIP.

Against this backdrop, the purpose of this research is to investigate the relationship between IS and the SIP and derive both research priorities for the academia and practical implications for service providers. In order to determine the influence of IS in the context of SIP, studies from both IS and service science

literature will be consolidated and evaluated. Studies regarding product development have been excluded from our evaluation, since, although their similarities (Forsman 2011), they are to be differentiated due to their difference in complexity and inseparability of various traits as creation and delivery or product and organizational innovation (Stevens and Dimitriadis 2005). This was done with especial caution since this conceptual study does consolidate empirical evidence that was not tested in a product innovation context.

Using the dynamic capability framework (Pöppelbuß et al. 2011) and the classification of software classes according to Laudon and Laudon (2015) as a theoretical basis, this study acts as a conceptual bridge between the IS applications and SIP environment, thereby answering the existing research calls from service engineering (Bullinger et al. 2003).

The remainder of this paper is structured as follows. Chapter 2 gives a brief description of the methodology used in this research. Next, we elaborate on the relevant theoretical foundations in the context of service innovation, dynamic capabilities as well as the classification of information systems in chapter 3. Chapter 4 states the main part of the paper by bringing the concept of SIP and the types of IS together. Finally, the paper ends with a summary of the results, limitation of the research and implications for future research priorities and practitioners.

Methodology

For our conceptual research, we conducted a literature review following the suggestions by vom Brocke et al. (2009) and Webster and Watson (2002). Literature reviews form an important part of all fields of research and can be used for both established concepts as well as new research areas (Bensman 2007). When conducting the literature review in October to December 2016, we searched for the relevant publications within the context of SIP and evaluated them with special attention to the theory of dynamic capabilities (DC). Additionally, publications on the role of IS for firm's agility and innovativeness have also been covered. In this first step, we covered the main academic search engines (Web of Knowledge, Google Scholar, EBSCO, Science direct, Elsevier and Jstor) as well as additional archives (AISEL, IEEE Xplore, Research Gate, and Springer). While searching these databases for SIP-relevant publications, we used the search term "service*" in combination with one of the following additional terms "innovation*", "engineering*" and "development*" in singular and plural. Further, to identify relevant IS literature in the context of SIP, we combined the search terms "information system*" with "service* innovation* OR class* OR type* OR classification* OR framework* OR definition*". In addition, using forward and backward search (Levy and Ellis, 2006), additional publications were identified. Upon closing this initial search, our findings comprised a total of 334 articles. Figure 1 gives an overview of the literature selection process.
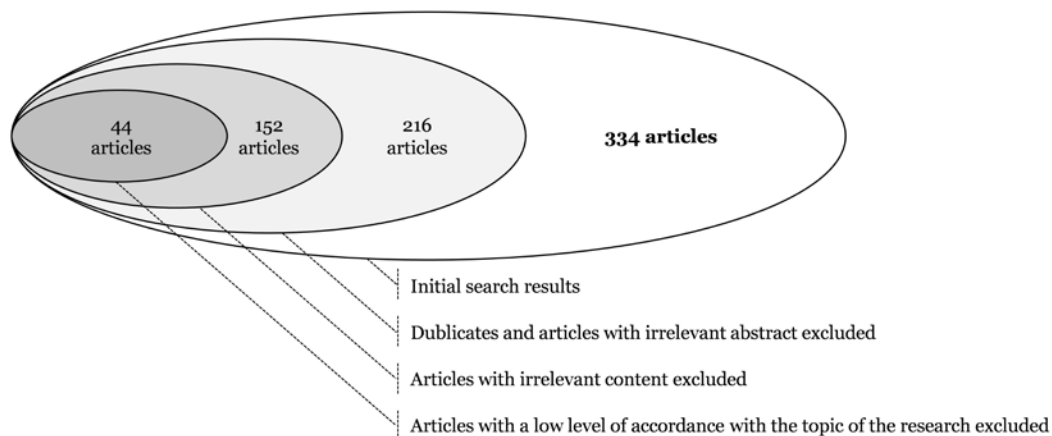

Figure 1. The selection of the literature

The selection of the literature was conducted in three steps. In the first iteration, duplicates that had occurred due to the recombination of the search terms were excluded and articles with relevant titles and abstracts (N=216) were selected. After their content was examined, 152 articles were identified as relevant for the research. In the last step, the articles were examined again and divided according to the relevance of the individual content and the density of the relevant information, which resulted in 44 articles. These articles were then coded with a software for qualitative data analysis (MAXQDA), which eased the process

of arranging, discussing and synthesizing prior research into greater units of analysis (vom Brocke et al. 2009). Based on these findings we bridge IS support effects within SIPs and comprise the results of the literature search.

Theoretical foundation

Sensing as a Dynamic Capability for Service Innovation

The DC theory is a further development of the resource-based view (Agarwal and Selen 2007, Teece 2007). According to this theoretical perspective, the long-term success of an organization under turbulent market conditions depends on its dynamic capabilities that enable constant development of innovative value propositions (Teece 2007). Thus, operational and dynamic capabilities can be distinguished from each other. While operational capabilities form the basis of the service provision and are based on organizational routines ("How to earn a living"), dynamic capabilities, in contrast, are the basis for the development of new operational capabilities ("How to change organizational routines") (Teece, 2007). Therefore, companies with strong dynamic capabilities are able to adapt to changing conditions faster than their competitors and have a high chance to gain strategic competitive advantages by exploiting business opportunities and avoiding unnecessary risks (Agarwal and Selen 2007). In recent years, the DC theory has been increasingly discussed in the context of service innovation (Pöppelbuß et al. 2011). In this respect, we adopt a service-dominant view of the world, where service is seen as a logic that explains how value emerges from the reciprocal interaction of different actors, who integrate their knowledge and skills for the benefit of each other (Vargo and Lusch 2004; Vargo et al. 2015). In line with previous research on DC, we consider service innovation as the emergence of elevated service offerings that are more compelling in a given context (Agarwal and Selen 2007). It is worth mentioning that the term "service innovation" is often used synonymously for both the "innovation process" and the "result of the innovation". This research emphasizes the process perspective on service innovation, which encompasses all activities of using new ideas and new technology to develop improved or new services (Johne and Storey, 1998; Zhang and Tao, 2007). This SIP can lead to changes in services such as the general service concept, the client interface, the delivery system and technological options (de Jong and Vermeulen, 2003). According to Nambisan (2013), IS can either take the role of an enabler of innovation processes, or they can themselves initiate innovation processes and thereby change business processes in companies

Recently, Plattfaut et al. (2015) have empirically shown the correlation between organizations' DC and the overall service innovation success. Furthermore, their findings suggest an interrelation between an organizations' use of IS in SIP and the three subordinate capabilities – *sensing*, *seizing,* and *transformation.* According to Nambisan (2013), IS can either take the role of an enabler of innovation processes, or they can themselves initiate innovation processes and thereby change business processes in companies. However, a deeper understanding of the role of IS remains absent and has been identified as a research gap in previous studies (Plattfaut et al. 2015). In this context, *sensing* capabilities are important for the alertness of an organization against business opportunities and market threats. Seizing capabilities are required to exploit opportunities and to avoid risks. The implementation of innovative services is finally driven by transformational capabilities. Given the rise of the new digital means for sharing and analyzing large amounts of data (e.g. Big Data Analysis) together with the shrinking service cycles and the overall globalization-driven competition, we believe that the potential for the use of IS to improve the sensing capabilities is the highest, thus being the focus of this research.

The corresponding activities of the sensing capability (table 1 shows the list of activities and their description) are, however, difficult to define and their results are often uncertain, which is why they are called "fuzzy front end" (Plattfaut et al., 2015). The sequence of these activities is not fixed and can also be carried out iteratively or in varying order (Pöppelbuß et al., 2011). The activities include capabilities that enable continuous identification of internal and external information as well as definition and resolution of problems. Additionally, the organization needs to quickly identify possibilities or needs for strategy and goal setting as well as their feasibility (Pöppelbuß et al., 2011). Lastly, the sensing activities include the precise definition of problems and the analysis of the context in which they occur (Chai et al., 2005).

Activities	Description
Dissonance	Initiating the innovation process by conflict or problem.
Formulation	Strategy and target definition based on marketing objectives and environmental analysis.
Learning	Permanent control, documentation, and reflection of insights through analysis, models and customer feedback of existing SIP.
Needs and Options	Systematic recording and integration of customer behaviour and needs. Furthermore, consideration of technical options that are relevant for the further development of services.
(Un-)bundling	Bundle or unbundle services. Use of existing services in a new context.
Co-development	Joint development / conceptualisation of service innovations.
Problem definition	The identified problem is described in detail by situation analysis, problem modeling and definition, and subsequent analysis of results.

Table 1. Sensing Activities (Pöppelbuß et al., 2011)

Classification of Information Systems

Within the last decade, IS have been increasingly recognized as drivers of growth and productivity (Seidel et al. 2013). In this context, they are understood as systems whose individual components can cope with specific tasks (Laudon and Laudon, 2015). While the term "information technology" (IT) is limited to hardware and software, our understanding of IS goes beyond and includes human components, tasks, and technical objects in order to transmit, process or store information within an organizational use context (Piccoli, 2007). In academia, the classification of information systems is mainly based on functional classes (Barron et al. 1999; Faraj and Azad 2012). As for the practice, separated terms such as ERP, CRM and CAD are often used but have been criticized by the IS researchers for quite some time. It is argued that the use of these terms, which are spread by organizational distribution and marketing, is not sufficient in the scientific context since they are not sufficiently precise (Barron et al. 1999; Faraj and Azad 2012).

At this point it is important to mention that it is not the purpose of the paper to develop a detailed classification similar to the information system cube (Cats-Baril and Thompson, 1995) or a semiotic-based model (Barron et al. 1999), but rather to provide a simplified framework, which would be sufficient to show the relationship between the IS and the sensing activities within the SIP. For this reason, we distinguish between four main classes of IS, which are relevant for this work, namely work-process-supporting systems (WSS), business intelligence systems (BIS), Group support systems (GSS), and knowledge management systems (KMS).

The first type of WSS enables the creation of workflows and process models, including their simulation and evaluation (Bernhard et al., 2013). Next, BIS are systems that enable the companies to organize and analyze relevant information collected during transactions. GSS enable effective inter-institutional and inter-organizational cooperation (Laudon and Laudon, 2015). As interdependence is increasing in the innovation of services, IT integration and monitoring of customers as well as customer-oriented activities play an essential role for service companies (Ghaffari and Aubert 2016). Finally, KMS are characterized by functions for storing and exchanging knowledge. They enable the collection and application of knowledge and expertise within the organization.

Results

Now that the theoretical background has been explained, the connection between IS applications and SIP, in general, can be established and implications specifically for the sensing activities derived. This limitation particularly applies to SIP as well, since it was refrained from including product focused studies to follows Stevens and Dimitriadis (2005) point of view, that product innovation processes are to be differentiated till their validity for the SIP has been demonstrated.

Bridging IS and SIP

Though the positive effect of IS in a service innovation context is accepted (Bullinger et al. 2003), little effort has been applied to investigate, classify and describe these effects. Previous studies often focused on the general benefit of IS applications and refrained from examining the underlying socio-technical effects (Kleis et al. 2012; Plattfaut et al. 2015). In the context of our research, we identified twelve potential IS use cases (Figure 2, where each activity is assigned to the corresponding IS type) to evaluate their influence on the following sensing activities, which will be described in detail in the following.
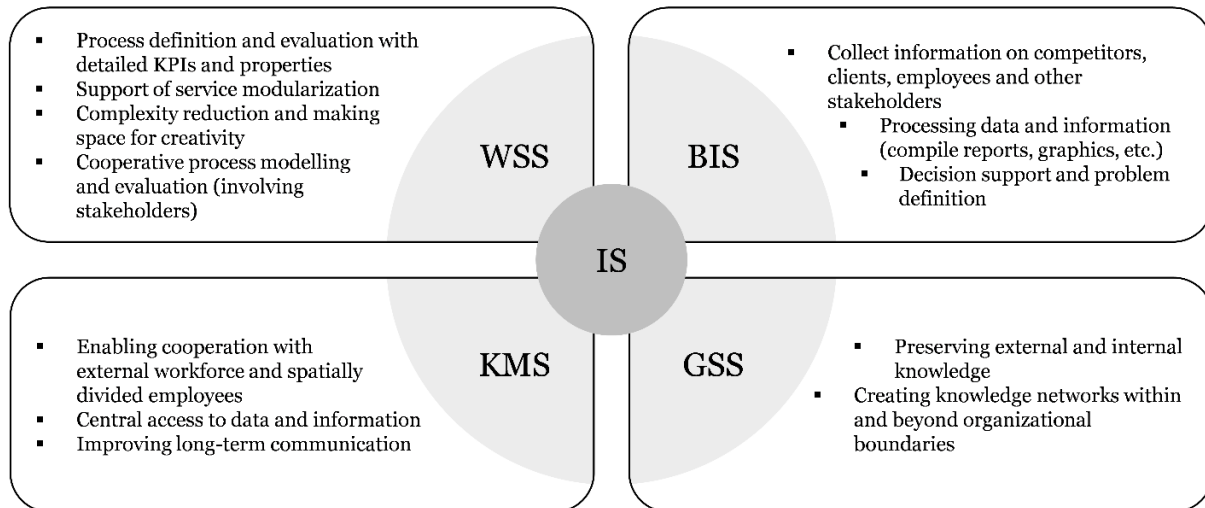

Figure 2. Potential use of information systems in SIP

The first group of four use cases falls under activities performed with *WSS*. According to Tax and Stuart (1997), the identification and audit of business processes are important sources for service innovation. Additionally, Klinger and Becker (2014) propose that customer-related service modularization creates competitive advantages and suggest using IS to (semi-) automatize service modules, thus improving service quality and standardizing processes. Furthermore, Mendling et al. (2012) describe several advantages related to the use of business process models when cooperating with relevant stakeholders. Apart from combining knowledge, problem-solution-competence and process validation, the cooperative modeling leads to the more precise analysis of requirements and needs, but, as a negative side-effect, can increase the completion time due to additional negotiations (Mendling et al. 2012).

Since the sensing capability mainly involves information collection and evaluation, *BIS* and *KMS* are considered as major drivers of innovations (Ghaffari and Aubert 2016). In particular, *BIS* enable knowledge creation based on aggregated data and information, resulting in better problem understanding (Ghaffari and Aubert 2016). The collected information on customers, partners, employees, key performance indicators and service level agreements, competitors and internal expertise build the foundation of problem definitions and solutions in the SIP (Majchrzak et al. 2013). As actors have their own strategies to deal with problems, which are often based on their own experiences, the process of solving the problem is limited by the knowledge of the actors (Chai et al. 2005; Karacapilidis and Papadias 2001). Cooperative decision-making processes can, therefore, extend the solution competence.

Bullinger et al. (2003) suggest that external and internal knowledge should be conducted both before and during the SIP. *KMS* enable the aggregation and interpretation of data generated in *BIS*, *WSS*, and *GSS*, making gathered expertise available on demand, hence building a *KMS*-supported infrastructure is inevitable (Ghaffari and Aubert 2016; Kleis et al. 2012; Liang et al. 2015). In this context, knowledge networks accumulate expertise of customers, competitors, partners and academia and therefore potentially improve SIPs (Shang et al. 2009).

Finally, targeting opportunities for the innovation of services requires analysis of customer needs and problems as well as the integration of external knowledge (Kleis et al. 2012; Pöppelbuß et al. 2011), which can be supported by the *GSS*. In order to gather this information beyond organizational boundaries, tools are needed to manage feedback, ideas, and information received from the different channels (Kleis et al. 2012). Within GSS, relevant conversations can be recorded and analyzed, making former and future

decisions more comprehensible and transparent (Ellison et al. 2014; Majchrzak and Malhotra 2013; Mendling et al. 2012; Treem and Leonardi 2012). With this regard, the ability to create appropriate channels and platforms via social media and (open) innovation networks, thus intensifying internal and external information flows, is increasingly regarded as a success factor in the SIP. (Charband and Navimipour 2016; Liang et al. 2015; Malhotra and Majchrzak 2012) . Such networks enable customers, employees and other stakeholders to communicate their needs, problems, and preferences (Kleis et al. 2012; Mendling et al. 2012; Pöppelbuß and Malsbender 2013), thereby being a critical success factor for enterprises in the context of knowledge formation and innovation (Kleis et al. 2012). Accordingly, it is important to build an infrastructure capable of storing and viewing internal and external knowledge as it would not be possible using physical resources (Ghaffari and Aubert 2016; Liang et al. 2015).

Implications for the sensing activities

Now that the bridge between different types of IS and the general SIP process has been created, implications specifically for each of the sensing activities (table 1) can be synthesized.

Dissonance: Within the scope of the dissonance capability, cognitive conflicts (i.e. confrontation with new information that contradicts prior beliefs and ideas) are identified, which initiate the SIP (Stevens and Dimitriadis 2005). To determine such conflicts within the service process or the whole organization in a structured way, the process and the corresponding internal and external information must be evaluated. If modeled appropriately, such process can be monitored and evaluated with the help of WSS (Klingner and Becker 2014; Mendling et al. 2012; Recker et al. 2013). Furthermore, a review of the process can be carried out jointly with customers for the purpose of possible problem identification (Mendling et al. 2012). In addition, information about the process can also be collected in BIS, e.g. CRM and ERM provide an overview of customer relationships and responsible employees, who are both valuable contacts in the identification of inconsistencies (Meiren and Barth 2002). If customer communication is supported by information systems (GSS), data collected here should also be used for the assessment of innovations (Kleis et al. 2012; Lusch and Nambisan 2015). All three systems make it possible to preserve process-related information over a longer period and make it accessible for different stakeholder groups. These functions may also enable a joint analysis and discussion of cognitive dissonances, and, therefore, can improve the overall communication and information quality.

Formulation: Medium to long-term decisions are made on the basis of extensive analysis (Gebauer et al. 2005). Not only the preservation of information is relevant for the analysis, but also understanding and recreating the origins and development of discussions and decision-making processes (Ellison et al. 2014; Treem and Leonardi 2012). Strategy and goal-setting are knowledge-dependent activities and, therefore, depend on the experience of their process participants (Lusch and Nambisan 2015; Reckenfelderbäumer and Busse 2006). To include external experts and stakeholders in the process and to secure results, GSS may be used. Additionally, knowledge can be secured and made available as an intangible resource through the use of KMS (Kleis et al. 2012).

Learning: In the sensing capability context, the service delivery process needs to be documented and audited in order to provide impulses for the service innovation (Bitran and Pedrosa 1998). As auditing is an iterative process (Tax and Stuart 1997), it is important to preserve knowledge and insight continuously. Here, the application of WSS, GSS, and KMS can be helpful. For example, WSS offer the possibility to map and analyze detailed process models and incorporate key performance indicators to improve feedback (Bernhard 2015; Klingner and Becker 2014). Similarly, GSS enable association between users and content, which improves the traceability of input and may encourage customer, employee or other stakeholder contribution (Pöppelbuß and Malsbender 2013). Finally, content such as feedback and suggestions for improvement can be supplemented and further developed by and with other participants (Treem and Leonardi 2012). Such generated knowledge can be, therefore, recorded in KMS and used for decision-making or strategy development (Charband and Navimipour 2016; Malhotra and Majchrzak 2012).

Needs and options: Most service innovations are developed in response to unsatisfied needs of existing and potential customers or based on technical impulses (den Hertog et al. 2010). This identification can be supported by IS (den Hertog et al. 2010; Kleis et al. 2012; Seidel et al. 2013; Shang et al. 2009), in particular, GSS and BIS, since information about customers can be collected and utilized in the SIP context. The function of creating and editing content over a period of time makes it possible to form precise contributions

by employees and customers. This also applies to the exchange and discussions between external and internal experts in BIS, GSS, and KMS systems to evaluate new technical options.

(Un-)Bundling: A further key competency in the context of the SIP is the bundling, recombination, and simplification of elements of existing services (den Hertog et al. 2010; Klingner and Becker 2014; Lusch and Nambisan 2015). In certain WSS, these elements can be decomposed into their properties, and later recombined to satisfy the individualized customer requirements (Karacapilidis and Papadias 2001; Klingner and Becker 2014). By using graphical process models, key figures and the documentation of the properties, transparency and analysis impulses are created (Klingner and Becker 2014; Rehm et al. 2014; Yu et al. 2008). It can be assumed that these action potentials can also be implemented with the use of KMS, which do not have any modeling functions but rather present text-based properties and thus enable the exchange of experts (Rehm et al. 2014).

Co-development: As already presented, the involvement of customers, suppliers, employees, and stakeholders is of high relevance for most dynamic capabilities (Den Hertog et al., 2010). Since different actors do not necessarily want to share their information with one another, the management of information and knowledge within the network, in particular, securing interests and data authority, are sensitive subjects (Den Hertog et al., 2010). In this context, departmental or organizational tasks and projects can be designed more transparently using WSS (Bernhard 2015; Klingner and Becker 2014). Simultaneously, BIS, GSS, and KMS should continuously collect data as well as information about the relationships between users and content, in order to make the thought processes comprehensible for all parties involved (Majchrzak et al. 2013; Treem and Leonardi 2012). This, in turn, can lead to increased generation of ideas and content (Pöppelbuß and Malsbender 2013), since information is easier understood and the complexity of the tasks is reduced (Koch et al. 2012; Malhotra and Majchrzak 2012). Finally, comment functionalities enable users to give each other feedback (Pöppelbuß and Malsbender 2013) and further develop ideas and contributions.

Problem definition: Problems identified during the sensing phase may be decomposed into useful and harmful sub-functions using IS (Chai et al. 2005). The use of IS in this context improves the subsequent generation of ideas through a more structured approach (Chai et al. 2005). The detailed description of the problem within the IS plays a central role, as it makes relevant information available to stakeholders, thus enabling a comprehensive, long-term analysis that provides a better understanding of the original problem, which, in turn, stimulates the generation of innovative solutions (Chai et al. 2005). Other WSS and KMS with CAD function can provide similar potentials regarding the analysis of sub-functions (Karacapilidis and Papadias 2001) and, therefore, enrich the SIPs.

	WSS	BIS	GSS	KMS
Dissonance	x	x	x	
Formulation		x	x	x
Learning	x		x	
Needs and Options		x	x	x
(Un-)bundling	x			x
Co-development	x	x	x	x
Problem definition	x			x

Table 2. Implications for sensing activities

Summarized, we identified multiple use cases in literature that explain the positive impact of IS support on SIPs (table 2), which formerly was agreed upon by Bullinger et al. (2003) and verified by Plattfaut et al. (2015). This research elaborates concise interrelations between SIP's success and IS support, clarifying their relationship by bridging findings from service innovation and IS literature. Primarily the relationship between SIP and IS seems to be originating from the facilitating functions of IS, tackling present issues such as information overflow, inter- and intra-organizational interdependencies and the resulting overwhelming complexity.

Conclusion

Despite the evident and recognized value of the service innovation for the competitiveness and the long-term growth of the service provider, both academia and the practice have not devoted the necessary attention to the analysis of the actual SIP. In particular, the use of IS as a mean to support this process, consisting of the phases sensing, seizing and transformation, remains under-researched. To cover this gap, our research helps to develop a better understanding of the general utility and objectives of specific activities, to support employees using IS to improve SIP substantially. We specifically address the phase of sensing, since we believe that using appropriate IS in this phase has the highest potential for supporting the employees to cope with the growing information overflow from the market.

Although the use of functional IS classes is criticized in research (Barron et al. 1999), this classification continues to be widely used in literature (Faraj and Azad 2012). Hence, we provided a simplified framework consisting of BIS, WSS, GSS and KMS that is sufficient to show the relationship between the IS and the sensing activities within the SIP, which states the main contribution of this research. Our results improve the understanding and necessity of the IS application, thus promoting their use in the SIP context. As sensing is the first step of the SIP, further research should concentrate on the remaining phases "seizing" and "transformation" as well as the transition from one phase into another. Furthermore, it is unlikely that a literature-based analysis will provide sufficient information to understand the complex interrelations between IS and SIP comprehensively. Therefore, we recommend examining the role of IS in SIP empirically in further research. In addition, it is worth mentioning that this research lacks a differentiation between service providers based on certain characteristics (e.g. industry, company size). Further differences could arise particularly for more complex industrial services (Yu et al., 2008), although it is assumed that most of the results obtained can be transferred to the SIP in the business-to-business area, and may be tested for use in a product innovation context.

As this work examines the relationship between IS and SIP with the theoretical lens of DC from an economic-strategic perspective, the analysis of IT-supported SIP from a sociological perspective could open up new vistas. Against this backdrop, the application of the theory of functional affordances could lead to new findings regarding the impact of the use of IS in organizations and therefore can explain in particular *how* IS contribute to services innovation (Seidel et al. 2013). Thus, this theoretical perspective requires consideration of the human component and the offered action possibilities of an IS (Faraj and Azad 2012). This lens specifically focuses on user capabilities, goals and motivations, and analyses how and why users utilize features differently. Thus, the focus is not just on functions of technical components of IS (technical subsystem), but also on the perception of IS by people in a particular use context (social subsystem), e.g. the sensing activities within the SIP (Faraj and Azad 2012; Majchrzak and Markus 2012). We believe that detailed insights on functional affordances are a critical factor in order to understand how the application of IT supports SIP. In particular, the IS affordance could help to identify socio-technical action potentials, which are necessary for a better understanding of potential effects on process performance. Finally, this conceptual paper contributed to the ongoing discussion on the SIP, thus calling for more research on the use of IS in this context. Our findings on the upper mentioned relationship shall, therefore, be tested empirically (e.g. with the help of case studies or action research) with various B2B and B2C service providers.

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