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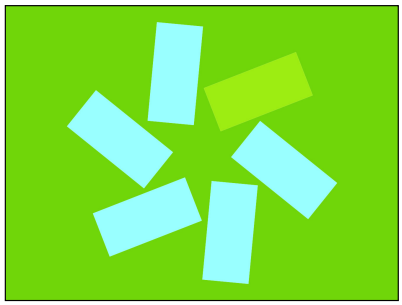
February 2015



2014 RESER Conference Logo

Technology in Service Innovation

Welcome to the February 2015 issue of the *Technology Innovation Management Review*. This month's editorial theme is Technology in Service Innovation. We welcome your comments on the articles in this issue as well as suggestions for future article topics and issue themes.

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Overview

The *Technology Innovation Management Review* (TIM Review) provides insights about the issues and emerging trends relevant to launching and growing technology businesses. The TIM Review focuses on the theories, strategies, and tools that help small and large technology companies succeed.

Our readers are looking for practical ideas they can apply within their own organizations. The TIM Review brings together diverse viewpoints – from academics, entrepreneurs, companies of all sizes, the public sector, the community sector, and others – to bridge the gap between theory and practice. In particular, we focus on the topics of technology and global entrepreneurship in small and large companies.

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About TIM

The TIM Review has international contributors and readers, and it is published in association with the Technology Innovation Management program (TIM; timprogram.ca), an international graduate program at Carleton University in Ottawa, Canada.

Editorial: Technology in Service Innovation

Chris McPhee, Editor-in-Chief

Stephen L. Vargo, Marja Toivonen, and Risto Rajala, Guest Editors

From the Editor-in-Chief

Welcome to the February 2015 issue of the *Technology Innovation Management Review*. The editorial theme of this issue is **Technology in Service Innovation**, and I am pleased to welcome our guest editors: **Stephen L. Vargo**, Distinguished Professor and Chair of Marketing at Shidler College of Business in Honolulu, Hawaii, **Marja Toivonen**, Research Professor at VTT Technical Research Centre of Finland, and **Risto Rajala**, Assistant Professor at Aalto University in Helsinki, Finland.

This issue is an outcome of the 2014 Annual Conference of the European Association for Research on Services (RESER; reser.net), which was held last September in Helsinki, Finland. RESER is a network of research groups and individuals active in services research and policy formulation. Our previous collaborations with RESER resulted in two issues of the TIM Review on Service and Innovation in April 2014 (timreview.ca/issue/2014/april) and May 2014 (timreview.ca/issue/2014/may).

The 2015 RESER Conference (reser2015.dk) will be held in Copenhagen, Denmark, from September 10–12. The overall theme of this year's conference will be "Innovative Services in the 21st Century", and it will be preceded by a doctoral colloquium (tinyurl.com/npzfjd5) from September 8–9, 2015. The deadline for submitting abstracts is May 11; please see the Call of Papers (tinyurl.com/kbdasme) for the conference themes and details of the submission process.

In March, our guest editors will be **Brendan Galbraith**, a Senior Lecturer, from Ulster University Business School in Belfast, Northern Ireland, and **Nadia Noori**, EU Researcher at BES La Salle – Roman Llull University in Barcelona, Spain. The March issue is based on articles selected and adapted from the 2014 International Conference on Engineering, Technology and Innovation (ICE) Conference, which took place in June 2014 in Bergamo, Italy. Dr. Galbraith is the Chair of the 2015 ICE Conference (www.ice-conference.org), which will be held from June 22–24 in Belfast. Note that the submission deadline for this conference is March 1st.

We hope you enjoy this issue of the TIM Review and will share your comments online. For future issues, we welcome your submissions of articles. Please contact us (timreview.ca/contact) with article topics and submissions, suggestions for future themes, and any other feedback.

Chris McPhee
Editor-in-Chief

From the Guest Editors

As a key enabler of business operations, technology drives service innovation and provision in the contemporary business landscape. Digitalization has facilitated the emergence of information-intensive service processes and the increasing connectivity of actors in a variety of service systems. Moreover, technologies have greatly influenced the design of service-based business models across industries.

The inspiration for this special issue draws from the global interest in the service business and the enabling technologies and infrastructure that make service business models a moving target for research and practice. Along with the developments in technology, efforts to advance our understanding of what is valuable to customers and how value is co-created in service systems have emerged as core themes in the research of service.

However, the processes by which value is created and co-created in the era of digitization are not comprehensively understood. The role of information technology in service innovation is of particular interest, because the increasing information intensity of services will transform into value for the users if service providers are capable of enabling users to benefit from the information in the contexts of use. Also, the service providers may benefit from the increasing volume and velocity of information by improving their own operations through effective management of service-related information.

Editorial: Technology in Service Innovation

Chris McPhee, Stephen L. Vargo, Marja Toivonen, and Risto Rajala

The theoretical backgrounds and research designs of the articles in this issue are rooted in multiple disciplines, including technology studies, industrial marketing, as well as business and management studies. This issue presents research on service by focusing on the interconnectedness of actors and the methods of their interaction in service systems.

We hope that this issue of the TIM Review will shed new light on the role of technology in service businesses, which is important for both research and practice. The articles included in this issue represent studies carried out in different geographical areas across Europe and Asia. The issue also has an interesting diversity in terms of research designs and methodological approaches. Many of the findings are generalizable across contexts and industries, irrespective of the geographical area.

In the first article, **Kentaro Watanabe**, **Ken Fukuda**, and **Takuichi Nishimura** of the National Institute of Advanced Industrial Science and Technology of Japan investigate a technology-assisted design methodology for employee-driven innovation in services in a Japanese elderly-care facility context. The article shows that employee-driven innovation is playing an increasingly important role in the service industry by responding to a variety of customer needs across industries. The authors propose a technology-assisted design methodology to promote employee-driven innovation in services and submit that further research is required to examine the activities and technologies that support employee-driven innovation.

In the second article, **Ute Reuter** of the VWA-University of Extra-Occupational Studies in Stuttgart, Germany, explores electronic procurement in service operations. The study highlights the potential for future use of electronic procurement solutions in business-to-business services. The construction of reliable measurement models in the research area of electronic procurement is a major step towards a more rigorous investigation of this important topic.

In the third article, **Chaoren Lu** of Karlstad University, Sweden, with **Wei Geng**, and **Iris Wang** of Southwest Jiaotong University, China, present a study of the role of mobile technologies in creating service experiences in the context of travel service. The article shows that, in some areas of consumer service, the traditional ways of service-provider–user interaction is being replaced by marketspace transactions, where the foundation of customer–provider interaction has changed. In particular, a travel experience can be expanded into the customers' life-long context by appropriate technologies.

In the fourth article, **Sabrina Cocca** of the Fraunhofer IAO Institute and **Ann-Mareen Franke** and **Simone Schell** of BioRegio STERN Management GmbH in Germany describe how a new service offering can be developed systematically using an agile development approach. Through a case of knowledge-intensive business services (KIBS), the article shows that knowledge gained in the early phases of service development plays a key role in agile new service development, and provides valuable information for subsequent testing and prototyping.

In the last article, **Doris Schartinger**, **Effie Amanatidou**, **Laura Pombo-Juarez**, **Günter Schreier**, **Susanne Giesecke**, **Totti Könnölä**, **Ian Miles**, and **Ozcan Saritas** from different European research institutions and universities in Austria, UK, and Spain investigate the critical issues in service and system innovations in the field of personal health systems technologies. The authors show that personal health system (PHS) technologies can enhance public and private health service delivery and provide new business opportunities globally.

Combined, these articles provide an overview of the increasingly important role of technology in service innovation. In particular, the studies shed new light on the ways new communication technologies enable different groups of people, including the users and employees in the service organization, to participate in service innovation. Also, the articles contribute to the understanding of the ways technology changes service procurement and delivery processes. We hope this issue inspires future research on the ways new technologies facilitate service innovation, and the organizational and business performance implications of making use of technology in the processes of value co-creation.

Stephen L. Vargo, Marja Toivonen, and Risto Rajala
Guest Editors

Editorial: Technology in Service Innovation

Chris McPhee, Stephen L. Vargo, Marja Toivonen, and Risto Rajala

About the Editors

Chris McPhee is Editor-in-Chief of the *Technology Innovation Management Review*. Chris holds an MASc degree in Technology Innovation Management from Carleton University in Ottawa and BScH and MSc degrees in Biology from Queen's University in Kingston. He has over 15 years of management, design, and content-development experience in Canada and Scotland, primarily in the science, health, and education sectors. As an advisor and editor, he helps entrepreneurs, executives, and researchers develop and express their ideas.

Stephen L. Vargo is a Shidler Distinguished Professor and Professor of Marketing at the University of Hawai'i at Manoa. He has held visiting positions at the Judge Business School at the University of Cambridge, the University of Warwick, Karlstad University, the University of Maryland, Collage Park, and other major universities. He has articles published in the *Journal of Marketing,* the *Journal of the Academy of Marketing Science,* the Journal of Service Research, and other major journals and has been awarded the *Harold H. Maynard Award* and the *AMA/Sheth Foundation Award* for his contributions marketing theory. Thomson-Reuters recently identified him as one of the *World's Most Influential Scientific Minds* in economics and business.

Marja Toivonen is Research Professor at VTT Technical Research Centre of Finland, her specialty being service innovation and service business models. She is also Adjunct Professor at Aalto University in Helsinki, Finland. Marja has written several articles on service-related topics and been an invited speaker in many international conferences focusing on these topics. She is a council member of the European Association for Research on Services (RESER), and she is a member of the European Union's 2013–2014 High-Level Expert Group on Business Services.

Risto Rajala, D.Sc. (Econ) is an Assistant Professor in the Department of Industrial Engineering and Management at Aalto University in Helsinki, Finland. Dr. Rajala holds a PhD in Information Systems Science from the Aalto University School of Business. His recent research has dealt with management of complex service systems, development of digital services, service innovation, and business model performance. Rajala's specialties include management of industrial services, collaborative service innovation, knowledge management, and design of digital services.

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Keywords: service innovation, system innovation, employee-driven innovation, electronic procurement, customer experience, knowledge-intensive business services, personal health systems, technology, value co-creation

A Technology-Assisted Design Methodology for Employee-Driven Innovation in Services

Kentaro Watanabe, Ken Fukuda, and Takuichi Nishimura

> *"In management, the first concern of the company is the happiness of people who are connected with it. If the people do not feel happy and cannot be made happy, that company does not deserve to exist."*
>
> Kaoru Ishikawa (1915–1989)
> Organizational theorist

The role of employees is becoming more important in managing complex service processes and in serving the variety of customer needs in the service industry. Within efforts to promote innovation in service fields, employee-driven innovation and service design are gaining attention. Though the relationship between employee-driven innovation and service design has been discussed, the effectiveness of service-design methodologies for employee-driven innovation has not been studied sufficiently. In this article, we propose a technology-assisted design methodology to promote employee-driven innovation in services. Through our case study at an elderly-care facility, we confirmed that the proposed design methodology assisted by the communication support system could trigger employee-driven innovation and expand its influence in the service field.

Introduction

The increasing complexity of service processes and the increasing variety of customer needs in the service industry had highlighted the role of employees in promoting innovation. Employees in many service fields are required to respond to customers and other employees both flexibly and autonomously. Their skills and practical knowledge of services are highly important to service innovation. Thus, employee-driven innovation (Høyrup, 2010; Kesting & Ulhøi, 2010) is expected to accelerate the improvement of productivity and quality of services.

The role of employees as a source of innovation is gaining attention not only in management science but also in other research fields, including design research. In addition to research from a management perspective, a service-design approach has strong potential to help employees promote innovation in the service industry. The relationship between employee-driven innovation and service design has been discussed(e.g., Hasu et al., 2011); however, the effectiveness of methodologies of service design for employee-driven innovation and their applicability to employees have not been studied sufficiently.

In this article, we explore a design methodology applicable to employees in service fields for triggering and promoting employee-driven innovation. Most of the existing methodologies in the service design literature are to be applied by professional designers. One of the promising approaches to realize an applicable design methodology for employees is the utilization of information technologies to enhance their capabilities to identify problems or opportunities in services and then represent and diffuse their innovation ideas. We propose a technology-assisted design methodology for employees and conduct a case study to clarify its effectiveness for employee-driven innovation.

This article is structured as follows. In the next section, we provide the theoretical background to this study through a description of existing research into employee-driven innovation and service design, including its technological support. Building on this background, we then propose a technology-assisted design methodology for employee-driven innovation and introduce a case study that illustrates the proposed methodology. Finally, we discuss the results of the case study and provide conclusions.

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Theoretical Background

Recently, it has been commonly noticed that company management is not limited to hierarchical and top-down processes. Particularly for innovation in services, the role of employees who are familiar with the needs of customers and problems in existing work practice is important. Within this context, employee-driven innovation (Høyrup, 2010; Kesting & Ulhøi, 2010) is gaining attention in service industries. According to Kesting and Ulhøi (2010), employee-driven innovation is "the generation and implementation of significant new ideas, products, and processes originating from a single employee or the joint efforts of two or more employees who are not assigned to this task." Though the research on employee-driven innovation is rather new, the features and requisites for employee-driven innovation have been studied through various case studies of business organizations (Rocha, 2010; Teglborg-Lefèvre, 2010). In service industries, healthcare service contexts such as hospitals are common research objects (Telljohann, 2010; Castren & Maijanen, 2013).

Employee-driven innovation can be discussed in relation to the existing theories and methodologies on improving, innovating, and designing practices in workplaces. For example, Høyrup (2010, 2012) highlighted the relevance of employee-driven innovation to organizational learning or workplace learning. Employees constantly attempt to adapt their work practices to the service situations they encounter; this learning process is considered fundamental for employee-driven innovation. And, this process can be considered as an opportunity to improve employability from the employees' perspective (Høyrup, 2010) and as a source of innovation from the management's perspective. Thus, the employees' ability to improve their workplace is a core driving force of employee-driven innovation. The innovation process by employees can be also explained in comparison with existing innovation forms such as "bricolage", an approach to managing problems using the existing resources at hand, and "ad hoc innovation", which refers to a solution to a particular problem posed by a particular client (Castren & Maijanen, 2013; Fuglsang, 2011). These two types of innovations are essential for resource-restricted situations and context-specific problems in service fields.

To promote employee-driven innovation, business managers could apply structured approaches such as an incentive system for employees (Teglborg-Lefèvre, 2010) and workshops to gather innovative ideas (Telljohann, 2010). In addition to these mechanisms, some researchers have studied the personal and cultural aspects of employee-driven innovation, such as how the agency of employees toward changing their work practices can affect activities in employee-driven innovation (Billett, 2012, Brandi & Hasse, 2012).

Service design, on the other hand, has been studied as another trend for innovating services. Service design, or the design of services, has been discussed in various research contexts, such as design research, management, and engineering (Kimbell, 2011; Mager, 2008). Many service design studies take human-centred approaches (Stickdorn & Schneider, 2012). The empathy for users in design thinking (Brown, 2009) is considered as an important element in service design and ethnographic approaches are commonly used to study the stakeholders of the target services. In addition, the recent studies on service design rely more on the active participation of employees based on approaches of participatory design and co-design (Sanders & Stappers, 2008; Steen et al., 2011). Various co-design projects have been conducted, particularly in relation to healthcare services as seen in studies by Garde and van der Voort (2013) and by Steen and colleagues (2011).

Though both of these studies focus on employees as sources of innovation, their approaches have significant differences. First, a different major actor innovates the services in each case. Employee-driven innovation is a bottom-up innovation process by employees who operate services. Though the co-design approach with employees is now appreciated, professional designers still take a major role in service design. As another characteristic of service design research, the methodologies and tools to create and realize new ideas from the practitioners' viewpoints are central. For example, design approaches are more interested in the representation of concepts and ideas. There is a variety of representation forms, including service blueprinting (Shostack, 1984), a miniature of service environments (Garde & van der Voort, 2013) and acting-out that is a kind of role-playing to simulate designed activities (Sunaga, 2009). Through continuous representation or prototyping, concepts of new services can be evaluated and refined (Stickdorn & Schneider, 2012). These methodologies and tools are designed to support the activities of service designers, though they also facilitate the participation of employees in design. However, if these methodologies and tools were available for employees to redesign their own services, it would be an effective way to promote employee-driven innovation.

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Observation and representation

Two methodological approaches in service design are particularly relevant to the context of employee-driven innovation: observation and representation. In service design, external observation and analysis are commonly performed to understand stakeholders and related situations. Meanwhile, in the existing research on employee-driven innovation, reflection is considered as an important process to understand work practices and situations in service fields (Høyrup, 2010, 2012). However, employees' thoughts tend to be focused on their own roles and tasks, and it is not necessarily easy for them to understand the perspectives of stakeholders and related situations by reframing their mindsets compared to the design practice of external designers. Further assistance should be considered, especially for busy employees.

The other methodological approach of service design is representation. Especially in service design, continuous prototyping (or representation) and evaluation by users are considered as important processes (Stickdorn & Schneider, 2012). How to externalize the ideas of employees is rarely discussed in the existing studies on employee-driven innovation, and addressing this challenge could be an important contribution of design research to employee-driven innovation. The externalized design ideas can be used to diffuse design results within the organization. Furthermore, it is unreasonable to expect all employees in service fields to be skilled in representation. Therefore, it is also important to know how to assist representation by employees in service fields.

A Technology-Assisted Design Methodology

In this study, we examine how to assist employees' design activities with information technologies. In the existing literature on employee-driven innovation, the methods and tools are considered to take an important role in promoting innovation activities by employees (Aasen et al., 2012). For example, there have been several case studies on the application of web-based technologies to collect innovation ideas (Teglborg-Lefèvre, 2010; Ackerman et al., 2013). However, few studies further explore technological assistance for employee-driven innovation beyond ways of sharing innovative ideas. Various technologies to support service design have been developed, for example, in the field of service engineering (AIST, 2008). Mobile technologies and ubiquitous technologies would be particularly effective in supporting employees within ordinary work settings in service fields (Frohberg et al., 2009; Kristoffersen & Ljungberg, 1999). These new technologies have a strong potential to enhance the capability of employees for employee-driven innovation.

In this section, we propose a technology-assisted design methodology to enable employee-driven innovation. Figure 1 shows a conceptual sketch of the proposed design methodology. The methodology is based on an autonomous and continuous design approach to service processes and systems by the community of employees: the user-driven product/activity design (UPAD) approach (Watanabe & Nishimura, 2013). The proposed methodology intends to concretize this design concept.

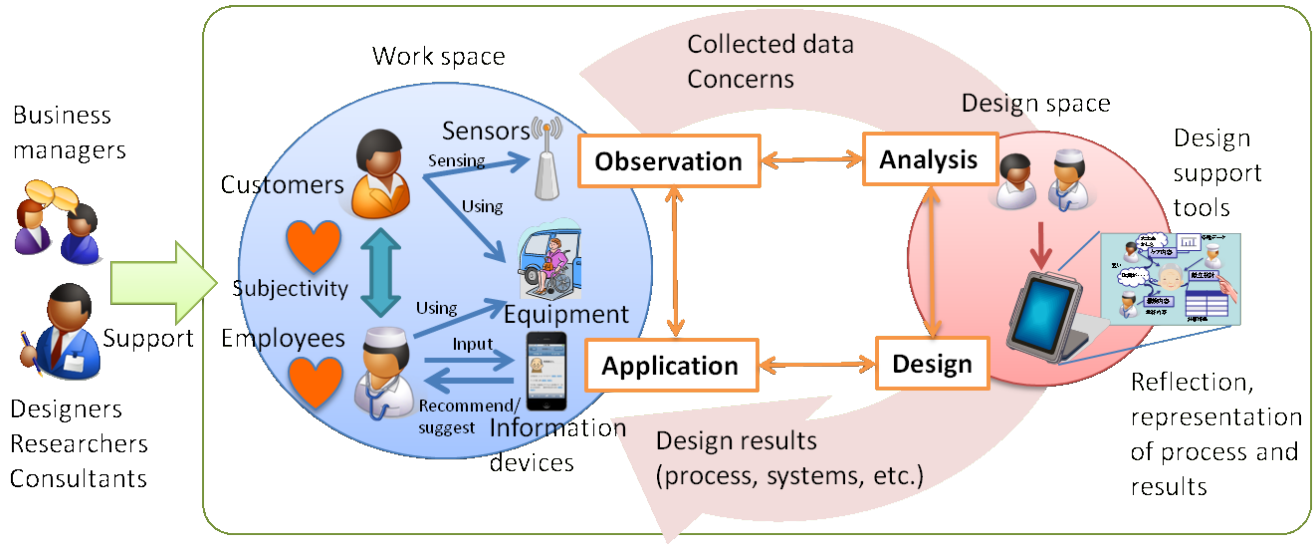

Figure 1. Conceptual sketch of the proposed design methodology

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In this design methodology, a community of employees performs design activities. These activities are supported by business managers and, if necessary, outsources such as designers and consultants, especially in the early stages.

In this design methodology, we define two types of spaces where employees are supported with technologies. The first space is the "work space": an ordinary work setting for employees, where actual service processes and encounters with customers are held. The second space is "design space": any kind of situation to reflect and redesign services by employees. Design space includes not only workshops or formal meetings set specifically for employee-driven innovation, but also informal meetings or even chats among employees relating to their specific concerns. These casual occasions arising from "in-line" activities (Høyrup, 2012) could create new findings and sources of innovation. Design spaces could emerge anytime and anywhere, and it is important to support design activities when and where they emerge.

Related to these spaces, concrete design activities are defined in this methodology. They are described as a design cycle with four phases: observation, analysis, design, and application. These phases are determined using the notation of the optimum design loop (AIST, 2008). As Figure 1 shows, these design phases are not necessarily a one-way process but they could proceed back and forth through the cycle.

1. Observation
Understanding the current status of a service is an important step in redesigning it. Observation is usually conducted by a third party, but in this methodology, employees themselves mainly observe their own service activities. Therefore, the observation in this methodology means self-observation by employees and mutual observation among employees.

To observe changing situations in a work space is not easy for employees. In addition to the complexity of services, the localized concerns of employees in their own tasks make it difficult to have an overview of their own services (Kesting & Ulhøi, 2010). Technologies can be used to support the observation phase, including sensors and information devices. The obtained data become a source to understand stakeholders and situations in busy daily work. Meanwhile, the subjectivity of employees – such as their concerns, perspectives, and feelings – strongly affects the performance of services. To understand stakeholders amidst this subjectivity, the following analysis phase is important.

2. Analysis
For the deep understanding of services, reflection by employees takes an important role. Design spaces provide opportunities not only to reflect on their service practices individually but also to share their perspectives and information to understand the current services from multi-dimensional aspects. For this purpose, the group representation of services is effective. For example, a representation tool to gather employees' perspectives on concerned issues has been proposed (Watanabe et al., 2014). In addition, the observed data could work as potential sources to understand the situations in service fields. By applying the analytical method to these data, such as a statistical and time-series analysis (Miwa et al., 2012), a new viewpoint could be provided that reveals new issues to be discussed.

3. Design
Based on the results of the analysis phase, employees discuss how to change services. The design objects could be service processes, jobs, team arrangement, and IT systems used in services. The representation of design objects by employees takes an important role in this design phase also. By representing required situations and how to realize them, employees can concretize their ideas. However, employees in service fields are not necessarily familiar with the representation methods of these design results.

To apply a support tool for employees to represent their services, its representation form should be flexible enough to express the employees' mental models (Watanabe et al., 2014). In addition, simple and instant representation is also important for its use by busy employees. By using this kind of tool, representation of concerned issues and design results can be stored. They can be used as a stock of practical knowledge in work spaces.

4. Application
Represented design results, such as new service processes, roles, and rules, should be disseminated to employees for their application in work spaces. This process has not been discussed sufficiently in the design research and the employee-driven innovation research. Given that the proposed methodology is conducted in an ordinary work setting, it should be straightforward to apply its results through the support

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of certain technologies. A communication support system using, for example, mobile devices can be used for the application of design results. An education system such as an e-learning system would be also a promising technology for this purpose. The applied design results are verified by using newly collected data in work spaces.

Case Study: An Elderly-Care Facility

Here, we illustrate the proposed methodology using a case study of Wakoen, a long-term care facility for elderly people. Located in Noto area of Japan, the facility contains three floors (work spaces) and 150 beds, and approximately 10 employees work on each floor. We have been conducting a co-design project with several employees to develop a mobile communication system for an elderly-care service provided by employees (Watanabe & Nishimura, 2013). In this facility, various kinds of informal information for elderly care, such as requests from a resident's family, used to be shared with paper notebooks. This new communication system, named DANCE, was designed and developed for timely communication support to replace the notebooks. Figure 2 shows sample screenshots of DANCE. This project also aimed at realizing the UPAD approach (described earlier) to promote the employees' design activities relating to service processes and systems used in the facility (Watanabe & Nishimura, 2013). We started by facilitating a user community consisting of employees. After continuous prototyping through their active participation, DANCE was deployed and has been used in the facility in an official capacity since February, 2014. Instead of paper notebooks, the new system uses approximately 23 iPod Touch and iPad devices.

There are two main functions in the DANCE system (Nishimura et al., 2013). The first function of DANCE is to create and share handover information about the care of residents, such as texts, photos, and voice recordings. DANCE can recommend candidates of related message examples based on the stored messages. Users of DANCE can also search for the handover information of a particular person by choosing recommended keywords. After checking handover information, users can leave a message as a reply or as additional information with texts and photos. The second function is to check and edit "face sheets", which are used to record a number of requirements for care relating to a resident's health, diet, and equipment needs, or other care notes for specific circumstances.

After deploying the DANCE system, we analyzed the change of employees' activities according to the proposed methodology. In addition, we analyzed data in DANCE and shared it with several Wakoen employees in a workshop, which provided an opportunity for them to reflect and redesign their work.

Figure 2. Screenshots of DANCE

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Results

Analysis of the design cycle using DANCE

DANCE is a communication medium for employees and it stores messages sent by them. These messages can be used to understand the current status of the service in the observation phase according to the proposed methodology. In addition, DANCE contains several functions for representation, such as the photo function. Thus, we wished to investigate how these functions may have been used in design activities also.

To confirm how DANCE was used in relation to the proposed design methodology, we conducted semi-structured interviews with a manager and four members who participated in the design of DANCE. The interviews focused on the changes in service practices after the system was deployed. We also analysed how the photo function was used in the elderly-care facility. The data from DANCE used for the analysis was collected from May 1st to June 11th, 2014. Through these studies, we attempted to confirm how employees represent their ideas in the design phase and how DANCE was utilized for these purposes.

From the interviews with the employees, we obtained several remarks on how the proposed methodology and DANCE were utilized for employee-driven innovation. First, the photo function of DANCE changed the communication on service activities among the employees. Some of the employees used to add drawings to the notebook on how to care for certain residents. By using the photo function of DANCE, employees were able to better understand the situation and to more easily explain how to assist with eating and how to support the posture of a certain resident. This function encouraged them to share their ideas about innovating their services.

The shift from a notebook to a mobile device also changes the timings to check and input handover information. Nurses and physical therapists who work at several work spaces mentioned that it had become easier to check the situations in each work space in advance. They could not bring their devices with them during work – usually because of the limited number of devices. But, in comparison to the notebooks, which used to be located in each work space, employees were able to check messages more frequently.

As other remarks, the interviewees noted messages sent frequently with similar contents. This observation indicates that these messages should be emphasized to promote discussion. In addition, the DANCE system clarified which employees had read messages left for them. When they used notebooks, this was not recognized correctly. From the interviews, it was confirmed that a remaining challenge was how to let all of the employees read the messages.

The interview results showed that the photo function was used mainly for design and application of service activities. The analysis of photos in DANCE revealed that employees wrote down work processes or how to care for a specific resident on a piece of paper, which they then photographed and sent to the other employees. For example, one worker used this method to send handover information on how to take a resident to a bathroom for several occasions (daytime and night time). To indicate important points about care, employees also used an additional drawing function on photos, which allowed them to show, for example, how to set a pillow on a bed for the comfort of the resident. From these examples, we observed that the design results of service activities were effectively represented and shared among employees.

Workshop based on the analysis of DANCE data

DANCE does not contain the analysis method of obtained data. Therefore, it is difficult to obtain findings on the analysis phase through interviews and analysis of the photo function. Thus, to clarify the effectiveness of data analysis, we conducted a workshop with several employees in which we showed them the results of the co-occurrence network analysis performed on DANCE data of residents about whom workers frequently commented using the system. The co-occurrence network analysis identifies frequently used words and their relationships, which are then visualized in a graphical form. The results enabled the employees to reflect upon and redesign their work.

The participants in the workshop focused on major words in the co-occurrence network, such as: "visit", "husband", "eat", and "without notifying". These keywords reminded them of messages sent frequently in relation to a particular resident, such as: “the husband helped her eat without notifying care workers”. This resident had difficulty in swallowing and needed assistance from care staff when eating. However, her husband helped her eat without notifying care staff, which could increase the risk of incidents, such as choking.

After the discussion among employees with different roles, they decided to allow her husband to help his wife eat, but only in the dining room. To prevent an incident,

they designed their care work to adjust the posture of the resident before eating and to tell her husband not to bring other food such as snacks. The DANCE system was used to send this result to every employee. After this change, no further messages related to this issue were sent.

Discussion

In this article, we propose a design methodology with four phases to promote employee-driven innovation. The observation phase in this case study was related to collected data on service situations and operations with DANCE. These data were continuously accumulated and utilized in the analysis phase. In the workshop, the co-occurrence network analysis was able to visualize the issues to be discussed, and the extracted keywords were able to remind employees of the problems in their services. This empirical result highlights the effectiveness of technological analysis in creating an opportunity to reflect on service practices, and as a result, to trigger employee-driven innovation.

In the design phase, the employees represented a number of design results to innovate their work processes. These results were developed not only in the workshop but also during the ordinary work. This point illustrates a feature of the design space: it can emerge anytime and anywhere. In addition, many of these design results were based on the existing resources of employees and therefore can be considered as examples of bricolage (Fuglsang, 2011). We also found that using photos is effective as a means of representation for those who are not accustomed to visual representation. More importantly, the representation results were immediately sent to every employee. This application phase was sufficiently supported by DANCE. The handover information was shared more frequently with DANCE according to the interview results relating to the ease of access to information. This finding shows the effectiveness of adopting the representation method of service design and the communication support among employees. The employees were able to show their innovation ideas to other employees, which could promote employee-driven innovation in the service field.

These results indicated that the proposed four phases of the design methodology could be performed with the support of information technologies. It was also confirmed that the analysed data from information technologies (DANCE, in this case study) could trigger employee-driven innovation. In addition, the influence of employee-driven innovation could be increased with the representation method and the communication support system by diffusing innovation ideas in service fields.

The case study illustrates the applicability of the proposed design methodology to the actual service. In addition, we identified several practical implications. First, the adaptation of information technologies would require time and effort. From the interview results, the DANCE system clarified that some employees had not used it effectively. Meanwhile, it becomes possible to know how many people actually use information technologies for employee-driven innovation. Based on these data, adaptations to these technologies can be considered.

It should be also noted that this case study was conducted after the long-term co-design project. Thus, the employees already have sufficient motivations to utilize DANCE in their work. Although the proposed methodology and DANCE are effective in illustrating required activities and in assisting employee-driven innovation, there remains the important question of how to develop a creative culture and motivate employees. The visualization of current situations in service fields, as was performed in this case study, may be one promising approach.

In this case study, we only used DANCE as a data source for observation and analysis. Further studies are required to investigate the influence of using different kinds of technologies, such as sensing devices. Here, DANCE was applied as a replacement for existing media, so there were few adverse effects. But, in other situations where technologies are introduced to collect new data from the service field, the range of application and access to these data should be designed adequately. This issue should be considered in future research. In addition, the proposed methodology should be applied to other service fields to confirm its versatility.

Conclusion

In this article, we explored how employee-driven innovation could be triggered and promoted with the methodology of service design and related technologies. We first introduced the theoretical background of employee-driven innovation and service design, which we then used as the basis for proposing a technology-assisted design methodology to trigger and promote em-

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ployee-driven innovation. This methodology includes four design phases: observation, analysis, design, and application, and it requires information technologies for each phase.

To clarify how the proposed methodology trigger and promote EDI, we conducted a case study at an elderly-care facility. From the results of interviews with the employees, the data analysis of the communication support system, and the workshop to redesign services, we confirmed that the proposed methodology triggered employee-driven innovation and the designed innovation ideas were diffused in the service field with the support of the communication support system and its representation function. In future works, we intend to conduct further case studies with other kinds of technologies to promote innovation in service industries.

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Implementation Prerequisites for Electronic Procurement of Services

Ute Reuter

> *"But with lots of good ideas, implementation is the key."*
>
> Mitchell Reiss
> 27th President of Washington College

Service procurement is a business function of increasing importance and is highly suitable for integration of electronic support, but it suffers from severe research deficits. As yet, implementation prerequisites for electronic procurement of services are obscure and not quantifiable. In this research project, organization, formalization, and specialization of procurement and standardization and strategic importance of the procured services are identified as relevant implementation prerequisites. Measurement models for these prerequisites are established and proven through quantitative empirical research. As such, this article is a major step towards a more rigorous investigation of electronic procurement of services.

Introduction

Procurement is highly suitable for the integration of electronic support (Wu et al., 2003) as long as the information and communication technology (ICT) systems of the purchasing company and the potential subcontractors are compatible (Rajkumar, 2001). In reality, however, the actual implementation of ICT in the procurement process usually leaves much to be desired (Quale, 2005). Accordingly, procurement of services is a business function of increasing importance (Hallal et al., 2010). Yet, in spite of this importance, questions of electronic procurement of services suffer from severe research deficits (Bensch & Schrödl, 2011; Reuter, 2013).

This lack of scientific studies in electronic procurement of services is confronted by the research project on hand, which concentrates on the implementation prerequisites of electronic procurement of services arising from the organization's structure or the specific nature of the service. The research project is situated at an interface area between procurement, innovation, and service research, while also integrating aspects of business informatics. A clearly defined research framework and clearly operationalized dependent and independent variables are the prerequisites for empirical testing of assumptions. Suitable operationalization implies the existence of statistical measurement models. As yet, no such measurement models exist for the implementation prerequisites of electronic procurement of services.

Therefore, the main objectives of this research project are twofold. First, to identify the organizational structures within a company that are relevant for the implementation of electronic procurement of services from a theoretical perspective. And second, to establish and validate measurement models that allow testing for the connection between these organizational and service-related structures and the implementation of electronic procurement of services from a quantitative-empirical perspective. To reach these goals, the research project focuses on the users of electronic procurement applications. The focus on the application users is one of the four relevant foci within publications concerning electronic procurement of services, see Azadegan and Ashenbaum (2009). The precise research question that is answered in this article is:

> *Which prerequisites are important for implementing electronic procurement of services?*

In the background section, possible implementation prerequisites arising from the organization's structure or the specific nature of the service are derived from theory. Then, measurement models based on reflective, multi-dimensional constructs are built, refined, and proven through quantitative empirical research. In the following section, the survey results are evaluated with explorative factor analysis and discussed in detail. Finally, the scientific importance of the findings is underlined and managerial advice is given.

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Background

To truly understand how a company is functioning, intimate knowledge of organizational processes is crucial (Levitas & Chi, 2002). Access to external resources has a direct influence on strategic decision making within a company (Gilbert, 2005) – this holds true with procurement given that the resources of the purchasing company and the external resources from subcontractors and intermediaries are vital for the whole procurement business. However, cross-company resource requirements often conflict with internal needs. Hence, relational aspects are important. Reuter (2013) offers insights into electronic procurement of services from a relational resource-based perspective, which in this case depicts the integration of the relational view (Dyer & Singh, 1998) into the resource-based view (Lavie, 2004). This line of theory integration is apt because purchasing and supply management research is, at the moment, unable to provide insights into the management of subcontractors as external resources (van Weele & van Raaij, 2014).

The company-specific organizational structure directly influences the scale and scope of innovative action within a company and has a strong influence on the implementation itself and on the extent of application of electronic procurement tools (Reuter, 2013). Organizational structures influence capabilities, motivation, orientation, and attitude of employees. A firm's sustainable competitive advantage depends on its organizational capital. Organizational capital consists of different structural dimensions. Centralization, formalization and specialization are very important in this context (Jansen et al., 2006).

Their importance leads to the first three possibly relevant implementation prerequisites, which are described in the subsections that follow.

Implementation prerequisite 1: Centralized organization of strategic procurement
Many companies organize procurement in a centralized, specific procurement department (Axelsson & Wynstra, 2002). The employees' direct influence on strategic procurement leads to easier implementation of new ideas and enhances the innovation potential in procurement. Learning effects become apparent, especially in the implementation of new technologies and software solutions. From a financial perspective, centralization is beneficial as well. Centralized procurement improves the bargaining position of the firm. Demand bundling allows better procurement conditions in general and discounts in software procurement in particular (Brandel, 2010).

Implementation prerequisite 2: Formalization of procurement
Employees do their work in accordance with the roles ascribed to them (Hage & Aiken, 1967). Organizational learning and sustainable development both depend on tasks, rules, methods, and orders that are put into writing (Child, 1972). The more specific a certain task – such as electronic procurement of services – the easier it can be unambiguously described. Task specifity is the very basis of role description and increases the formalization potential of rules. To abide by these formalized rules is vital for the viability and operability of a company (Hage & Aiken, 1967). Unclear descriptions lead to confusion and disarray, which in turn, give rise to role ambiguity. In a formalized organizational structure, each employee knows what to do; this clarity simplifies decision making (Sine et al., 2006) and organizational learning.

Implementation prerequisite 3: Specialization of procurement
Organizations learn from the experiences their employees have made in former electronic procurement assignments. Especially in electronic procurement of services, specialization of employees is crucial for the efficiency of the procurement process as the knowledge basis expands and the number of specialists rises. A high number of procurement department employees, who are specialists in electronic procurement of services, raises the importance of electronic procurement of services within this firm (Reuter, 2013).

Constitutive characteristics of services can lead to notable differences in the implementation of electronic procurement of material and services. Procurement of services needs more information on the services to be procured than procurement of material. The consideration of service-related aspects is a major success factor in procuring services (Large & König, 2009). Therefore, the next two possibly relevant implementation prerequisites are identified, as described in the subsections that follow.

Implementation prerequisite 4: Standardization of services
The degree of standardization of services determines whether the services-to-be-procured can be adequately compared with each other. In spite of numerous examples of service standardization efforts, efficient, practically relevant approaches were not to be seen in the past and are still rare now (Reuter, 2013). If a service is standardized already, its degree of standardization can

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be identified. A highly standardized service can be procured electronically without further amendments. In this case, the respective service can be easily described. The risk of potential inefficiencies caused by inadequate description of services is minimal in this case (Ancarani & Capaldo, 2005).

If a service is not yet standardized, information about its standardization potential is sought after. A service with a high standardization potential can be easily described and can then be purchased electronically. To decide which service has a high standardization potential, the employees have to be very familiar with the services. Otherwise, misunderstandings are inevitable. In the worst case, such a misreading can result in the procurement of services that do not meet the quality standards of the procuring company. Or, the company who wins the bid (in case of an electronic auction) is not prepared to produce the offered services in the relevant time-frame because time-consuming adjustments become necessary (Reuter, 2013).

Implementation prerequisite 5: Strategic importance of services

The constitutive characteristics of services determine the degree of strategic importance of the services in question (Daub, 2009). The higher the strategic importance of a certain service, the lower seems the incentive to procure this self-same service externally. Concurrently, if the extent of external procurement of a service is low, the utilization of electronic procurement is even more improbable. The strategic importance of services (Aurich et al., 2010) seems to be another viable implementation prerequisite of electronic procurement of services.

Empirical Methodology

Measurement models for the different variables were created based on reflective, multi-dimensional constructs (Figure 1). These constructs condense and summarize the relevant items. Next, the measurement models depicted in Figure 1 were refined and proven through quantitative empirical research.

The construction of the measurement models requires the operationalization of the underlying constructs. Table 1 provides an overview of the constructs in the hypotheses that represent the implementation prerequisites originating from the organizational structure and the specific nature of the service. As a rule, all indices are built from several items (Curtis & Jackson, 1962). Furthermore, all underlying items are adjusted to the context of services procurement.

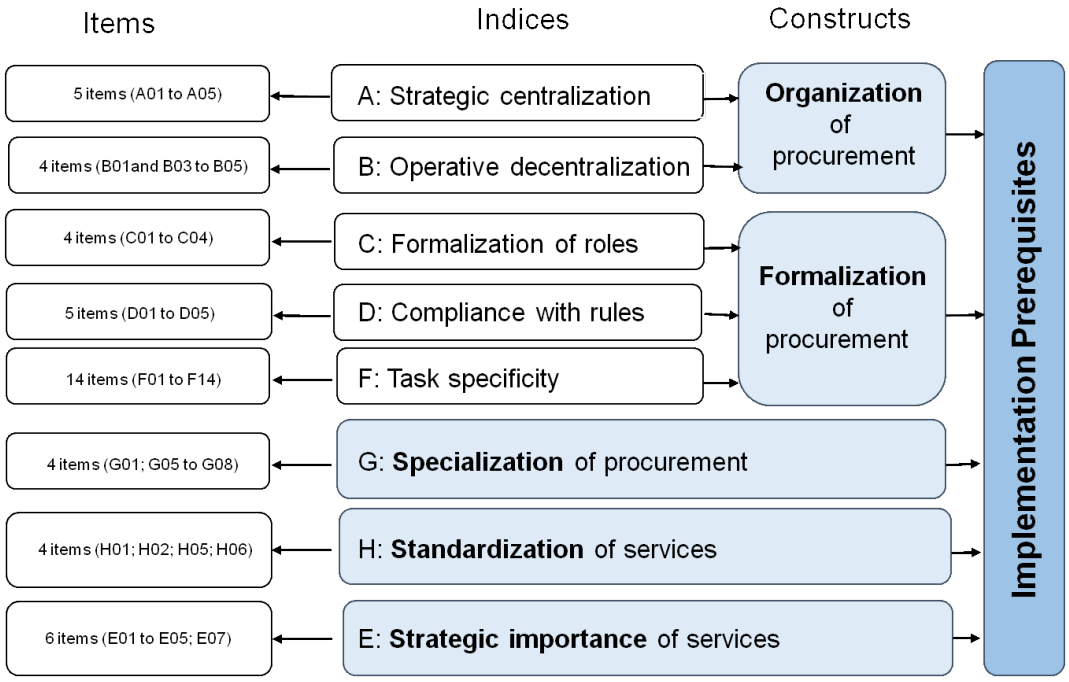

Figure 1. Measurement models

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According to Deutskens, de Ruyter, and Wetzels (2006), an online survey is as reliable as any postal survey. Therefore, data was gathered online. Zikmund (2000) characterized the relevant population as a group whose participants share commonalities that are relevant for a certain statistical examination. In this case, the relevant population was the group of all facility management service providers in Germany. The exact number of participants in this group could not be determined. Therefore, a random sample was drawn from several sources. All in all, 1,048 facility management companies in Germany were identified as relevant members of the random sample.

During a survey, the researcher has no opportunity to intervene. Therefore, the design of the questionnaire is highly important and the exact meaning of items is extremely relevant in the development of measurement models. Hence, a preliminary survey was carried out in order to rule out any misunderstanding and ambiguity (Rossiter, 2002). As a result, several items were rephrased and the length of the questionnaire was reduced considerably.

The online survey itself took place in May and June 2011 using the Unipark EFS survey tool (unipark.com). The overall response rate was 12.5% (131 companies), which is an average, but still meaningful response rate (Röderstein, 2009) in terms of the representativity of the gathered data (Armstrong & Overton, 1977).

The analysis controlled for company size (Hallal et al., 2010), company age (Aiken & Hage, 1968), and size of the procurement department (Jansen et al., 2006). None of these control variables had a significant influence on particular answers.

Evaluation and Discussion of Survey Results

The validity of reflective metrics is extremely important in correlation research. A valid metric measures what it is intended to measure (Field, 2011) and is situated within the subject area of the relevant construct (Combs et al., 2005). The items that best reflect existing correlations are identified with explorative factor analysis.

Table 1. Operationalization of constructs

Construct	Indices / Items	Derived By / Reliability Proven By
Organization	Strategic dimension of centralization; operative dimension of decentralization	Dewar et al. (1980): *Cronbach's alpha 0.92*
Formalization	Formalization of roles	Dalton et al. (1980)
	Compliance with rules	Hull & Hage (1982)
	Task specificity	Dewar et al. (1980): *Cronbach's alpha 0.76*
Specialization	Number of specialists	Sine et al. (2006): *highly reliable*
Standardization	Describability	Holcomb & Hitt (2007)
	Functional specificity	Ancarani & Capaldo (2005)
Strategic Importance	Rarity	Poppo & Zenger (1998): *Cronbach's alpha 0.82*
	Value	Nothnagel (2008): *reliable*
	Imitability	Nothnagel (2008)
	Substitutability	Nothnagel (2008): *reliable*

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Explorative factor analysis is applicable if more than 100 questionnaires are analysed (Hair et al., 2010) and at least four items are used to build a construct (O'Leary-Kelly & Vokurka, 1998). Furthermore, the existence of correlations between items is another utilization requirement. According to Field (2011), Pearson's *r* has to be at least 0.3. In the current research, all three of these basic requirements are fulfilled for the items in question. Therefore, explorative factor analysis is applicable to assess the relevance of the proposed constructs.

There are two different methods of explorative factor analysis: main axis and main component. The goal of this research project was to reduce data but to conserve most of the variables variance; hence, the main component method (Hair et al., 2010) was used. In a first step, the number of relevant components was derived with a scree test (Field, 2011). Most of the variables could be described through one single component. For those that could not, factor rotation was used (Reuter, 2013). Furthermore, the items' factor loading was taken into account. According to Hair and colleagues (2010), factor loading has to be at least 0.5, if 120 to 149 questionnaires are considered. Therefore, nine items with factor loadings below 0.5 were eliminated from the analysis.

In a second step, factor analysis was run again with the remaining items only. Factor loadings showed that all items loaded highly on the respective factors: the results were all above 0.5. In the literature, the interpretation of extracted communalities is inconsistent. Field (2011) labelled extracted communalities of less than 0.5 as not acceptable. However, he also indicated that it is up to the researcher whether extracted communality or factor loading is used as decision criterion. Hence, most of the items exhibit high enough factor loading and high enough extracted communality to qualify as relevant. Eight items are relevant for their factor loading alone. The factor loadings and extracted communalities in question are displayed in Table 2.

Table 3 gives an overview of the second circuit of explorative factor analysis and its results. The highly significant results of the Bartlett test show that multicollinearity is evident for all tested items. Furthermore, the suitability of the random sample was tested using the Kaiser-Meyer-Olkin (KMO) criterion (Hair et al., 2010). According to Field (2011), results greater than 0.5 are acceptable. A look at the information in Table 3 (column: Suitability of the Random Sample) shows that the random sample is highly suitable to test the importance of the proposed constructs.

Table 2. Extracted communalities and factor loadings

Construct / Sub-Construct	Item	Extracted Communalities	Factor Loading
A: Strategic centralization of procurement	A01	0.914	0.956
	A02	0.875	0.935
	A03	0.847	0.920
	A04	0.915	0.957
	A05	0.624	0.790
B: Operative decentralization of procurement	B01	0.310	0.557
	B03	0.812	0.901
	B04	0.590	0.768
	B05	0.749	0.865
C: Formalization of roles of procurement	C01	0.785	0.886
	C02	0.825	0.908
	C03	0.804	0.896
	C04	0.266	0.515
D: Compliance with rules of procurement	D01	0.758	0.871
	D02	0.468	0.684
	D03	0.650	0.807
	D04	0.645	0.803
	D05	0.734	0.857
E: Strategic importance of procured services	E01	0.439	0.663
	E02	0.381	0.617
	E03	0.690	0.831
	E04	0.641	0.801
	E05	0.374	0.612
	E07	0.653	0.808
F: Task specificity of procurement	F01	0.594	0.771
	F02	0.653	0.808
	F03	0.734	0.856
	F04	0.740	0.860
	F05	0.518	0.720
	F06	0.762	0.873
	F07	0.768	0.876
	F08	0.748	0.865
	F09	0.801	0.895
	F10	0.612	0.783
	F11	0.797	0.893
	F12	0.771	0.878
	F13	0.661	0.813
	F14	0.588	0.767
G: Specialization of procurement	G01	0.487	0.698
	G05	0.488	0.698
	G06	0.708	0.841
	G07	0.756	0.869
H: Standardization of procured services	H01	0.806	0.898
	H02	0.781	0.884
	H05	0.745	0.863
	H06	0.699	0.836

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Furthermore, the reliability of the measurement models was tested. Cronbach's alpha was used to illustrate the reliability of the constructs. Following Nunnally and Bernstein (2008), the results for Cronbach's alpha are considered to be acceptable if higher than 0.6. As all results were considerably higher than this threshold; all (sub-) constructs were proven to be reliable. The results for both the multi-dimensional and the single-dimensional constructs are displayed in Table 3.

Regarding the implementation prerequisites originating from the organizational structure, the construct of organization of procurement features an average suitability of the random sample of 0.752 (KMO criterion) and explains an average of 72.496% of the existing variance. Cronbach's alpha ranged between 0.755 and 0.950, which is very high. Thus, the results of explorative factor analysis show that organization of procurement is important for the implementation of electronic procurement of services.

As a construct, formalization of procurement, exhibits an average suitability of 0.843 (KMO criterion). An average of 67.237% of the existing variance can be explained with the respective construct. The results for Cronbach's alpha range between 0.819 and 0.966. Both results are even stronger than the above-mentioned results. Hence, formalization of procurement is important in measuring the implementation prerequisites arising from the organizational structure, and so is specialization of procurement.

In what concerns the service-related implementation prerequisites, the results for standardization of procured services clearly indicate the importance of the implementation of electronic procurement of services. A small question remains regarding the strategic importance of procured services: with only 52.9% of the variance explained by the strategic importance of the procured services, it is by far the weakest of the implementation prerequisites examined.

In summary, explorative factor analysis showed that the theoretically derived measurement constructs were highly suitable for depicting the implementation prerequisites of electronic procurement of services. The partitioning into implementation prerequisites arising from the organizational structure and the nature of the service proves to be justified as well.

Conclusion and Managerial Implications

There are two different forms of prerequisites influencing electronic procurement of services. First, there are implementation prerequisites arising from the organization structure: organization, formalization, and specialization of service procurement. Second, there is the service-related perspective, which includes the degree of standardization and the strategic importance of the procured services.

Through this research, these five different prerequisites were transformed into constructs and measurement

Table 3. Explorative factor analysis and results

Origin of Implementation Prerequisites	Construct	Sub-Construct	Explained Variance (%)	Suitability of the Random Sample (KMO Criterion)	Cronbach's Alpha	Significance (Bartlett)
Organizational Structure	Organization of procurement	A: Strategic centralization	83.483	0.829	0.950	0.000
		B: Operative decentralization	61.510	0.675	0.755	0.000
	Formalization of procurement	C: Formalization of roles	66.981	0.779	0.819	0.000
		D: Compliance with rules	65.119	0.815	0.865	0.000
		F: Task specificity	69.612	0.934	0.966	0.000
	G: Specialization of procurement		63.631	0.802	0.847	0.000
Nature of Service	H: Standardization of procured services		75.768	0.830	0.893	0.000
	E: Strategic importance of procured services		52.977	0.775	0.815	0.000

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models. Explorative factor analysis identified the items that describe the constructs. Most of the theoretically derived items easily pass the quantitative-empirical testing. The KMO criterion shows that the items are highly suitable for measuring the random sample. Cronbach's alpha values show that the constructs are highly reliable. Hence, quantitative-empirical testing underlines the importance of the theoretically derived prerequisites.

All in all, the implementation of electronic procurement solutions of services holds a lot of potential for future use in business-to-business procurement. The construction of reliable measurement models in the research area of electronic procurement of services is a major step towards a more rigorous investigation of this important topic.

Furthermore, rigorous investigation of this topic allows practitioners to take advantage of the scientific results. Already, practitioners can use the identified implementation prerequisites to adjust their organization's structure. The relevant managerial implications are as follows:

1. Examine the organization of procurement within the company and centralize strategic procurement, leaving operative procurement decentralized.

2. Formalize procurement processes in order to render them describable and more easily sought after electronically.

3. Make use of or train employees specialized in electronic procurement of services. With the outlined organizational adjustments, electronic procurement of services will become much easier to handle.

The service-related implementation prerequisites can be useful when new service procurement requirements arise. For example, strategically important services should not necessarily be procured electronically, whereas highly standardized services seem a good choice for electronic procurement.

Finally, this research project has certain restrictions that should be highlighted. The measurement models were constructed with a quantitative-empirical survey within the facility management branch in Germany. This approach limits the generalizability of the research results. Therefore, the constructed measurement models should be tested again for other branches than the facility management branch and within other countries. Also, concerning the strategic importance of procured services on the usage of electronic procurement of services, the role of this implementation prerequisite should be further investigated.

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The Role of Self-Service Mobile Technologies in the Creation of Customer Travel Experiences

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> *"It is good to have an end to journey towards; but it is the journey that matters, in the end."*
>
> Ursula K. Le Guin
> in *The Left Hand of Darkness*

Through the use of self-service mobile devices, the traditional marketplace interaction is being replaced by a marketspace transaction, in which the foundation of customer-company interaction has changed. This article discusses the main actors of experiencial value creation through the physical world and virtual world in the context of transport service. The empirical data is collected from semi-structured interviews with 19 young urban transport commuters. The results show that self-service mobile devices enhance the information accessibility for passengers to create customized travel experiences through a closer interaction with other actors, including transport service providers, transport-related service providers, and other passengers. Moreover, the scope of travel experience was expanded beyond the traditional service encounter both temporally and spatially. This article is an exploration of the influence of self-service mobile devices in the changing roles of customers and companies. A key message is that executives must pay attention to how their companies create experience value in both the physical world and the virtual world, separately or in combination.

Introduction

The customer experience is important for all kinds of services; both scholars and practitioners view its creation as an imperative component of a service firm's success (Helkkula et al., 2012; Prahalad & Ramaswamy, 2004). Previous research has shown that the creation of an extraordinary customer experience can lead to extra benefits, particularly with experience-centric services, such as the retail, hospitality and tourism industries (Pine & Gilmore, 1998; Zomerdijk & Voss, 2009). However, the customer experience is also important for other non-experience-centric service industries, such as urban public transport (Carreira et al., 2013).

Public service places greater focus on functional value based on collective interests than on personal hedonic value. However, with the development of customer capability in terms of self-service mobile technology, customers have more opportunities to create a personalized service experience using their own knowledge and skills (Meuter et al., 2000). Therefore, the traditional management-oriented perspective of experience creation has been challenged by a customer-dominant perspective (Gentile et al., 2007; Zomerdijk & Voss, 2009). The customer experience tends to emerge through the more complex service ecosystem rather than through a single company's service system (Laghari & Connelly, 2012).

The academic literature lacks a unified view, but does contain fragments of when and where the customer experience emerges (Zomerdijk & Voss, 2009). Driven largely by the widespread usage of self-service mobile devices, the traditional "marketplace interaction" in the physical world is being replaced by a "marketspace transaction" in the information world (Rayport & Sviokla, 1995). For instance, when customers find a taxi on the street to go to their destination, their service experiences are emerging in the marketplace; but, when they order and select a car ride service through their mobile device, their service experience partly emerge through the marketspace, where products and services exist as digital information and can be transacted through the

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online information channel. Therefore, the customer–company interaction has changed significantly in terms of the value-creation process (Meuter et al., 2000; Rayport & Sviokla, 1995). In the physical world, the information collected within the stages of the value chain enables the company to produce and sell products or services more efficiently; in the virtual world, it is potential value in itself (Lariviere et al., 2013; Rayport & Sviokla, 1995). Therefore, customer experience can be created within all stages of the value creation process, where it is a potential source of new revenue, as well as a potential source of risk. The temporal boundary of experience creation – the point where the customer experience starts and ends – becomes fuzzy and hard to define (Helkkula et al., 2012).

Through this article, we seek to understand who is the main creator or co-creator of the customer experience and to understand through whom the superior customer travel experience can emerge. We set the study in the context of public transport service for two reasons. First, current research in terms of customer experience lack focus on the non-experience centred service, such as public transport. Second, customer experience research on public transport mainly stands in the physical world; there is a lack of research on how the digital service information influences customer experience creation in the virtual world.

We will examine whether the use of self-service mobile devices influences the temporal boundary in the creation of the customer travel experience. Specifically, we attempt to answer two research questions:

1. What are the roles of company and customer in the creation of the customer travel experience?

2. Does the use of self-service mobile devices change the temporal boundary of the customer travel experience?

This article is structured as followed. First, we examine the literature on customer experience, with a particular emphasis on travel experiences. Then, we outline our research design. Next, we provide the empirical results from 19 interviews. Finally, we present a framework for the creation of customer travel experience to answer the two research questions listed above.

Customer Experience

The concept of customer experience was first conceived in the mid-1980s, along with the customer behaviour literature, which articulates that customers are not rational decision makers, but are “feelers”, “thinkers” and “doers” and that the underlying emotional elements affect customer behaviour (Gentile et al., 2007). Pine and Gilmore (1998), view experiences as a new type of economic offering to customers, which emerges as the next step after commodities, goods, and services in what they call the “progression of economic value”. Furthermore, a comprehensive contribution has been offered by Carù and Cova (2007), who identify a “continuum of consuming experiences” ranging from the experience mainly constructed by companies to the experience created mainly by customers, passing through experiences that are co-created by both customers and companies.

Building on the work of Meyer and Schwager (2007), the customer travel experience can be defined as "the holistic individual response arising from the passenger [to any direct or indirect] interactions with all aspects (e.g., tangible factors, multichannel services, or other passengers) and across all moments of transportation provision" (Carreira et al., 2013). Such “moments” encompass the total experience, including the pre-service, in-service, and after-service stages of the experience, and involve different experience factors (e.g., social environment, service interface, retail atmosphere, assortment, and price) (Verhoef et al., 2009). Such experience factors can be defined as customer perceptions of all aspects of service that contribute to the customer experience.

Actors in customer-experience creation

Research into who facilitates customer-experience creation shows divergent arguments. The traditional approach to customer-experience creation mainly emerged from management practice and the service design literature, which refers to a management-oriented perspective (Berry et al., 2006; Edvardsson et al., 2005; Meyer & Schwager, 2007; Zomerdijk & Voss, 2009). According to this perspective, customers are only invited to engage in the pre-designed service encounter conducted by the service company. The customer experience emerges through the customer’s subjective reaction to such predesigned physical facilities and standard processes.

The collaborative perspective argues that the customer experience is co-created by both the customer and service provider (Prahalad & Ramaswamy, 2004), much in accordance with service-dominant logic (Vargo & Lusch, 2004). In this perspective, customers co-create unique experiences through their interactions with a service provider across different touch points, respond-

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ing to the different designed elements, along with other elements that are not under an organization's control, such as the social environment (Vargo & Lusch, 2004).

The customer-oriented perspective posits that customers create their own experience with a service (Helkkula et al., 2012; Verhoef et al., 2009). This perspective, which is coherent with customer-dominant logic, views customers as actively creating their own service process and experience landscape by selecting service elements to achieve their desired experience (Heinonen et al., 2010).

Temporal scope of customer-experience creation

The temporal dimension is one of the core characteristics of customer experience, which originated from the all moments of contact between the customer and the company, or the company's offerings (Meyer & Schwager, 2007). The traditional approach views customer experience as emerging from within customer–company encounters, where customer experience is created at the interaction and purchasing stages (Berry et al., 2006). The temporal scope of such experience creation is based on all encounters with the service providers, both present and past (Zomerdijk & Voss, 2009). According to the collaborative perspective, the temporal scope of customer-experience creation has been viewed over the lifecycle of the customer relationship, aggregating all previous and present experiences, rather than only service activities (Teixeira et al., 2012). The customer-oriented perspective further broadens the scope of customer-experience creation that takes into account not only core-service-related experience, but also non-related phenomena, which means that the customer experience is viewed based all the past, current, and future imaginary value in the context of the service customer's lifeworld contexts (cf. Helkkula et al., 2012; Verhoef et al., 2009).

Characteristics of self-service mobile devices

Recently, academic researchers have recognized the critical importance of technology in the delivery of services the traditional marketplace interaction is being replaced by a marketspace transaction (Meuter et al., 2000) . The marketspace is defined as "a virtual realm where products and services exist as digital information and can be delivered through information-based channels" (Rayport & Sviokla, 1995). The foundation of customer-company interaction has significantly changed in such marketspace environments. Self-service technologies are typical examples of marketspace transactions, where no interaction is required between customer and company. Based on the attribute model, self-service technologies can influence various attributes of the customer experience, such as expected speed of delivery, ease of use, reliability, enjoyment, and control, which affect the customers' attitude toward using technologies and the need for interaction with employees (Meuter et al., 2000). In the digital age, the application of self-service technologies in mobile devices largely facilitates the value co-creation between customer and company through direct or indirect interaction. The combination of portable, personal, networked, textual/visual, and converged characteristics of mobile devices enable customers to have closer interaction with service providers and other customers in real-time, and they enable customers to create customized travel experiences (Lariviere et al., 2013).

Research Design

This study aimed at an in-depth understanding of customer perceptions and responses to address travel-experience creation in the context of mobile technologies, and as such, a qualitative approach was adopted. Interviews and focus group discussion were adopted as the appropriate method to identify value perceptions that customers were able to verbalize. The customer interviews were done mainly at the metro stations in Chengdu, China, and at the campus of Southwest Jiaotong University. The respondents were selected within such areas with a preference for young and highly-educated people, because such groups of people tend to favour self-service technologies using mobile devices (Meuter et al., 2000).

We interviewed 19 people between the ages of 20 and 40 who were frequent users of both public transportation and public transport related mobile applications.

We designed semi-structured interview questions through APPolls Survey (http://appolls.com), a mobile device application that facilitates offline surveying, including audio recordings.We asked the respondents questions relating to their use of self-service mobile applications in the context of their daily travel. Each interview was recorded and lasted approximately one hour. Additional open-ended questions helped respondents to describe their personal stories relating to self-service technologies that influenced their past travel experiences. Those questions included, for instance, "what do self-service technologies mean to you in terms of your daily travel journey?" and "how you view the time spent using self-service technologies?". During the interviews, we observed other relevant aspects and non-verbal behaviour.

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We also collected data about customer complaints and feedback from the urban transport operation company. This additional data broadened our view of customer value expectation and value perception within the process of travel-experience creation, including its negative aspects.

The data analysis followed the approach of Miles and Huberman (1984), which involves three concurrent activities: reducing data, visualizing data, and drawing/verifying conclusions. The goal of such inductive and deductive process was to systematic creating appropriate codes and categories. During this process, the theory was allowed to emerge from the empirical data to enable a better understanding about the customer travel experience.

Results

We categorized the travel experience values created in the marketspace through the use of self-service devices. Below, we describe the results of three cases: Chang-Zhou Pocket Bus, Didi Taxi, and Sina Weibo. The different types of value discussed in the three cases are summarized in Table 1.

Table 1. Summary of the types of value discussed in the three cases

Experiential Value	Illustrative Quotations	Actor(s)	Temporal Boundary
Function value			
Convenience	"I can book a taxi to pick me up at a convenient place by using Didi [Taxi], even in rush hour".	Firm and passenger	Before or during the service
Information value	"I normally check out the bus times [by using Changzhou Pocket Bus] before I go to the bus station. So, I don't need to spend more time on [waiting at] the station."	Firm and passenger	Before or during the service
Monetary value	"I can use the 10-yuan 'red pocket' (ticket) each time I use Didi [Taxi]".	Firm and passenger	After the service
Hedonic value			
Communication	"I can contact friends or share moments on Sina [Weibo] while I take the bus to work."	Passenger	During or after the service
Social value	"I am a bus travel expert on Sina [Weibo], and I have 2000 fans that follow me. I share many travel-related news stories on Sina [Weibo], when I have time, especially on the bus".	Passenger	During or after the service
Identity value	"The taxi driver can trust me and let me pay the fare [online] even a half day later. Because she [the taxi driver] can see that I have 35 payment records on Didi [taxi] and she has to pick up another passenger during a busy period.	Passenger	Before or after the service

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ChangZhou Pocket Bus
The ChangZhou Pocket Bus is a mobile app that was co-developed by the Changzhou Transit Group and China Unicom. It is designed to let passengers access real-time bus and Bus Rapid Transit (BRT) schedule information, allowing them to find a suitable route from their current location to their destination. Our results show that many passengers feel a sense of security from ready access to travel information through their mobile devices; they can better manage their time and anticipate their itinerary and experience before beginning their trip. One office worker highlighted the value of a feature that alerts users that the bus is approaching their stop, which helps them avoid missing their stop and makes their journey less stressful. This feature is particularly helpful because bus riders can be distracted or tired, or may even fall asleep, during their bus journey. Other features allow users to save their favourite travel lines and customize their routes for greater time efficiency.

Didi Taxi
Didi Taxi is a taxi-ordering mobile app developed by Xiaoju Technology Co. Ltd., a privately-owned company. The Didi Taxi platform allows customers to directly communicate with taxi drivers without requiring intermediary organizations. The service saves time for passengers wishing to order a taxi, especially during rush hour and in remote locations. The mobile app changes the method of interaction between passengers and the travel company. Our results show that the service allows passengers to better anticipate the time and location of a taxi service based on the location-based system. Compared to alternatives, passengers state that the service allows them more control over their travel plan; they can call the taxi service to arrive "just in time" or even let the taxi wait for them. Moreover, an online payment method challenges the traditional taxi fare payment method. With the mobile app, passengers can pay inside or outside the taxi; this personal credit system enhances trust between taxi driver and passenger and saves time. There are financial benefits to passengers in the form of digital "red pocket" tickets, which reduce the cost of travel and can be shared with other passengers, meaning they have both financial and social value to passengers. This approach has helped Didi Taxi become the market leader among taxi-ordering services.

Sina Weibo
Sina Weibo is a mobile app for crowdsourcing and microblogging, and it was developed by a privately-owned company. Sina Weibo provides a large variety of text, audio, and visual information relevant to its customers' daily lives. The news and other information provided from Sina Weibo is chosen by each individual customer, which is more valuable than traditional media found onboard buses. Customers both consume and generate information that they share with others, especially during their journeys. The platform not only provides a channel for customer feedback and complaints to the travel company, but it provides access to information about travel-related news and events. Both passive and negative participation into social interaction allows customers to enjoy their travel experiences, receive information, and grow their social identity, among other benefits..

Discussion

Our results show that self-service mobile devices enhance the information accessibility for passenger to create customized travel experiences though a closer interaction with other actors, including transport service providers, transport-related service providers, and other passengers, as shown by the framework illustrated in Figure 1. The direct service provides value through reliable travel information and a convenient service. However, the company can only play the role of platform provider if it enables other service operators to facilitate interactions with and between customers.

Didi Taxi, for example, is a transport-related service provider; it provides a platform but does not own any physical service assets, such as taxis. Nonetheless, the users that we interviewed indicated that Didi Taxi was responsible for the convenient service experience rather than the taxi provider. The wide use of this platform is due to its economic benefits and convenient user experience; it provides value to both taxi driver (service provider) and passenger (customer). Didi Taxi do not own any of the information it provides about taxi services; however, the economic promotion provided by Didi Taxi attracts individual service providers and customers to provide their location information. Therefore, customers perceive experiential value more from the value propositions embedded in the service platform and less from the sensorial feeling associated with the service itself.

In terms of the experience platform, a customer achieves the experience value not only from the core service and related service, but also from the non-related service. For instance, in terms of a public transport service, taxi and bus services can be substituted for one another. Therefore, if we view the bus service as the

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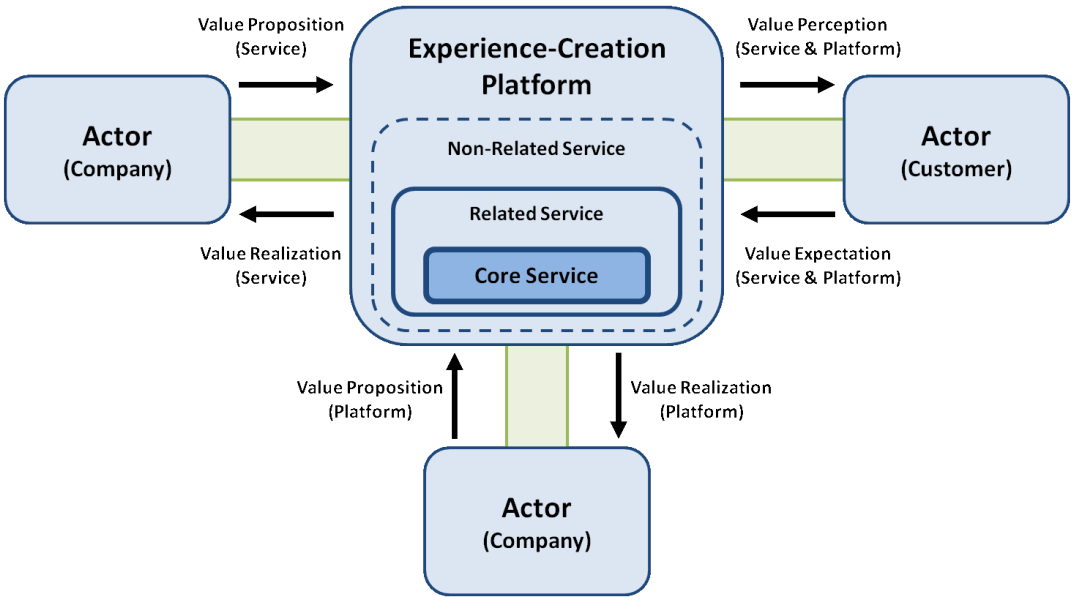

Figure 1. Framework for the creation of customer travel experience

core service, then the taxi service can be the related service, and vice versa. The social network plays the role of non-related service in this case. Passengers can perceive experiential value from the bus service, or the combination of bus service initially, then taxi service later on, with a social communication service along the way. Passengers can co-create value directly with the transport service provider or indirectly through interaction with the transport service provider by using the transport service platform. Also, passengers can co-create value with other passengers by sharing information, experiences, or even vouchers.

Moreover, both passenger and company in the experience creation process can be viewed as an actor within a value network. It is hard to define which actor provides a direct value proposition to the passenger in the self-service encounter, due to the many traditional, direct forms of communication around the interaction, which have been replaced by an indirect method of interaction and communication. Furthermore, the traditional service provider could mainly provide a convenient and reliable transport service, which represents the functional value from the passenger's point of view. In this sense, such functional value is co-created by both service provider and passenger. However, the role of passenger cannot be ignored; they could also create value for other passengers by sharing personal experiences and comments related to certain issues that will also influence other people's travel journey. In some situations, passengers could also provide value to the service company in the form of market insights and customer knowledge. In this case, passengers play as an active role in creating value rather than simply being passive receivers of value.

An individual passenger can create their own travel experience through close interaction during all moments of contact within the transport service process (Carreira et al., 2013; Verhoef et al., 2009), where some elements are outside the service provider's control but within the passenger's control, and some elements are outside both actors' control. Especially based on the enhanced communication channel, the transport service experience becomes less controllable. The transport operator could mainly focus on the controllable elements and also the important travel experience factors. The customer, however, can always actively find and share with the transport-related service provider to achieve their personal expected value. The transit-related service provider may not need to create the platform; rather, it can focus on one element of the transport service, such as taxi ordering and booking. However, only the value proposition provided by one actor can facilitate other actors to create further value propositions favoured by passengers. Passengers tend to prefer indirect contact with social actors rather than service providers, which depends on the convenience and speed of interaction.

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Among the large volume of information resource available online, customers choose the service elements as they wish. Therefore, a service provider's responsibility to support the formulation of their passengers' travel experience is to provide structured service information and attract customers' cognitive, affective, emotional, socials and physical responses to such travel service elements.

One important way to attract and motivate customers to engage in the travel experience is to provide a service platform with more value propositions and facilitate customers to achieve value by close interaction with other actors within such service platform. For most passengers, the travel experience is based on the utilitarian trip (Carreira et al., 2013). Therefore, the service platform should enhance the utilitarian value achievement through enhancing the visibility and mirroring capability of the transport information. Moreover, the relationship building through such service platform can be substantial.

Temporal scope changes in the marketspace transactions
With the help of self-service mobile technologies, the scope of travel experience was expanded beyond the traditional service encounter. Using self-service mobile technologies, passengers experience their current and anticipated future travel simultaneously through multichannels, both online and offline. For instance, a customer can monitor the taxi's real-time route to check whether the taxi driver has chosen detours. Moreover, mobile technologies extend the customers' scope for social interaction. Such social interaction can include active information searching and passive information receiving. The social sharing real-time experiences with other passengers can enhance the travel experience of both parties.

The temporal boundary of the holistic travel experience is expanded into the customers' lifeworld contexts (Helkkula et al., 2012). However, this does not mean that one passenger will experience every transit service by watching news and videos, playing games, etc. With the help of their mobile device, the passenger can experience transit service more flexibly. Customers can perceive service experience value even before or after the transport service by monitoring the transport information through engaging into the online platform or marketspace. By using mobile technologies, the travel experience becomes more personal and complex, as well as extends the temporal boundary compare to alternatives.

Conclusion

Self-service mobile devices enable customers to experience direct and indirect interactions with service companies and other passengers during travel. All actors, such as service providers, service platform providers, and customers, could contribute experiential value to customers. The former two actors contribute more functional value and the latter contributes value mainly in terms of hedonic dimensions. Passengers can achieve experiential value from either actively participating in the service process or passively receiving the information or other value provided by the service company or other customers. Therefore, the temporal boundary of the travel experience is not strictly defined within each service encounter. With the help of self-service mobile devices, passengers can access certain parts of the transport service anytime and anywhere, such as checking information, paying taxi fares, etc. Customer can personalize their experiential value by freely switching their sensory channel among the core, related, and non-related services during each travel journey.

The contribution of this article is an exploration of the influence of self-service mobile devices in the changing roles of customers and companies, where the traditional marketplace interaction has been replace by a marketspace transaction. Further research should look into the customer reaction and motivation in engaging into the self-service encounter in more specific situations to understand the influence of self-service technology in the creation of the customer travel experience.

What all these means to managers is that they must pay attention to how their companies create experience value in both the physical world and the virtual world, separately or in combination. To create a superior service experience in the new realm of activity, executives must understand the differences between value creation in the offline marketplace and the online marketspace. Service companies can not only create value through the online service platform, but also extract value from such platforms by organizing and synthesizing the information generated by customer usage of self-service technologies.

Moreover, opening the marketspace to bring additional actors into the service platform – and thereby providing multiple new value propositions – is beneficial to customers. However, managers need to evaluate the potential benefits and risks of opening resources when

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multiple actors become involved in activities to create experiential value. The marketspace could provide opportunities to more actors, and they should mainly focus on certain points of activity during the transport service process, because the information in the marketspace can be a potential source of new revenue.

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Keywords: travel experience, customer experience, mobile technology, self-service device, value co-creation

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> *"The key then to attaining this higher level of intelligence is to make our years of study qualitatively rich. We don't simply absorb information – we internalize it and make it our own by finding some way to put this knowledge to practical use."*
>
> Robert Greene
> In *Mastery*

This article it shows the role of services in a highly interdisciplinary context: promoting cooperation between organizations in the life sciences industry and in the engineering and automation industry. It provides insights on how required offerings of knowledge-intensive business services (KIBS) are developed systematically based on a simple service engineering process model. In addition to the content-related view of new service development, findings from a meta-view are presented. Cooperating researchers and practitioners in the new-service development process observed their own collaboration and how the applied service engineering model had to be modified dynamically to the requirements of the use case. The results show that an easy-to-use service engineering model in a highly interdisciplinary context has benefits, but success is dependent on the joint efforts of an accordingly interdisciplinary team of engineers and natural scientists; a close communication with the customers both from the life sciences industry and the engineering and automation industry; and a more agile approach.

Introduction

Companies face many challenges in developing and innovating services, particularly in the domain of knowledge-intensive business services (KIBS). For example, KIBS require in-depth interaction between the service company and their customers, and therefore, these services are highly customized. Thus, the specific demand areas of the customers must be covered in service provision using special knowledge or appropriate combinations of knowledge obtained, for example, through interdisciplinarity. Although KIBS companies do not typically offer standardized services, it is useful for them to: assess the feasibility of their service ideas; analyze internal and external requirements; describe their offerings; plan required resources; model their service processes – particularly when it comes to customer interaction – and, finally, test their service concept. In particular, this last step is not yet common in practice, but it would help companies to bring a successful offering to market.

Accordingly, service researchers seek to provide both theoretical insights and practical solutions in the form of process models, guidelines, and example cases to illustrate their application. However, general, one-size-fits-all approaches may not be sufficient when new-service development seeks to bridge two disparate industries with their own cultural and linguistic norms. In such cases, a tailored approach to interdisciplinary cooperation is required. In this article, we draw upon the service engineering discipline to develop a useful framework for developing KIBS to guide users systematically through the new-service development process in an interdisciplinary context. Based on a real company's case, we present a successful transfer of market study results into the practical application of services and how these findings can be used for extending a service engineering process towards agility and for use in the context of KIBS.

The case examined here comes from BioRegio STERN Management GmbH (Box 1), a German service com-

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pany located in the federal state of Baden-Württemberg, where it supports the economic development of the life sciences industry. The service portfolio of the company falls within the category of KIBS and mainly consists of highly specialized consulting services in areas such as business development, grant applications, and corporate finance. Their target groups are business founders, entrepreneurs, and researchers in the life sciences industry. One of the main objectives of the company is to initiate cross-sector cooperation between organizations in the life sciences industry and the engineering and automation industry to expose considerable synergy potential beyond the core businesses of the portfolio companies. Both represent economically strong and important industries in Baden-Württemberg. Combining these two industries should strengthen the industrial location and help life sciences to achieve an improved economic efficiency.

At present, the life sciences industry is predominantly producing small quantities using time-consuming manual processes. Given that the life sciences are frequently subjected to requirements such as efficiency, quality, reproducibility, and human safety, innovative automation solutions are gaining importance. Engineering and automation may develop customized, flexible automation solutions across the complete product-creation process (e.g., automated cell cultures, regenerative implants). Enterprises within the engineering and automation industry are active in automation technology, machine building, and mechanical engineering, which are predominant fields within the automotive industry. However, the life sciences industry offers a great economic potential for the automation industry, particularly because biotechnology is a key and interdisciplinary technology with a significant potential for growth, highly dynamic innovation, and increasing demand. To be used successfully in the life sciences industry, automation solutions should be both miniaturized and flexible in use, and they should help reduce process costs (Ballesteros & Schell, 2012).

Cooperation between the two industries is currently still in the fledgling stages. Although there is high potential for synergy, cooperation between engineers and life scientists at first glance involves a number of challenges that are due to the differences existing between the industries. The challenges include, among other factors, difficulties in finding suitable partners and stringent regulations due to current legislation. Moreover, special challenges are the different ways of working, the corporate cultures, and the specialized technical languages used in each industry. The key differences are graphically illustrated in Figure 1.

As a result of these contrasts, interdisciplinary work is a prerequisite for realizing interface projects between the engineering automation industry and the life sciences industry. In this respect, an appropriate service offering is intended to provide support to both life science and

Box 1. About BioRegio STERN Management GmbH (bioregio-stern.de/en)

BioRegio STERN Management GmbH is a skill-sharing network and centre that provides help and advice to founders of new businesses, entrepreneurs, and researchers in the life sciences sector in the cities of Stuttgart, Tübingen, Esslingen, and Reutlingen and the Stuttgart and Neckar-Alb regions of the federal state of Baden-Württemberg, Germany.

BioRegio STERN Management GmbH represents the interests of these market players in dealings with political circles, the media, and associations, and it provides advice on grant applications and corporate financing. Key focal points include regenerative medicine, medical technology, and the automation of biotechnology.

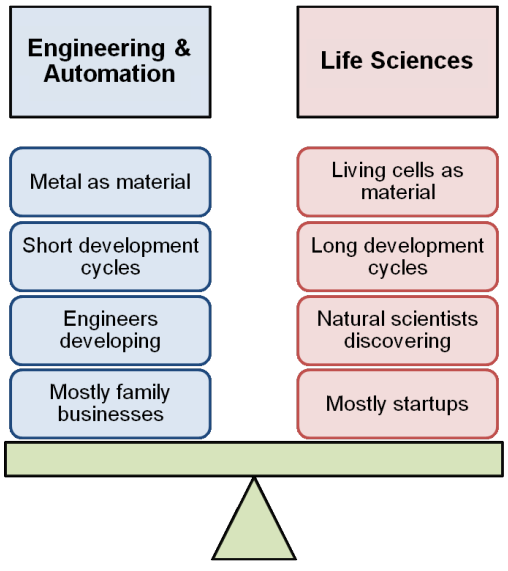

Figure 1. Differences between the engineering and automation industry and the life sciences industry (cf. Ballesteros & Schell, 2012)

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engineering and automation enterprises in order to facilitate the link between these industries. To develop such a suitable offering, it is necessary to first investigate the general market and cooperation conditions because these economic waters are completely uncharted. To overcome these challenges, an appropriate service platform should be established to support projects at the interface between engineering and natural sciences.

To move from the initial state (little or only loose cooperation between companies of the two industries and no support to promote cooperation) to the desired state (more opportunities and awareness for cooperation as a consequence of promotion and consulting), BioRegio STERN Management GmbH followed a structured process that is described in the following section. The main challenge was that the service portfolio that should be developed actually has to be highly customized to single target groups or even companies with specific cooperation requirements and challenges. Nevertheless, the company needed some basic "service components" that would be useful to promote and support cooperation, and that could be adapted quickly to specific requirements. Furthermore, they needed an easy-to-use approach that would not add complexity to this interdisciplinary project. Accordingly, the company chose a process model could serve as a reference without requiring them to rigidly adhere to its every detail.

Methodology

The present article is based on a sample case from BioRegio STERN Management GmbH and describes how KIBS can be developed systematically for a previously unknown market and introduced at only a minimum of risk by choosing a structured, but agile and prototypical service engineering approach.

The methodology can be described along the phases of a new-service development process (cf. Figure 2): idea finding and evaluation, requirements analysis, service design, test, implementation, and market launch. A specific focus was on the compilation of requirements, by combining the results of a broad survey and in-depth in-

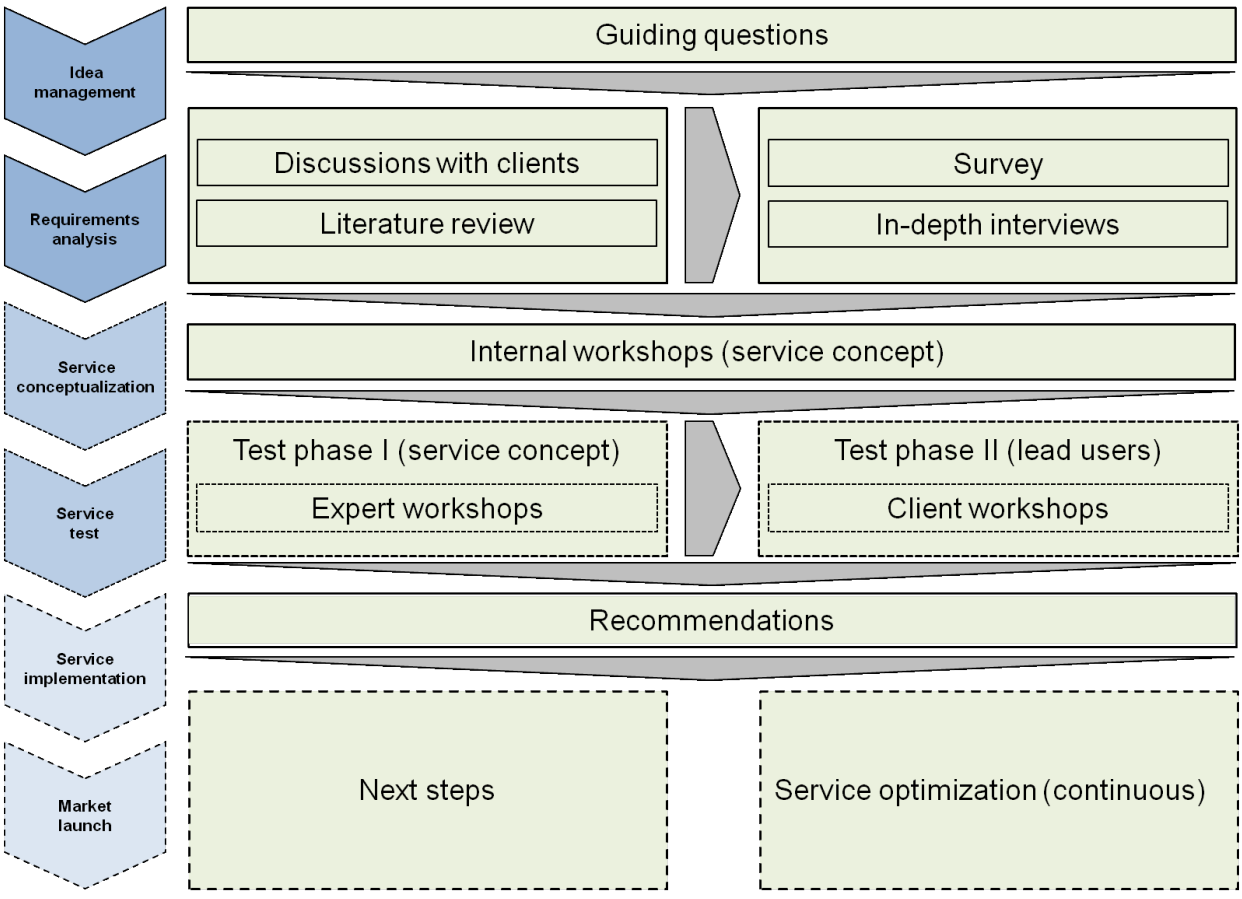

Figure 2. The new-service development approach used in the present case study

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terviews to explore best practices, and on testing the service offerings, which can be structured according to two phases. Test phase 1 focuses on the prototypical test of the service concept whereas test phase 2 uses the lead-user approach for further trial and optimization of the service offering. The company is currently still in the conceptualization and test phase. Along with the implementation and market launch, continuous optimization and customization of the offering to current requirements will be performed.

Furthermore, findings that are useful for further service research are reflected and shown explicitly in parallel to the practical development process. Hence, the sample case is a hands-on trial of a procedure model in the context of KIBS in a highly interdisciplinary environment. This approach results in new knowledge being fed back into the development process and makes it possible to recognize further needs for the development of new services.

Theoretical background

The research disciplines of new service development and service design were not recognized before the 1980s. In the 1990s, the concept of "service engineering" emerged. This concept describes the systematic development and design of services using suitable models, methods, and tools – and thus adopts to some extent the approach of product and software development common in the engineering sciences. Since the time when the research discipline emerged, numerous methods and instruments for the design of services have been developed (e.g., Bullinger et al., 2003; Bullinger & Scheer, 2003; Salvendy & Karwowski, 2010; Scheer & Spath, 2004).

Given that the sample case of BioRegio STERN Management GmbH deals with the development of new services in an entirely new market – supporting cooperation between two industries, which are (still) fairly unknown to each other – the uncertainty and the risk of undesirable developments are particularly high. The company therefore is using a systematic approach to avoid developing services that "miss the market" but rather align them with the requirements of both industries. The development and testing activities were geared to a procedure model (see Figure 3) which takes all phases of new service development into account: idea management, requirements analysis, service conceptualization, test, implementation, and market launch. This type of model was preferred by the company over other models because it was seen as a balanced solution between the required degree of detail and the desired ease of use. Also, the service developers of the company felt that they could use this model intuitively and adapt it easily to their conditions.

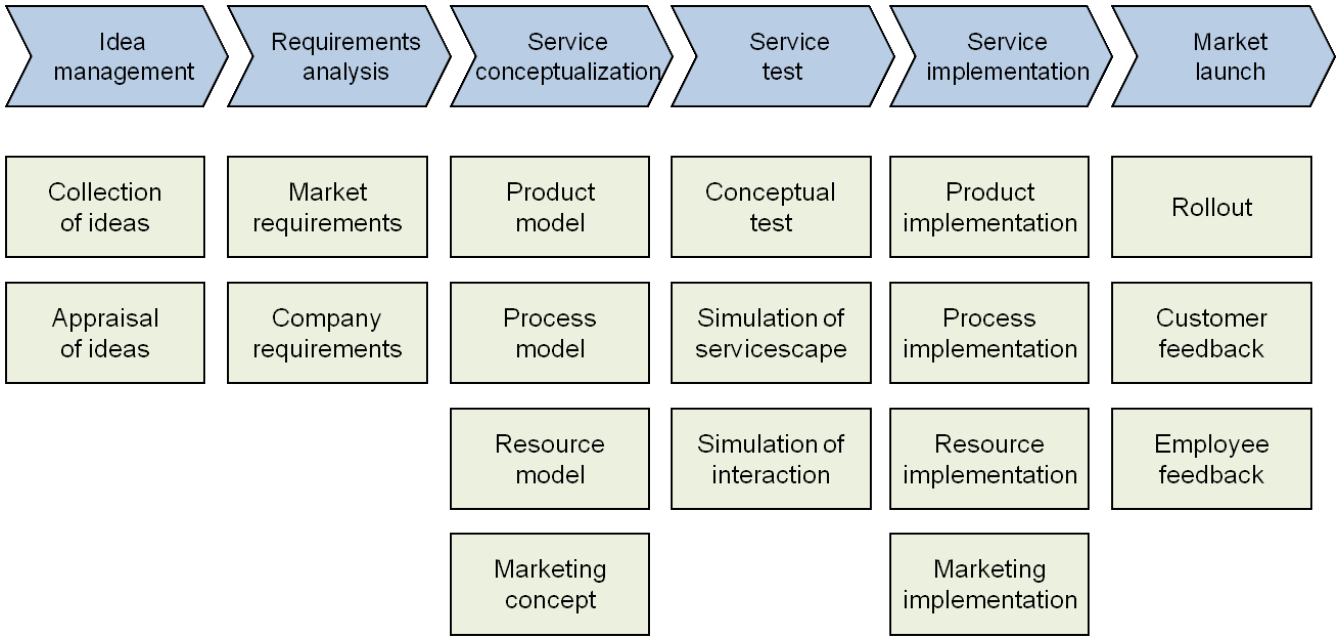

Figure 3. The service engineering process (adapted from Burger et al., 2010)

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The present case is about KIBS representing a main challenge for the development process. KIBS and the associated sectors and sub-sectors are usually defined on the basis of the *Classification of Economic Activities in the European Community* (NACE, 2008) and mapped to the parameters 71 to 74 (see Figure 4) as services provided on the basis of specialized knowledge. Their provision and use could lead to a growth of knowledge (cf. Muller & Doloreux, 2007; Schnabl & Zenker, 2013; Schricke et al., 2012). In particular, consulting services fall into this category (e.g., business consulting, technology consulting, engineering, and market research). Knowledge-intensive services, also referred to as knowledge-focused services, are usually characterized by high contact intensity with customers and a high number of variants (cf. Baumgärtner & Bienzeisler, 2007). For the present sample case of BioRegio STERN Management GmbH, this characterization results in a certain complexity (e.g., the specific nature of the customer's problem and of the technical or scientific field) and interactions with the customers become necessary in the service processes (e.g., analysis of the initial situation, data collection at the customer's location, and acceptance of the result by the customer). These particular characteristics should be taken into account as early as possible during the development process.

In contrast with other concepts from services research (cf. Edvardsson & Olsson, 1996; Jaschinski, 1998; Ramaswamy, 1996; Scheuing & Johnson, 1989; Shostack & Kingman-Brundage, 1991), which are usually either sequentially or iteratively (cf. Schneider et al., 1998), the chosen service engineering model features modularity as a property. At first glance, the chosen procedure seems to be rigid and linear (i.e., without any iteration or optimization loops provided). Generally, it is said that this type of process model is rather not suitable for the development of knowledge-intensive services because there needs to be a high level of customization rather than a "ready-to-use" standard service offering. For this reason, the model was slightly modified *in application*, without making any change to the fundamental idea. The background for this is the concept of agile development such as it is known, for example, from software engineering. Here, iterations are provided that permit returning or jumping to other phases in order to be able to respond to errors and any optimization opportunities at an early stage; so, an incremental availability of the result is possible (Moran, 2014). Furthermore, the development process is less rigid and formal, and is characterized by a simultaneous specification from customer requirements to the actual development of the services. In the sample case, for example, iterations were inserted between idea management and the requirements analysis, between service conceptualization and test, as well as between service implementation and market launch. Furthermore, the single service offerings are adjusted dynamically to changing customer requirements and tailored to different customers during the development process. This customization is made possible by a high level of customer interaction.

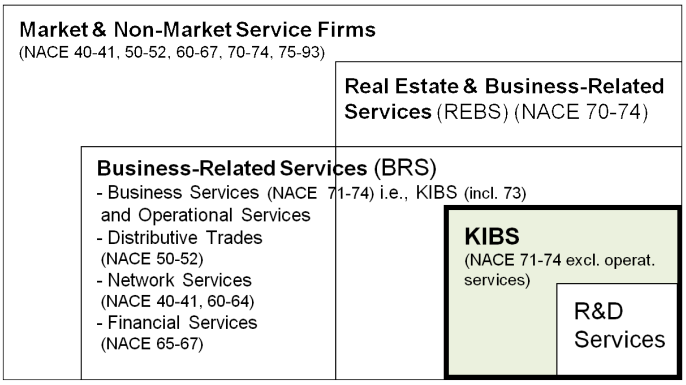

Figure 4. Classification of knowledge-intensive business services (KIBS) in the NACE (Hertog et al., 2006)

Requirements Collection

The requirements analysis of the service engineering process was particularly important for the use case due to the lack of knowledge about the market requirements. These requirements are driven for example by the general attitude towards cooperation projects within and between the engineering and automation industry and the life sciences industry, and the actual potential for automation in the life sciences industry. Thus, an extensive study was conducted, including two components: a broad survey and in-depth interviews with representatives of best practice examples. The methodology is described in more detail below and is illustrated in Figure 5.

Survey

The survey was intended as the core foundation for determining market requirements and deriving a service offering to support cooperation between the two industries. Because it is a new field of study – cooperation between the two industries was uncommon before – and because of the promising prospects, this process held many challenges, which highlights the explorative nature of the survey. Target groups for the survey were decision makers (i.e., holders of strategic positions) from enterprises in both industries. In order to safe-

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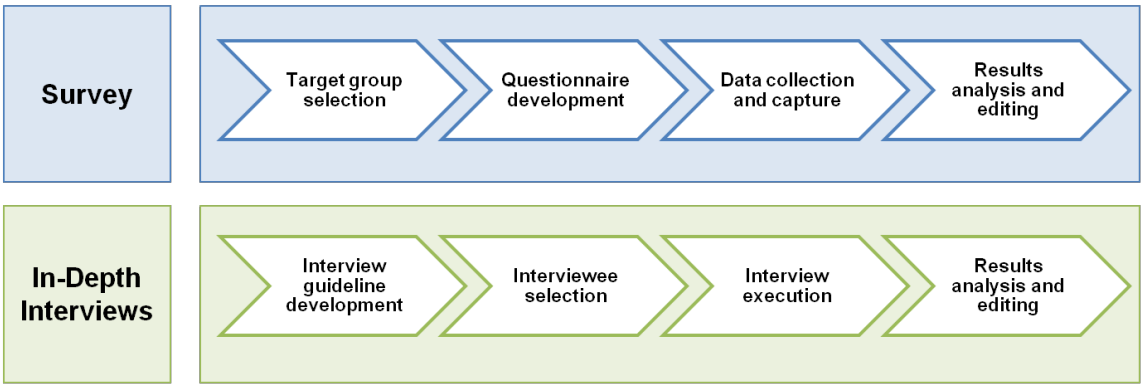

Figure 4. Methodology and components of the study

guard comparability but also to be able to address the specific aspects of both industries, the representatives of the industries were addressed with questionnaires of the same structure but with individual questions customized to the target groups. The questionnaires were made available in both printed (sent by mail) and digital (sent by email) formats and in an online version using LimeSurvey (limesurvey.com). In addition to cooperation between the life sciences industry and the engineering and automation industry, general issues relating to cooperation and specifically "cooperation within the life sciences industry" were subjects of the study, thereby enabling the derivation of requirements and fields of action. The latter subject was particularly interesting in determining whether life sciences enterprises cooperate at all or do not usually enter into cooperation – neither within their own industry nor with other industries. The likelihood of future cooperation projects between the two industries was also studied.

Both general factors for success and failure of cooperation projects and industry-specific issues that may have an impact on the cooperative behaviour were considered when preparing the questionnaire. Individual areas of study that were subjects of the survey included, for example: cooperation projects by industries, attitude of the industries towards mutual cooperation, factors for successful cooperation, obstacles when initiating cooperation, and need for support for initiating cooperation.

The analyses were made using the statistics software IBM SPSS Statistics 20 (ibm.com/software/analytics/spss/). The percentages specified refer to the valid answers. Rounding up or down may result in totals deviating slightly from 100 percent. Only those findings that had a sufficiently high significance from the statistical point of view were included in the preparation and documentation of the study results.

The survey was conducted during September and October of 2012. The scope of the study covered 131 enterprises to which 2,500 questionnaires were sent and 5% responded. Because cooperation between companies of the two different industries represents uncharted waters for their representatives, it turned out to be quite difficult receive responses to the survey. However, the number of responses was sufficient given the explorative character of the study. Forty-three percent of companies participating can be categorized to form part of the life sciences industry; 57% are from the engineering and automation industry. Most of the life science companies are from the fields of biotechnology (36%) and medical technology (38%); a smaller portion are from pharmaceutics (6%). The persons surveyed from the engineering and automation industry see themselves in the fields of automation technology (43%), machine building (35%), and engineering (24%), with some of the companies positioning themselves in more than one of the three fields, representing possible focuses.

In-depth interviews

In order to gain more profound knowledge about challenges and approaches in the cooperation between enterprises in the life sciences industry and the engineering and automation industry, semi-structured, in-depth interviews were made with two representatives from each industry. All of the total of four interview cases prepared are "lighthouse examples" of functional and fruitful cooperation. Nevertheless, obstacles surfaced that made it necessary to resort to external consulting and support in both industries from the point of view of the representatives of the companies interviewed (cf. Ballesteros & Schell, 2012).

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Individual areas of study included, for example: experience from cooperation projects with the other industry, risks in cooperation projects with the other industry, solutions applied in the area of life sciences, utilization of external support when initiating cooperation projects, and criteria for the selection of cooperation partners from the other industry.

Results of the Market Study

The study revealed core findings about the two industries that are fundamental to establishing a service offering tailored to the needs of the industry and target group. First, the synergies from cooperation of both industries are recognized and there is a substantial need for consulting services regarding mutual cooperation. The factors for success determined for cooperation activities can be outlined by these keywords: *building trust, interdisciplinarity, interface personnel,* and *professional project management.* Moreover, it was possible to identify obstacles and challenges that may lead to conflicts between industry experts and that are intended to be specifically addressed by the service offering. They include, above all: *financing issues, lack of contacts and ideas, lack of industry-specific know-how, different objectives and intentions, technical languages,* and *time horizons.* It is necessary to try to find a common level of language between the two industries. In addition, *finding suitable partners* is an issue for many enterprises. For engineering and automation enterprises, a *lack of human resources* and *different corporate cultures* are additional obstacles for cooperation projects. Refer to Figure 6 for a summary of the results.

Important and useful instruments for initiating cooperation projects are, in particular, *recommendations from existing partners.* Hence, the personal component plays an important role and supports building trust. This focus is important for new service development. The second rank among useful instruments is held by *personal networks of the enterprise's own employees.* Hence, it is important that individual employees are able to establish contacts autonomously in order to be successful in a cooperation project. Similarly, *events* (e.g., conferences, meetings, fairs, and information and networking events) and *activities of industry associations and networks* (rated equally on an average) are among the top three useful instruments. The latter initiation instrument, however, is predominantly emphasized by enterprises with a tendency to a higher potential of innovation. Online platforms play only a minor role; the human factor is at the focus.

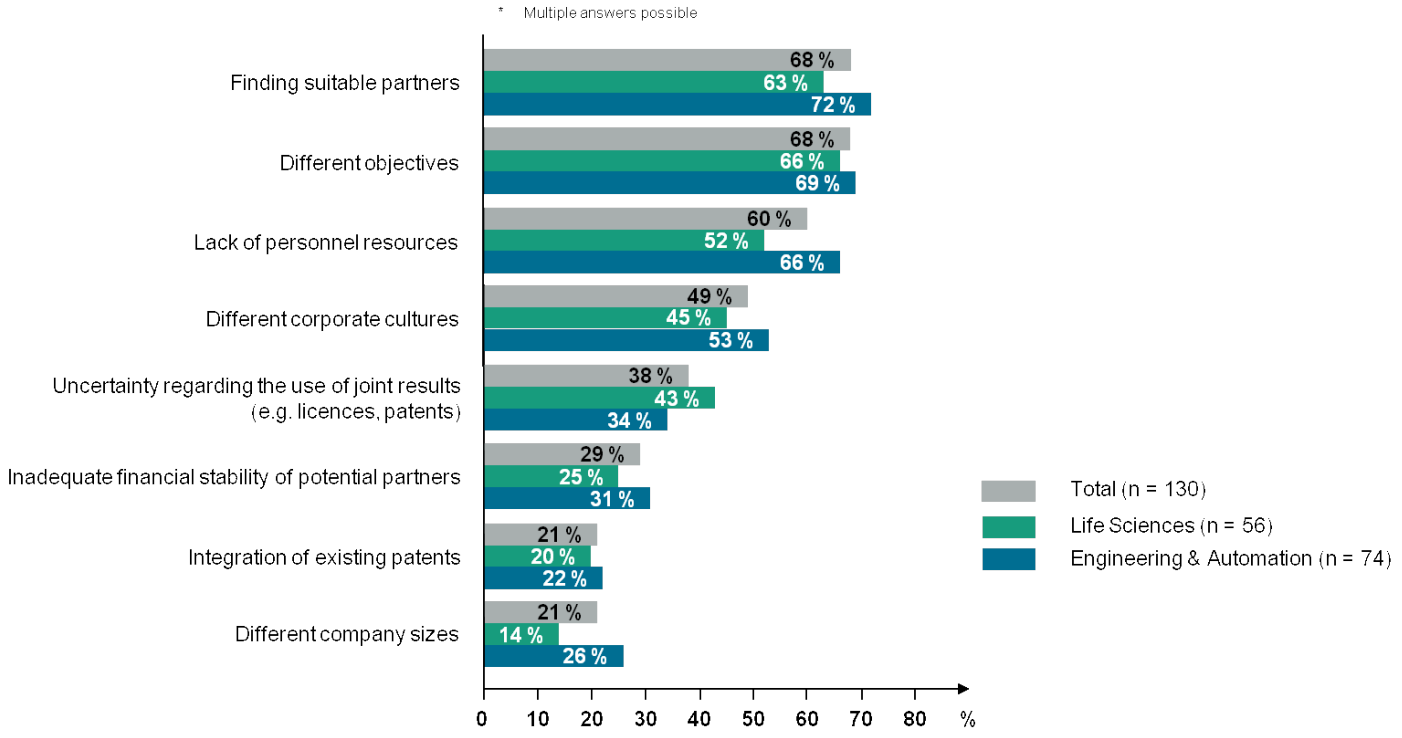

Figure 6. Typical obstacles when initiating cooperation projects

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With regard to the need for support when initiating cooperation projects (see Figure 7), *contractual issues* and the *procurement of cooperation partners* are particularly relevant. Enterprises from the life sciences industry expressed a need for support in the contractual arrangement of the cooperation (64% versus 41% among engineering and automation enterprises). Numerous enterprises from the engineering and automation industry find ratings of potential cooperation partners useful (35%). With regard to the need for support, there is also a difference between enterprises with a high and those with a slightly lower potential for innovation. The more innovative ones, for example, think that the procurement of cooperation partners (55% versus 36%) and support in the contractual arrangement of the cooperation (52% versus 39%) are more important. Enterprises with a lower degree of innovativeness usually rate content-related support in the arrangement of the cooperation higher than the more innovative ones (30% versus 18%). Although *training of employees* involved is at a very low rank (15%), there is a general agreement that support is needed in this area. However, enterprises with a lower potential for innovation emphasize this aspect more than those with a higher potential for innovation (27% versus 9%). With regard to the contractual arrangement of the cooperation, need for support is expressed rather by small and medium-scale enterprises (SME) than by large-scale corporations (52% of SMEs versus 21% of corporations). In order to determine the readiness of the enterprises to enter into cooperation projects with the other industry, specific potential activities were suggested. It is striking that enterprises from the engineering and automation industry show a higher readiness to take action relating to company strategy, organization, and human resources in order to give an impetus for such cooperation. The engineering and automation enterprises already acknowledge the significance of in-house interdisciplinarity and can easily imagine hiring specialists from the domain of life sciences directly. However, given that the overall readiness is only average, it is evident that cooperation projects are currently rather based on loose constructs of individual enterprises than on close intermeshing of industries (cf. Ballesteros & Schell, 2012).

There are also differences with regard to supply and demand of automation solutions for the life sciences industry. The life sciences enterprises were asked about applications of such solutions in order to assess which ones are currently of interest. In order to compare the demand with the supply of automation solutions for life sciences, engineering and automation enterprises were also asked about their automation solutions being used

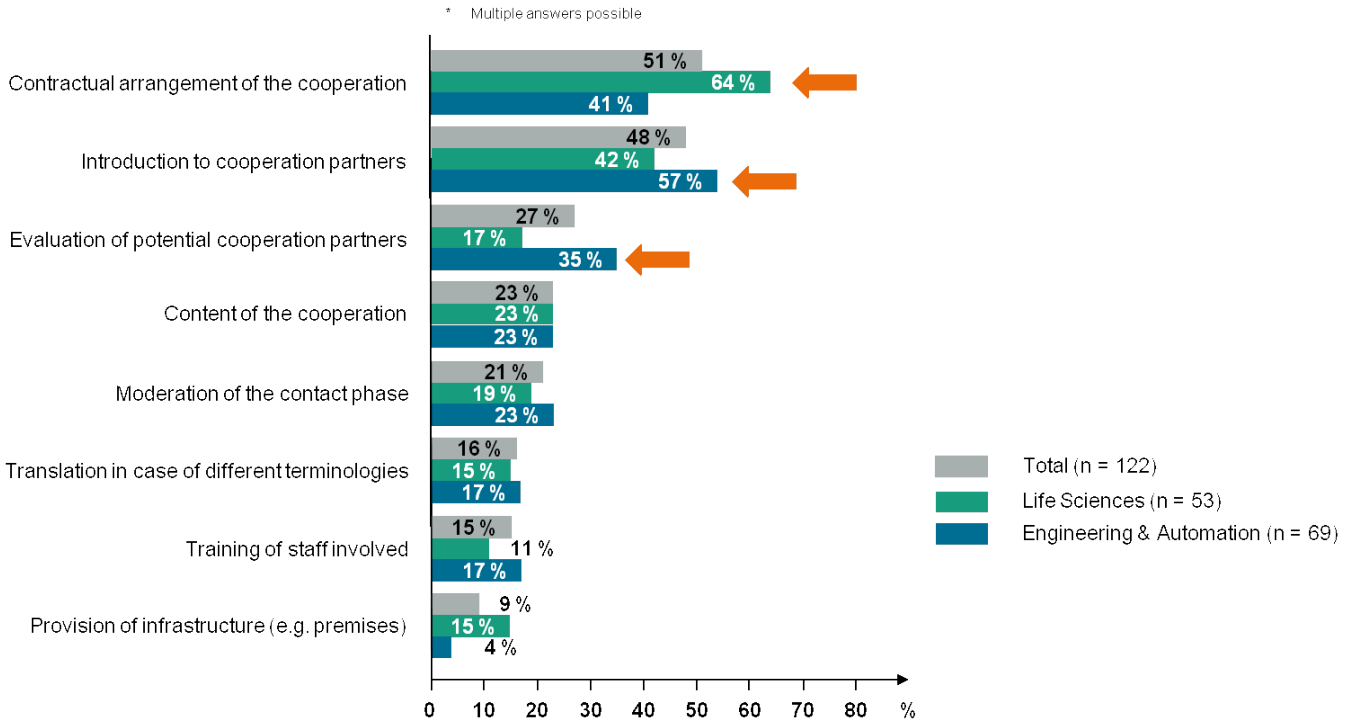

Figure 7. Need for support when initiating cooperation projects

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by life sciences enterprises. The results differ. For example, life sciences enterprises are currently using predominantly solutions from the fields of measurement and electrical technology (65%), microelectronics and sensor technology (60%), as well as information and communication technology (55%). In contrast, there are engineering and automation enterprises specializing particularly in the fields of production technology (64%), and robotics, development, and manufacture of single special machines (47%). At first glance, the offering of the engineering and automation enterprises and the demand on the part of the life sciences enterprises for automation solutions for life sciences diverge, however, the opinions with regard to the future importance of individual solutions are very similar. Thus, the industries will probably show a sufficient amount of future connecting factors and do not move into entirely different directions at least with regard to their expectations.

The results from the expert interviews are useful as a supplement to the broad survey and for the development of good practice examples. All in all, there is still work to be done to make the two industries aware of each other. It has also been confirmed that engineering enterprises getting into the life sciences industry need support in order to familiarize themselves with *licensing regulations, market requirements, business models,* and *market access options*. Moreover, it is important to find a suitable partner who understands one's own industry. For example, engineering and automation enterprises may have competencies in the specific fields of application of life sciences – or vice versa, life sciences enterprises may have staff that can recognize their potential for automation. *Joint networking events* and *fairs* play an important role in helping meet representatives from the other industry. However, representatives of both industries frequently tend to go to fairs of their own industry. In particular, biotechnology and medical technology specialists need to be brought closer to automation fairs. With a view to increasing the cooperation between engineering and automation industry and the life sciences industry, enterprises with a think tank function play a core role: they can complement the lack of interdisciplinary work in an enterprise and generate new automation solutions for life sciences.

Transfer of Results to the Practice of Services

Findings regarding the company's KIBS offerings

The following requirements and needs for the development of a service offering to support cooperation between the two industries can be derived by considering the service concept and the results of the study:

1. **Bringing together the demand and the offering:** The offerings of engineering and automation enterprises and the demands of life science enterprises for automation solutions differ. This is a starting point for new service development. This divergence can be adjusted by addressing individual companies directly. For example, a campaign could be launched to directly attract new companies from measurement and electrical technology to the market of life sciences because the need in the life sciences industry is greater than the current supply.

2. **Personal contacts:** The human factor and direct interaction play a core role in supporting the initiation of cooperation. If a service provider merely sends information materials or provides service via telephone hotlines, online platforms, and chats, they will not get very far. It is much more important to actively facilitate interaction between potential cooperation partners. In addition, other program-specific services such as "business speed dating" or cooperation exchange may be offered as future services. An online platform may be implemented; however, the personal component should be reinforced, for example, by information events or video presentations.

3. **Training and workshops:** This aspect is closely related to personal contacts. Although only a minority of the persons interviewed mentioned qualification issues explicitly, a need for training can be deduced implicitly. In addition to the transfer of knowledge to employees involved, particularly in companies having less experience with cooperation, or about companies of the other industry, the subject of awareness raising also plays an important role. In particular, such trainings and workshops can support engineering and automation enterprises in reducing fear of differences in corporate cultures. In this regard, a training or joint workshop proves to be more helpful than written materials such as information brochures. Other content that may be offered, such as courses, guidelines, or online tutorials, may be specifically tailored to the enterprises such as: "production and automation for natural scientists" or "life sciences for engineers". Training about the economic efficiency of projects or the design of requirements specifications and detailed specifications may also be helpful.

4. **Differentiation by industries:** It has become evident that the two industries are more similar than expected. This similarity facilitates the arrangement and organization of shared offerings, such as events).

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However, there are also industry-specific needs and obstacles that have to be addressed in different ways. Whereas for life sciences enterprises (especially for SMEs), support in the contractual arrangement of cooperation projects tends to be important (i.e., when designing the cooperation), enterprises in the engineering and automation industry instead need support for the evaluation of potential cooperation partners and to reduce constraints (i.e., help in initiating contacts). Hence, automation companies need support at an even earlier stage in the process – before entering into the cooperation. However, providing an evaluation of cooperation partners as a service turns out to be difficult because, usually, there are no indicators at this point regarding the enterprises from the life sciences industry. Nevertheless, it may be beneficial to offer external project management for interface projects as a service. This service considers obstacles and constraints in the cooperation and includes them into the project management task.

5. **Interdisciplinarity and communication:** Personnel at the interface between the two industries raise an important issue on two levels: first within the enterprises themselves and second with a view to the consulting services. Not only do the two industries need an interdisciplinarity approach to understand each other and to be able to cooperate better, they also need external service providers to support cooperation projects between the two industries. For example, a "translation service" between the two industries could be considered, either in terms of a dictionary or in terms of a personal "translator" that can be requested for project meetings to translate between the two industry languages. Such a service addresses the different specialized languages which are often a cause for failure of interdisciplinary cooperation.

6. **Visualization:** Another potentially beneficial aspect is visualization.. For example, laboratory processes can be visualized for improved presentation, allowing the biotechnology specialist to recognize the processes and identify with automation more easily. Another example would be a biotechnology truck or exhibition events organized at enterprises that are able to show lab automation products. Rapid prototyping could also be used to present ideas visually in a quick and efficient way.

Findings regarding the service engineering process model

The individual phases of the procedure model as well as the backgrounds for customization are described below:

1. **Idea management and requirements analysis:** In order to be able to develop and select sustainable ideas, the company first required to know the market and its requirements. This need is particularly important because the market is fairly unknown with regard to cooperation between industries. In addition, the differences between the industries had to be addressed in this phase. Each industry has its specific requirements, which have to be considered. After the first collection of ideas, on the basis of various informal interviews and a workshop with representatives of potential target groups, specific requirements were established, as described earlier with regards to the survey and in-depth interviews. The ideas were subsequently refined by supplementation, delimitation, and evaluation before making a selection. The potential advantages to customers using the service were worked out in detail. In the context of BioRegio STERN Management GmbH, the "customers" are the cluster protagonists. Because the objective is to establish further cooperation projects at the interface of life sciences and engineering and automation, the services are defined in such a way that this objective can be achieved. Those enterprises that will use the services are to be enabled to enter into a cooperation more easily.

2. **Service conceptualization and test:** It is not possible to cover all customer groups of the target industries and service scenarios with an initial service concept because of the individual nature of the need for support between the industries and the large number of possible cooperation constellations. In order to align the service offering with the real customer needs, which may be higher than evident from the information obtained from the requirements analysis, an early concept test of the planned offerings should be made with pilot customers in workshops and individual interviews. Subsequently, the service concept is aligned with the more detailed requirements. This prototyping method prevents the enterprise from being too late in recognizing needs for adjustment and unnecessary costs (e.g., for production of sales brochures, procurement activities, purchasing external consulting services, or recruitment of new employees) that would have been incurred by a service concept that might have failed in the market.

3. **Service implementation and market launch:** Iterations involving re-testing and re-engineering or a further development of the service offering are also provided between the last two phases – the imple-

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mentation of the service and its rollout in the market. Hence, the agile approach runs throughout the complete new-service development process. BioRegio STERN Management GmbH is currently preparing for the transition to the two phases of conceptualization and test as well as implementation and market launch. The close cooperation with pilot customers or partners with a lead user role makes it possible to run these two phases nearly in parallel and upscale them for additional customers in case of successful adaptation. A critical factor may be that the market does not accept the service in spite of the conducted market analysis. A risk assessment should be carried out to accompany the new service development.

Conclusion

The application of the selected procedure model worked in the sample case without any problems although the formal model had to be adapted during use. The modular nature allowed individual adjustments and jumping between phases even though this is not depicted in the process model itself. Below, the degrees of freedom used in the model show points of departure for the further development of procedure models for new service development. The main conclusion is that the service engineering model of Burger, Kim, and Meiren (2010), including the extensive test phase, is usable as a general guide to develop KIBS. Nevertheless, there needs to be more research on how to change the representation and description of the model so that it offers additional application guidelines concerning agility and interdisciplinarity.

The degrees of freedom used in the model are as follows:

1. **Agile new service development, testing, and prototyping:** Owing to the completely unknown market and the risk that the target groups are not yet ready for the subject matter (i.e., cooperation with a different industry), the sample case is used to approach the solution by way of prototyping. For this reason, the test phase is particularly intensive in addition to the requirements collection. All in all, an agile approach (i.e. an iterative, flexible, and highly customer-interactive procedure) plays an important role in the development of complex services. Accordingly, a more detailed investigation of the relationships and an extension of known development models by an agile concept are necessary.

2. **Lead user approach and customer focus:** Moreover, close cooperation with lead users has turned out to be useful, particularly in connection with testing a first concept and a first specific offer. This approach can help to minimize the risk of developing offerings that "miss the market" because future needs are anticipated in time and correctly. Hence, customer focus is not only "glanced at superficially" by a compilation of obvious requirements but ensured by developing more substantial requirements into the service. In this way, customers develop from the passive role of mere informants and objects of study into development partners. Given that such lead users want to actively drive the development of innovative products and services themselves, the development project becomes more dynamic and economically more efficient for the service provider. A future subject of study in this context is how such lead users are identified and how points of interaction within the development process of a service can be defined and visualized.

3. **Awareness raising and marketing in "early markets":** The model includes the establishment of a marketing concept for the new services in parallel to the development of the service concept. In the case of BioRegio STERN Management GmbH, the focus is predominantly on raising the awareness of the target groups (life sciences enterprises and engineering and automation enterprises), most of which first have to be made aware of the advantages of cooperation with the other industry. In this respect, the importance of areas such as business communication, marketing and sales and, in particular, collaboration in close development partnerships with potential customers can take in the development process needs further attention. It should be demonstrated which variation of the development model allows an early push into markets where the needs are not known. It is also possible to show mechanisms for how experience gathered by lead users can be communicated efficiently to other potential customers in order to facilitate the roll-out of the service in the market.

4. **Interdisciplinarity:** The case of BioRegio STERN Management GmbH has shown that the interdisciplinarity requirement can be covered by service offerings, in this case for the collaboration between the engineering and natural scientific disciplines. In the sample case, interdisciplinarity already exists in the service development process. Other research activities could investigate the role of services at interfaces and optimum compositions of developer teams for services in different areas (e.g., joining designers with natural scientists).

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Service research offers many solutions or starting points for companies to solve challenges in service business. Typically, these solutions come in the form of process models (e.g., service engineering model) and guidelines (e.g., how to actually apply a service engineering model). Nevertheless, listening to feedback from practitioners and adapting theoretical approaches dynamically to real use cases is essential for service researchers. Furthermore, a systematic test phase for a new service should never be omitted. Although KIBS are seen as rather non-standardizable in contrast to automated services or physical products, there should be an effort to test and evolve the service concept. A test could be conducted together with close customers to really tailor the services to their needs and represents the first "acid test" before rolling a new service out on the market. As this article has shown, the service engineering discipline provides a useful framework for developing knowledge-intensive (business) services to guide users systematically through the new-service development process, but it has to be carefully adapted during use.

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Keywords: new service development, interdisciplinarity, life sciences, engineering and automation, service engineering, knowledge-intensive business services, KIBS, agile

Personal Health Systems Technologies: Critical Issues in Service Innovation and Diffusion

Doris Schartinger, Ian Miles, Ozcan Saritas, Effie Amanatidou, Susanne Giesecke, Barbara Heller-Schuh, Laura Pompo-Juarez, and Günter Schreier

> *"If I could time travel into the future, my first port of call would be the point where medical technology is at its best. Because, like most people on this planet, I have this aversion to dying."*
>
> Neal Asher
> Science fiction novelist

Personal health system (PHS) technologies can enhance public and private health service delivery and provide new business opportunities in Europe and around the world. Although much PHS technology has already been developed and could potentially provide virtually everyone with access to personalized healthcare, research driven primarily by a technology push may fail, because it fails to situate PHS within the wider health and social care service systems. In this article, we explore the scattered PHS research and innovation landscape, as well its relevant markets, using several types of analyses: bibliometrics, patent analysis, social network analysis, stakeholder workshops, and interviews. Our analyses aim to identify critical issues in the development and implementation of service systems around PHS technologies.

Introduction

Healthcare systems face well-known challenges: rising costs, ageing populations, increasing demand, and shortage of health care professionals, among others. Personal health systems (PHS) assist in the provision of continuous, quality-controlled, and personalized health services to empowered individuals. PHS involve a variety of patient groups, clinical specialties, technology fields, and health services. Hence, the development of PHS requires and can mobilize the emergence of novel cross-disciplinary and cross-sectoral innovation partnerships. For the purposes of this article, we build on earlier definitions (Codagnone, 2009) of PHS, which we define as consisting of:

1. Ambient, wearable, or in-body devices that acquire, monitor, and communicate physiological and other health-related data
2. Intelligent processing of the acquired information (i.e., data analytics), and coupling it with expert biomedical knowledge and, in some cases, knowledge of social circumstances and living conditions
3. Action based on the processing of acquired information, either applied to the individuals being monitored, or to health practice more generally, concerning information provision or more active engagement in anything from disease and disability prevention (e.g., through diet and lifestyle management) to diagnosis, treatment, and rehabilitation

We need deeper understanding of mismatches between the potential of, and need for, PHS, and current policy and innovation initiatives and framework conditions, for example, in terms of future technological opportunities and societal demands. To date, research in the area of PHS has often given little account of special pat-

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terns of innovation in the PHS sector (Cunningham et al., 2005). Knowledge and experience about implementing relevant research results into concrete policy and strategy development in health (particularly at the European level) remains in its infancy.

The main question of this article is why PHS technologies do not diffuse readily despite the advantages they offer to a variety of actors in the health and social care system.

This article is structured as follows. In the next section, we introduce the conceptual approach of this research by examining the concept of "service systems" and describe the shift to PHS as a system transition. Next, we discuss the various methods of investigation we applied to answer our research question, and then we present the results of our analyses. Finally, we discuss the implications of the results and present our conclusions.

Conceptual Approach: Service Systems

Services are often thought of as essentially person-to-person interactions, where the service "product" is co-produced in the course of a service relationship. But, we have become familiar with technology-to-person services, where instead of directly interacting with a member of staff of a service organization, the client interacts with technology – often through online and mobile communications, and sometimes through devices based at the premises of service organizations. The service is created within a "service system", involving the customer/client and the devices (and software) they are using, the service organization they reach through these interfaces, the personnel of this organization – some of whom they may interact with (front-office staff) and others who provide unseen support services (back-office staff) – and the technologies these organizations use, some for information processing and communication, some for surgery and other medical interventions, physical transport, and so on.

The concept of service systems is one that has evolved quite rapidly, with some specialist versions (often coming from the information systems community) being rather elaborate and restrictive. One well-known definition introduces the notion of POTI, or "people, organizations, technologies, and shared information", in which service systems are seen as "dynamic configurations of resources [POTI] that can create and deliver value to customers, providers, and other stakeholders" (IfM and IBM, 2008). Maglio (2010) sees these four key building blocks of service systems as varying on two dimensions: i) physical / non-physical and ii) possessing / not possessing rights. This view characterizes the various four resources of service systems as follows:

1. People (physical, with rights)

2. Organizations (non-physical, with rights)

3. Technologies (physical, without rights)

4. Information (non-physical, without rights)

Various authors, such as Karni and Kaner (2006), stress that, in service systems, as compared to many other sociotechnical systems, customers/clients are much more important parts of the "P" component – their participation and inputs are vital in service design and provision. They may also place limits upon what the (formal) service provider can do, and set standards for what should be achieved. In health and social care systems, the customers/clients can include not only the recipients of care, but also other stakeholders (such as family members), any of whom may make their own demands upon, and inputs into, the service.

People – whether consumers or service suppliers – are complex agents, with highly diverse cognitive frameworks, values and attitudes, physical and emotional needs, and so on. Service systems are thus complex to model and manage – but they may also be resilient and innovative. People can be empowered to act in non-mechanical ways, responding to unexpected circumstances and collaborating to solve problems. They can be linked together in new ways through new information technologies.

Now, what is the service that we are discussing in this study? Many levels of granularity could be considered: which level is chosen for analysis depends on the practical purposes at hand. For some purposes, the issue may be the immediate response to a particular event (e.g., the administration of a drug); for other purposes it may be the set of interactions immediately surrounding this specific service activity (e.g., a visit by the consumer to a clinic or other appointment or a visit by a health and social care professional to the person's house); or the broader treatment of the consumer in question over a series of interactions (i.e., "touchpoints") with the service organization across their "service pathway" or "service journey"; or the overall service to the community that is provided by a particular health and social organization (which may be a constellation of many of the specific services discussed above).

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System innovation and transitions

Rotmans (2006) has described system innovations as "organization-transcending innovations that drastically alter the relationship between the companies, organizations, and individuals involved in the system". Such ambitious innovations are required to address many of society's grand challenges, including those associated with active independent living and the introduction of PHS. System innovation often implies to the need for "transition management" (Schot & Geels, 2008), which enables breaking out of various locked-in heritages and organizational routines. There are costs as well as benefits in such changes, and protracted processes of learning and negotiation are liable to be involved.

The transitions approach argues for the need to take the interests and perspectives of numerous stakeholders into account. For example, hospitals are an important part of the health and social care chain, but hospital management may not benefit from the reduction of inpatient stays associated with the use of PHS. The approach suggests experimenting with and developing of strategic niche markets; determining "boundary objects" through which stakeholders can gain their own appreciation of the innovation; and developing transition pathways through which the new service system can be constructed.

The shift to PHS may be understood as a system transition in the sorts of terms established in transition management accounts and drawing on ideas from the approaches developed in "social construction of technology" and similar approaches to innovation studies. As an example, Broch (2011) provides a multilevel analysis of innovation around care services for the elderly.

Methodology

Figure 1 gives an overview of the different types of analysis that were applied in our research project. The first approach was to obtain a comprehensive overview of the various types of PHS projects through web-based research. Apart from purely technical research projects, PHS projects exist at different levels of aggregation and analysis:

1. **Meta-level PHS projects:** These are mainly research projects that have made considerable efforts in defining and demarcating the PHS area. They are academic projects that follow an analytical approach in their occupation with the field. They are mostly publicly financed and well documented.
2. **Meso-level PHS projects:** These projects combine an analytical approach with a strong applications focus. Typically, the project partners involved are from research and consulting organizations. Also, academic organizations are typically found on one side, and on the other side, the partners are based on various case studies distributed over Europe where actors from the private, public, and third sectors are involved in implementing local personal health systems. These projects are well-documented, especially on the single-case level.
3. **Micro-level PHS projects:** These are national/regional local bottom-up projects, primarily focused on application – they are PHS cases according to the definition applied in this article. Project partners develop out of their ecosystems and receive financing at some points in time. Typically, projects and follow-ups develop over at least one decade; it is often difficult to demarcate the start and end of these undertakings. A wide variety of these projects exist on the national and local levels. They are not well documented – in most cases there is not even a project website.

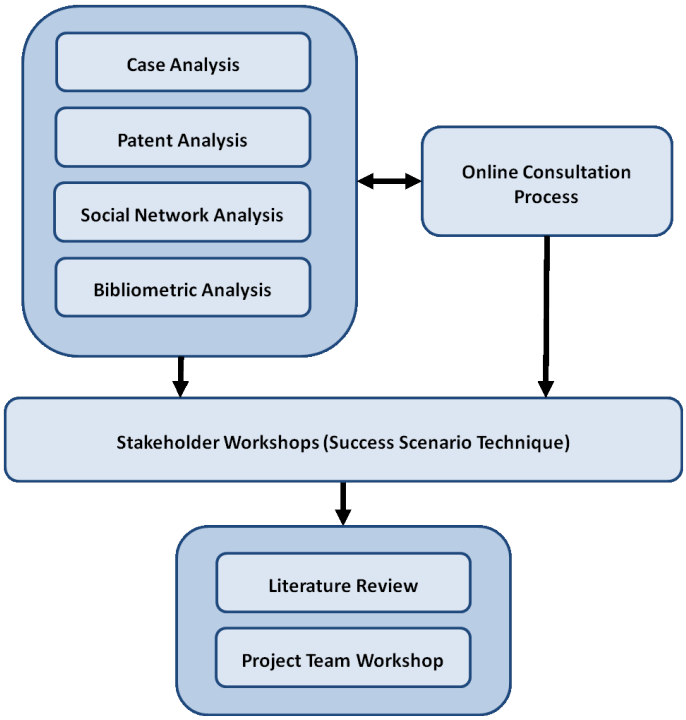

Figure 1. Methodologies applied in the course of the project

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At the outset, we conducted several small analyses to provide a first overview of the PHS area:

- A bibliometric analysis was used to explore the present state and future trends on the PHS topic.
- A small study analyzed the patents in the PHS field, using information obtained from the Derwent Innovation Index and the "Patent Citation Index".
- Social network analysis (SNA) tools and concepts were used to visualize R&D collaboration networks and central actors in the area of PHS on the European level, to move the focus beyond the individual social actors and toward the broader interaction contexts within which the actors are embedded.

The project website (phsforesight.eu) was deployed to establish an online platform for launching a structured and systematic online consultation process, with multiple phases for generating and clustering visions concerning breakthrough innovations and societal demands.

Two stakeholder workshops were organized in order to explore pathways for desirable future developments, and to use scenario analysis to deepen our understanding of how PHS might be configured and applied to specific health/wellbeing conditions over the coming decades up to a time horizon of 2030. In particular, we sought to deal with the challenging questions of system organization: what sorts of business model might be pursued and what is the organizational ecology of service provision? The scenarios were not intended to be predictions of what will happen, but to provide some idea of the range of plausible developments that might characterize the PHS field. The purpose of scenarios is to provide us with insight into the circumstances under which different developments might unfold, and the relations between different issues. Reality is liable to be a complicated and diverse mixture of different elements of these scenarios, varying over time, place, organization, and even medical conditions. The scenario workshop process involved alternating between plenary and break-out group discussions. The workshop, bringing together individuals with knowledge and expertise of the operation of health pathways, or of the potential of new PHS systems, and combining different perspectives (from academia, policy, industry, and society) discussed ways in which these pathways and systems might evolve over the next decade and beyond. Stakeholders invited to the workshops were identified via different channels: stakeholders registered via the PHS project website were asked to pass the word and invited their colleagues and networks to engage. Furthermore, outreach activities were established through social networks, printed leaflets, and targeted promotion (by way of emailing to the stakeholders of initiatives and through the website visibility with banners and hyperlinks). Coordinators or leading members of other projects in the PHS field were emailed. For the workshops, we took care of a roughly equal distribution of stakeholders with a research, business, policy, and third-sector background. For more information on the workshops, please see the report by Amanatidou and colleagues (2014).

Results from all previous analyses, the online consultation process, and the stakeholder workshops were then again cross-checked with existing literature and discussed and rounded up in a project team workshop.

Results

The various strands of analysis identified a number of critical issues and related governance deficits:

1. **Social acceptance of PHS:** issues that enhance the positive appraisal, and finally use, in stakeholder groups of PHS (e.g., patients, informal carers, medical professionals)
2. **Service systems of PHS:** issues such as systemic failures or lock-ins, including networks that are too weak (e.g., barrier to knowledge transfer, missing mutual understanding of actors' perspectives and roles) or too strong (e.g., causing incumbent actors to be dominant)
3. **Markets for PHS:** supply-side and demand-side issues; issues of interfaces between supply and demand; business models; and market opportunities
4. **Research and technological development of PHS:** covers research for technological solutions (i.e., precommercial), for standardization, but also for indicators about success of PHS
5. **Framework conditions of PHS:** cover institutional change, including the creation of new organizations/institutions, assigning new missions to existing institutions, regulation, and legislation

These critical issues can be the basis for possible policy designs to facilitate the adoption and diffusion of PHS technologies and services. We discuss each issue in greater detail in the subsections that follow.

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1. Social acceptance

Stakeholders with whom the PHS project engaged in interviews and discussions, as well as the literature reviewed, see individualization in healthcare and growing affinity for technology as drivers for PHS diffusion. The global dissemination of sophisticated technologies and mobile phones and consequently the use of these devices (e.g., Internet access, smartphones, and application development) is a strong trend that is reinforced as the senior part of the population becomes increasingly familiar with advanced ICT, having used it already in their professional and private lives (The Capital Region of Denmark & Health Care Innovation Centre, 2011). Technology affinity contends with technology skepticism: elderly individuals show hesitancy as to new technologies, frequently commenting, for example, that they are unable to use touchscreens. There is suspicion that technical devices may fail, through operating errors or technical deficiencies.

Social acceptance of technology includes also acceptance on behalf of professionals. Innovation-mindedness on a lower management level, and a positive attitude of care professionals, can be of vital importance for eHealth innovations. If there is a general fear of operating errors or hard-to-control alarms, this will slow down adoption rates of PHS service systems (Gkaitatzi et al., 2010; van der Plas & van Lieshout, 2012). These attitudes depend on several factors, including: levels of digital literacy in society; alleviation of public and professional concerns about confidentiality of health-related data; approaches to pricing of and payment for PHS use; and strategies concerning the "imposition" of PHS or changes in – or even the withdrawal of – the traditional services they may replace.

Social insurance funds have a culture of financing health services once the damage is done – providing healthcare services to prevent further damages is increasingly the role that is expected from them, but has not always been. Implementation of PHS may entail that actors in health and social care have to leave their predefined and expected roles; this is always likely to cause resistance. Physicians may be reluctant to engage in further services and training in order to empower patients and treat them as equals, as experts themselves; this reluctance may prevent PHS implementation and use. Patients are often expected to show more commitment, participation, and self-management, abandoning the traditional doctor–patient hierarchy: not all may be keen on this change of role. A further obstacle is medical professionals' primary mono-disease orientation.

A point of general concern in the workshops organized during the PHS foresight project was the issue of equity and equality of access to PHS. The equal distribution principle applied in hospitals (i.e., that all people should receive equal attention and treatment) may be harder to apply when healthcare is "brought out into society". More advantaged social groups will probably be able to afford more sophisticated services that can the less advantaged, but there is also the possibility of PHS directly contributing to social inclusion, for example by reaching out to remote geographical locations that have been less well served by centrally managed public health systems (Amanatidou et al., 2014).

Social acceptance of PHS is crucial for their widespread implementation and use. Discussions and analyses during the PHS workshops and interviews suggest that social acceptance relates to: digital literacy of the population as a whole; concerns about confidentiality; and issues around the pricing of and payment for PHS use. What is often neglected in discussions about social acceptance are fears that the introduction of new services relating to PHS technologies may be accompanied by a premature withdrawal of traditional services, or that access to other services (e.g., insurance) may be made conditional on the use of PHS.

2. Service systems of PHS

A wider systems approach takes into account the need to design complex architectures relating together people (e.g., recipients of care, care-givers, and others), organizational structures and processes (e.g., that determine divisions of labour and responsibilities and flow of resources) and technologies – especially the information technologies, but also other devices and software related to health and social care – and information.

One notion that has increasingly attracted attention in this context is the notion of ecosystems. Ecosystems consist of different stakeholders, each with its own goals, perspectives, and challenges. Stakeholders here include part of the science and technology system (e.g., firms, technology developers, the scientific community), the health and social care delivery system (e.g., public and private practitioners and managers, and also patients and their organizations and relatives). All of these stakeholders are heavily influenced by regulators and the institutional framework in general.

In order to introduce innovative ideas in healthcare successfully, it is often vital to take account of the ecosystem. Integrated service solutions require aligning

various actors in the ecosystem, and are hinged to the healthcare reimbursement and financing models, regardless of the differences in institutional set-ups of public health care in EU countries. Basically, there are two models of reimbursement in public health care: fee for service (e.g., reimbursement based on diagnosis-related group, or DRG, which is typical for hospitals), and fee per capita (e.g., number of patients treated, regardless of measures taken, which is typical for general practitioners). Both models for reimbursement applied in public health and social care systems can be problematic for the implementation of PHS and integrated service solutions for health and social care in general. Keeping patients out of hospital – through successful implementation of PHS – reduces the fee for services that hospitals receive, and hence reduces their incentives to adopt PHS. On the contrary, general practitioners who receive fees per capita may be unwilling to accept extra (and maybe unpaid) work that is associated with the additional PHS services (Abadie et al., 2011). These funding silos in residential and hospital care pose substantial difficulties to the introduction of PHS services, which often aim at linking the two or avoiding one for the other. Reductions in inpatient services can lower the burden on health and social care expenses, and technologically advanced outpatient services can help healthcare providers to deliver better and more individualized service. This situation suggests alternative funding mechanisms, additional fees (for PHS services), or other types of remuneration and financing. These new approaches are only likely to develop in the medium and long term.

But, this discussion also highlights some of the problems that a transition between service systems can involve. As already noted, the challenge of system innovation typically requires more than just excellent technological solutions, but also a multi-stakeholder process of service system design. Another major problem in health and social care is the division in many countries between healthcare and homecare practice and funding, which has severe consequences for the widespread introduction and adoption of PHS.

3. Markets for PHS

Reliable data on the markets for PHS are rare, despite the variety of reports by market research companies and consultancy firms that promote optimistic views of the markets, or particular market segments, of PHS (e.g., Baum & Abadie, 2013; Datamonitor, 2007; Frost & Sullivan, 2010; Khandelwal, 2010; Ludwig, 2009; Taga et al., 2011). Such reports tend to use a technology-driven market segmentation, and often are unclear as to their methodology and definitions of what units are actually counted in sales figures. Some of the reports note that ehealthcare investment has generally been proxied by ICT investment rather than healthcare investment (Baum & Abadie, 2013). In general, the perception of PHS markets by these market reports is skewed by a supply-side view.

There is an inherent difficulty in surveying the supply-side of the PHS market, as it is likely that supply is also characterized by individuals or very small companies. The advent of smartphones has significantly lowered the market-entry barriers for new producers, who can now rely on an existing platform and program an "app" at nearly marginal price (Baum & Abadie, 2013). The mHealth supply is dominated by individuals or small companies, with 30% of mobile app developer companies being individuals and 34.3% being small companies (defined as having 2–9 employees) (IDC, cited in European Commission, 2014).

In contrast, existing surveys of the PHS supply side suggest that most suppliers are large and medium-sized firms (e.g., Baum & Abadie, 2013). This finding points to the difficulties of identifying small-scale operations (e.g., individual programmers) and young firms, which can be assumed to also populate the supply-side of the PHS markets, especially in the mHealth and fitness realms.

Still, in terms of markets share it seems likely that most markets are dominated by large incumbents (Baum & Abadie, 2013). Purchasing decisions of public healthcare organizations may be powerful factors of success. Such customers typically have long innovation and adoption cycles of five to 10 years. Firms need certain characteristics to cope with such lengthy adoption processes, which often involve much adaption to customer needs. Furthermore, public healthcare providers need reliable partners over years or decades, which make them more likely to ally with incumbent supply firms with established track records and relationships.

Furthermore, the present research project suggests that that the optimistic market projections from market research and consultancy firms may fail to take into account the demand side and more general systems features. A wider systems approach led to the following considerations concerning the demand for PHS:

1. It seems to be a characteristic of demand in PHS markets that clients are on the one hand users and may on the other hand be patients, in which case the cli-

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ent may be a different kind of person/organization. This relationship depends of course on the type of PHS service solution, and accordingly, the literature on PHS markets is torn between the focus on users (i.e., an ICT focus) and on patients (i.e., a health focus). The question arises as to whether demand for PHS will rise substantially on the basis of out-of-pocket money from users/patients, on the basis of private insurances who acquire additional services for their clients, or from financing or spending decisions from public health care bodies (see also Abadie et al., 2011).

2. Another, issue impacting on demand in the PHS area is lack of confidence in individual applications. If many applications exist, which one should the user/patient as an individual trust? And does the physician trust the same one? How then, does a general need for change and efficacy in healthcare translate into demand for single PHS products and services?

3. Finally, this translation may be difficult, because it often involves systemic innovation which, as noted above, needs a multi-stakeholder process and thus takes time. Furthermore, PHS solutions are often related to age-based conditions, and demand for age-based innovations shows distinct features depending on the obviousness of the *age-specialization of the product or service* (Levsen & Herstatt, 2014). Products or services with a moderate to high age specialization face distinct challenges. First, that users are hard to reach when their autonomy has been substantially impaired, and their search for information and ability to make purchasing decisions are limited. Distribution via regular consumer channels may be significantly restricted, which results in costly and difficult sales processes. Second, if others, such as informal carers, take over the purchasing decision, these products and services bear the risk of non-acceptance by the targeted users. Third, if users do not suffer from significantly reduced mobility or cognitive abilities, products with moderate to high age specialization bear the risk of stigmatization, or of being non-prestigious at the least.

Stakeholders in the PHS area expect that new business models have to develop in order to gain value from PHS technologies (Amanatidou et al., 2014) – the logic being that valuable market opportunities for PHS solutions pass because of ill-defined value propositions for stakeholders. This shortcoming poses the question of why new business models in the PHS area do not develop readily. What prevents profit-seeking individuals or organizations from defining new value propositions and exploiting technological opportunities if they seem obvious?

The few studies of business models in health technologies indicate that the definition of value propositions may indeed be fraught with difficulties. Other than studies of the pharmaceutical industry and its alliances with biotech spin-offs, there is little examination of how business models and health technology co-evolve. One of the few exceptions is Lehoux, Daudelin, Williams-Jones, Denis, and Longo (2014), who stress that business model innovation may take time because a number of interacting factors are relevant: the development of a business model results from a "sequential adaptation to new information and possibilities" and articulates an innovation's value proposition and its market segment, the value chain, the revenue model, the value network, and the competitive strategy (Chesbrough & Rosenbloom, 2002: cited in Lehoux et al., 2014). It starts with a selection of one value proposition (out of several that are latent in the new technology). The definition of the market segment to which the (health) technology will offer value also has important consequences. There is an uneven distribution of benefits resulting from the new technology, and of ability and willingness to pay for these, from patients and their relatives, informal carers, physicians, nurses, health care managers, governments, employers, and third-party payers. Managing the value chain for creating and distributing the value(s) offered involves tradeoffs and affect different stakeholder interests (Lehoux et al., 2014). Hence, the development of a business model faces significant uncertainties regarding the innovation, its market, and its supplier (uncertainty being higher for a newly founded firms – especially those emerging from non-business spheres, but even firms emerging from the industrial sphere may face uncertainties reflecting the industry's dominant logic) (Sabatier et al., 2012).

Thus, the establishment of a business model may well involve successive synergistic readjustments – or even drastic reconfigurations of the original business model (Lehoux et al., 2014).

PHS technologies and services are associated with positive externalities – benefits accruing to others than those who pay the price. In case of PHS, many different stakeholders may experience benefits from the introduction of PHS, as suggested above, but which are priced depends on the business model. Economic theory sees this as one type of market failure that justifies

government action. If left to private producers, the product or service in focus is supplied insufficiently, which may slow the growth of PHS markets. Private firms expect investment by public actors, who face financial restrictions, and would have to engage in a process of system innovation in order to implement PHS service systems efficiently. The public actors expect investment by private firms. These mutual expectations may result in underinvestment on both sides.

4. Research and technological development of PHS
In the PHS workshops, the main role of public policy, in order to ensure quality of services and allow interoperability, was seen to be certification and standardization of hardware, software, devices, and systems. Processes for health and social care often engage many system players, in several different organizations: one way of dealing with the interfaces that arise in such contexts is promoting interoperability (i.e. the capability of systems to exchange data in a plug-and-play like fashion). Interoperability is generally thought to have at least three distinct levels:

1. Syntactic interoperability (e.g., Bluetooth, USB)

2. Semantic interoperability (e.g., IEEE X73, HL7 CDA)

3. Pragmatic interoperability

Most standards widely in use today are concerned primarily with the syntactic layer: they deal with data communication protocols and message composition. Standards for the semantic layer, which are concerned with the "meaning" of the data, are much harder to use and less mature today. Such standards are essential for enabling systems to understand each other. For example, decision support on a multi-modal data basis, taking into account information from clinical documents and data provided by patients directly via PHS, requires that these data can be meaningfully related together.

Finally, to achieve pragmatic interoperability means being able to orchestrate different healthcare providers (and their ICT infrastructures) into a continuous caring process, spanning the borders of healthcare organizations – or even, considering cross-border healthcare, whole healthcare systems.

Standards alone are often not enough to achieve higher levels of interoperability: this requires initiatives that guide the utilization of standards in the context of well-defined use cases. Major interoperability initiatives in the field of healthcare are the "Integrating the Healthcare Enterprise" (IHE) and the "Continua Health Alliance" (CHA) initiatives. IHE is an initiative by healthcare professionals and industry to improve the way in which healthcare IT systems share information. IHE promotes the coordinated use of established standards to address specific clinical need in support of optimal patient care. CHA's mission is to "establish an ecosystem of interoperable personal connected health systems that empower individuals and organizations to better manage their health and wellness" (Carroll et al., 2007). Neither organization creates standards itself, instead promoting clearly defined use cases in which existing standards are deployed.

Whereas IHE is primarily healthcare system focused and becomes relevant mostly in the last step while sending healthcare related data to EHR systems, CHA focuses on systems and devices close to the patient. CHA's mission is broader; it includes not only telehealth in terms of remote monitoring of vital signs but also systems more dedicated to wellness and fitness, as well as those supporting elderly people in terms of independent living (e.g., ambient assisted living) and those being cared for at home (e.g., telecare). As such, CHA is of prime importance to the PHS domain. IHE, however, is also essential in cases where PHS systems are to be linked to healthcare professionals and are not confined just to the patients themselves, informal care or consumer-oriented systems (i.e., "gadgets").

Market-entry barriers are a major concern for competition policy. Organizations promoting standards thus should construct open alliances that provide access to various types of firms and organizations in partnership; otherwise, market entry may be restricted.

Finally, research on PHS is not only necessary for technologies and standards, but also to analyze the benefits of PHS applications. This is the basis for comparing PHS applications and also for communicating success. The empirical investigation of efficacy and effectiveness of PHS implementation in turn is the basis for the wider diffusion of these technologies and development of new services around these technological solutions. However, further research on criteria for success and indicators is needed in order to compare either different service solutions or before-and-after situations.

Questions guiding this kind of research are likely to be:

- What are criteria for the successful implementation of PHS in new services?

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- How did PHS solutions impact health and wellbeing in society?

- Who benefits and how can this benefit be measured best?

5. Framework conditions
During the PHS workshops and interviews, it was often suggested that healthcare services will not be solely provided by traditional caregivers such as nurses or physicians. Many other qualifications will continue to emerge in health and social care. Policy makers need better evidence to assess these developments and take decisions to maintain a critical supply of the service workforce (see also MovingLife, 2012). New technologies require technically skilled experts able to implement, run, and maintain the systems and to train and support users (i.e., patients, nurses, doctors, relatives) for daily usage of such systems. By the same token, many caregivers who originally are not affiliated with modern technologies are facing new challenges when needing to adapt to their daily use. Different patients might need different technologies, with (multiple?) devices in people's homes and, in many cases, it is actually the caregiver rather than the patient using them. All players in the health sector will need to think how these additional skills can be achieved by the caregivers – and how they will be reimbursed.

How healthcare organizations deal with their accumulated digital information (i.e., big data) is crucial for the uptake of health ICT. Sharing sensitive patient data in a large, heterogeneous environment complemented by the use of web-based applications raises a number of privacy and security concerns. Case study evidence by OECD (2010) suggests that appropriate privacy protections must be integrated in the design of new health ICT systems from the beginning – they proved difficult to be introduced ex-post (OECD, 2010).

According to EHTEL (2008) the implementation of incident-reporting procedures – similar to those employed by the pharmaceutical industry – would also be welcome. Associated with such incident reporting should be ways of checking that eHealth information systems have been properly implemented and audit trails managed; this should be the subject of constant monitoring for incorrect operation or abuse. Despite standards for medical products on the basis of the Medical Device Directive (MDD; tinyurl.com/d7o56wj), there are apparently gaps with respect to service packages based on PHS technologies.

Discussion and Conclusion

The concept of PHS is often collapsed into the specific information systems that are constructed to support new health and social care services, or even into the specific devices that are employed within these information systems, such as wearable sensors to monitor health conditions or behaviour patterns. This article has argued the importance of a wider systems view, one that situates PHS within health and social care service systems. Such a wider approach takes into account the need to design complex architectures relating together people (i.e., recipients of care, caregivers, and others), organizational structures and processes, with their divisions of labour and responsibilities, flows of resources, etc., and technologies (especially information technologies, but also other devices and software related to health and social care). It also highlights some of the problems that a transition between service systems can involve – the challenge of system innovation. This challenge typically requires more than just excellent technological solutions, but also a multi-stakeholder process of service system design.

It is widely, and plausibly, argued that PHS can contribute to improved health outcomes *and* increase the efficiency of health services. In principle, there should be very substantial contributions, though early demonstrator studies are at best equivocal in displaying major gains and, in particular, cost-savings. This ambiguity reflects the fact that we are dealing with “wicked problems” involving numerous stakeholders and numerous specialized types of expertise – and indeed, a multiplicity of specific problems aggregated together under the health and social care rubric, and often intertwined in the circumstances of specific individuals and communities. PHS are emerging at a time when complex restructuring of health systems – and even of the notion of health itself – is being prompted by demographic, technological, and social changes. PHS will be part of this restructuring, and the extent to which the potential gains of PHS are achieved will be affected by the form it takes. Substantial challenges are involved in shaping this restructuring so that it can rapidly capitalize on the potential of PHS, while supporting equity, patient empowerment, and movement towards more healthy lifestyles.

Numerous stakeholders will be involved in this process, which involves building what participants described as "a PHS innovation ecosystem". It will be important to recognize the very real interests of different stakeholders – for avoiding deterioration in health outcomes; for main-

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taining and extending the equity and social inclusion elements of health systems; for stimulating the development of innovative and effective health interventions and medical technologies; for maintaining professional competences and social status; for rewarding entrepreneurial behaviour; and for protecting and for using personal data. At present, the emergence and potential of PHS has not been widely debated beyond expert communities. Much wider processes of consultation, dialogue, and vision creation will be required to ensure that interests can be articulated – and where necessary challenged – in a transparent manner.

Meeting these challenges will require experimentation, dialogue, and monitoring of change. This study indicated some of the major aspects of change that will need to be addressed. They range from the creation of new business models and partnerships between organizations of different kinds, through stimulating the acquisition of new skills and the emergence of new professions in health (and related) workforces, to putting regulatory frameworks into place that can allow for informed acceptance of evidence-based solutions. In all of these aspects of change, public attitudes will need to be taken into account, because citizens are crucial stakeholders in these processes. These processes will need to be the focus of much greater effort in the near future.

The present study is, hopefully, one step in the direction of adopting a holistic and combined approach in understanding PHS and establishing and sharing visions of the desirable futures that can be achieved with the use of PHS, and the problems that may be encountered and the ways in which these may be addressed, in the course of shaping these desirable futures.

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