Lappeenranta
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REFRAMING THE RELATIONSHIP BETWEEN SERVICE DESIGN AND OPERATIONS: A SERVICE ENGINEERING APPROACH

Thesis for the degree of Doctor of Science (Technology) to be presented with due permission for public examination and criticism in the Auditorium of 1382 at Lappeenranta University of Technology, Lappeenranta, Finland on the 21st of February 2014 at noon.

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ABSTRACT

Henri Karppinen

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The significance of services as business and human activities has increased dramatically throughout the world in the last three decades. Becoming a more and more competitive and efficient service provider while still being able to provide unique value opportunities for customers requires new knowledge and ideas. Part of this knowledge is created and utilized in daily activities in every service organization, but not all of it, and therefore an emerging phenomenon in the service context is information awareness. Terms like big data and Internet of things are not only modern buzz-words but they are also describing urgent requirements for a new type of competences and solutions. When the amount of information increases and the systems processing information become more efficient and intelligent, it is the human understanding and objectives that may get separated from the automated processes and technological innovations. This is an important challenge and the core driver for this dissertation: What kind of information is created, possessed and utilized in the service context, and even more importantly, what information exists but is not acknowledged or used?

In this dissertation the focus is on the relationship between service design and service operations. Reframing this relationship refers to viewing the service system from the architectural perspective. The selected perspective allows analysing the relationship between design activities and operational activities as an information system while maintaining the tight connection to existing service research contributions and approaches. This type of an innovative approach is supported by research methodology that relies on design science theory. The methodological process supports the construction of a new design artifact based on existing theoretical knowledge, creation of new innovations and testing the design artifact components in real service contexts. The relationship between design and operations is analysed in the health care and social care service systems.

The existing contributions in service research tend to abstract services and service systems as value creation, working or interactive systems. This dissertation adds an important information processing system perspective to the research. The main contribution focuses on the following argument: Only part of the service information system is automated and computerized, whereas a significant part of information processing is embedded in human activities, communication and ad-hoc reactions. The results indicate that the relationship between service design and service operations is more complex and dynamic than the existing scientific and managerial models tend to view it. Both activities create, utilize, mix and share information, making service information management a necessary but relatively unknown managerial task.

On the architectural level, service system -specific elements seem to disappear, but access to more general information elements and processes can be found. While this dissertation focuses on conceptual-level design artifact construction, the results provide also very practical implications for service providers. Personal, visual and hidden activities of service, and more importantly all changes that take place in any service system have also an information dimension. Making this information dimension visual and prioritizing the processed information based on service dimensions is likely to provide new opportunities to increase activities and provide a new type of service potential for customers.

Keywords: Service Design, Service Operations, Service System, Design Science, Service Information, Service Delivery

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To be honest, becoming a doctor has never been a dream for me. The inspiring dream for me has always been an opportunity to work with interesting topics, people and challenges that provide powerful motivation every morning. Therefore I consider this dissertation as an intermediate result, and the journey will continue.

I wish to thank my supervisor Professor Janne Huiskonen for his constructive comments and ideas, and most importantly for the freedom of choosing such an interesting but very challenging topic. It is an honor to thank my opponent and pre-examiner Professor Tuure Tuunanen and pre-examiner Professor Lars Witell for their inspiring contribution and comments for improving the quality of this dissertation. I also wish to thank Professor Timo Pirttilä for his early advice and support when the whole process was only a sketch.

While completing a dissertation project is a lonely task most of the time, the whole process is highly dependent on co-workers and cooperative actors. Though our research team has always been very small, the intensive work, the innovative ideas and open-your-mind-attitude have supported me through all these years. I thank Kaisa, Minttu, Veera, Mikko, Petra, Jouni, Kirsi, Petri and all the other coworkers that I have been privileged to work with. Special thanks to Sinikka Talonpoika whose strict but supportive comments have helped me improve my scientific language skills.

In long-term projects, some persons play a more significant role than others. My closest family deserves thanks for their support and interest in my research work. Without Terho's recommendations, my goals and selections would have been very different.

Behind all success, there is a woman. It is clear that without Anna, my dear wife and best friend, I would not be here. Her support and constant motivation have pushed me forward throughout the process, although it has not always been easy. Now it is my turn to be the supporter!

Savitaipale, February 2014

Henri Karppinen

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PUBLICATIONS

This dissertation consists of two main parts, an overview (Part I) and publications (Part II). The publications are listed below. Each publication has gone through a double blind review of the full paper by journal reviewers. For each publication, the roles of the authors and their actual contribution are described in detail (co-authors: Kaisa Seppänen, Ph.D. Student; Janne Huiskonen, Professor and doctor (Tech.), Dissertation supervisor).

PUBLICATION 1 (status published)

Karppinen, H., Huiskonen, J. and Seppänen, K. 2013. Recovering existing service design through reverse engineering approach, *International Journal of Business Excellence*, Vol. 6, No. 2, pp. 214-230

> The present author created the research design, conducted the literature review and made the final conclusions of the paper. The research interviews and data analysis were conducted in collaboration with the co-authors, including also researchers that were not listed as authors. The research process was monitored and managed by the dissertation supervisor.

PUBLICATION 2 (status accepted, in press)

Karppinen, H., Seppänen, K. and Huiskonen, J. XXXX. Identifying product and process configuration requirements in a decentralized service delivery system, *International Journal of Services and Operations Management*, Vol. X, No. X, pp. xxx-xxx.

> The research design, interviews and data analysis were done in collaboration with the co-authors, and part of the interviews were conducted in collaboration with non-author research colleagues. Creation of the research framework, conducting the literature review, and concluding the final results were done by the present author. The research process was monitored and managed by the dissertation supervisor.

PUBLICATION 3 (status published)

Karppinen, H., Huiskonen, J. and Seppänen, K. 2013. Service designs and mindsets – extracting experiential knowledge from service realisation, *International Journal of Procurement Management*, Vol. 6, No. 5, pp. 561-577.

> The present author created the research design, including the development of the employee experience concept, conducted the literature review and made the final conclusions of the paper. The research interviews, as well as the data analysis were conducted in collaboration with the co-authors, excluding the experiential part focusing on design artefact development, which was completely done by the present author. The research process was monitored and managed by the dissertation supervisor.

PUBLICATION 4 (status accepted, in press)

Karppinen, H., Seppänen, K. and Huiskonen, J. XXXX. A modular response model for increasing awareness of systemic variety in service operations, *International Journal of Services Sciences*, Vol. X, No. X, pp. xxx-xxx.

> The research framework was constructed in collaboration with the dissertation supervisor. The relevant research process and required literature analysis were conducted by the present author. The interviews in the case domain A were done in collaboration with the co-authors, including also researchers that were not listed as authors. The data analysis, including also analysis of the case system B was done by the present author, but the final conclusions were made in close collaboration with the dissertation supervisor. The research process was monitored and managed by the dissertation supervisor.

PUBLICATION 5 (status, accepted with minor revisions, in review process)

Karppinen, H., Huiskonen, J. and Seppänen, K. XXXX. Resource integration and production approach for managing a service-technology interface in service systems, *International Journal of Qualitative Research in Services*, Vol. X, No. X, pp. xxx-xxx.

> The research framework, research process and literature analysis were conducted by the present author. The interviews were done in collaboration with the co-authors, including also researchers not listed as authors. The data analysis and forming the final conclusions were done by the present author. The research process was monitored and managed by the dissertation supervisor.

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LIST OF ABBREVIATIONS

A2A = Actor-to-Actor

DS = Design Science

DSR = Design Science Research

DSRM = Design Science Research Methodology

Et al. = *Et alii/ aliae*/ *alia* (Latin), and others (Eng.)

Ibid. = Ibidem (Latin), the same place/citing (Eng.)

IS = Information System

NSD = New Service Development

Op.cit. = Opere citato (Latin), in the work cited (Eng.)

PCM = Perceived Cycle Model

SOM = Service Operations Management

SD = Service Design

SE = Service Engineering

SDS = Service Delivery System

SS = Service Science

PART I: OVERVIEW OF DISSERTATION

1 INTRODUCTION

The overview of the dissertation begins with an introduction section which focuses on the motives behind the study and explaining why there is not only need to understand but also to create new knowledge, tools and even experiences about designing service systems with enhanced design expertise and operational perspective. The selected viewpoint, methods and language used throughout the dissertation form a learning experience for the reader: an example of how the academic and scientific concepts are transformable into practical tools and also how the connection should be made bidirectional – in the service context the practice forms a laboratory that provides valuable data and actions for knowledge creation on a daily basis.

1.1 Research background and motivation

Services dominate the global business, forming about 63 % of the nominal Gross Domestic Product globally (International Monetary Fund, 2012). From the statistical perspective services are defined as a non-material equivalent of a good, not creating an ownership status or as "nonmanufacturing" (Schmenner, 1995). Considering service as not being something originates from the history where the industrial sector formed the core of the economics and society (Sampson, 2010). Though the significance of the service sector is undeniable according to statistical data, service as an object or action still creates confusion and depreciation in science and practice.

In general, science assists in understanding the essence of "things", including how they change over time (Spohrer and Maglio, 2010). In the science focusing on services, it is necessary to define 'service things' and then try to understand how they change. Due to the fact that services appear everywhere and people participate in services as users or providers, the main interest in the service context has focused on the active role of customers (Morris and Johnston, 1987). This also causes new competence needs - when streamlining production technology to improve a manufacturing business, it may not create a sustainable or even temporal basis for creating effective service. The obvious question is how this can be done and how to obtain, maintain, develop and operate 'service things' that are valid throughout the change.

When service is considered as 'not exchanging goods' and 'not manufacturing', service can be defined as application of competences (knowledge and skills) for the benefit of a party (Vargo and Lusch, 2004). The party that applies the competences may be the one that benefits from the service, or the applier may be a party that provides applied competences for the customer. The application of competences can be used as a synonym to creation of service, which refers to the work process that is entailed in providing the service itself (Chase, 1978). Gadrey's (2002, p. 41) definition of service enriches the view on services: "a service may be defined as a change in the conditions of a person or a good belonging to some economic unit, which is brought about as a result of activity of some other unit with the prior agreement of the former person or economic unit". Therefore the work process is not the only process in service creation, also a change in the conditions creates a process for a person or object whose condition is changed. Operationalizing these abstractions may provide an acceptable approach in the context where the internal activities are not affected by the context or the external environment – a circumstance that is becoming more and more obsolete even in public sector services.

Relying on industrial concepts such as process, products and delivery may cause additional challenges if the world around the delivery context does not follow the pre-scripted production rules. For example Lillrank et al. (2011) state that the process approach assumes a tightly coupled production system that allows detailed scheduling. Loosely linked supply networks require different planning tools. In addition, Lillrank (2010) proposes that there are two alternative ways to create service: emerging the service through a work process or designing them intentionally and operating them on the basis of the designs. As a criticism to the industrial logic, Grönroos (2011) underlines that service is fundamentally a valuable unit only for the party that uses it as a part of value creation, but the party that creates the potential for the value creation may consider the chain of activities as a production system.

Ng et al. (2011) argue that service science and research tend to take a too reductionist approach when analyzing services. One of the main problems is analyzing only one process or change per time, whereas the reality consists of multiple simultaneous independent or interdependent changes with material, immaterial and information processes creating a system of changes or a service system. Spohrer et al. (2007) define a service system as a dynamic value co-creation configuration of resources, including people, organizations, shared information (language, laws, measures, methods), and technology, all connected internally and externally to other service systems by value propositions. Though this definition has been cited in multiple studies, relatively few authors acknowledge the main point in it – a service system is a dynamic value-creation system, not a directly manageable or observable working system.

What seems to be reductionist for a scientist may provide a holistic insight for the practitioner (Simon, 1962). Service is a research context where new concepts and ideas can be created easily, but connecting existing ones or removing outdated concepts is not common. Considering service through multiple and interconnected characteristics instead of is-or-is-not definitions creates potentially new opportunities for service research and service organizations. The change drivers presented above can also be used to explain why there is a need to reengineer the basics of service creation. Instead of focusing only on how to predict service creation and behavior through pre-scripted rules, the approach in this study acknowledges the emergent properties and value of service operations. Wieland et al. (2012, p. 15) state that “The importance of seamless and reliable service systems design is highlighted by the fact that these systems are increasingly becoming more complex and global.”

1.2 Research gaps

The main motivation for this study is to understand more but with less – not to create a static meta-model for describing everything. Before setting the research questions, this sub-section focuses on explaining the existing research gaps that are at least partly caused by misleading or overlapping service conceptualizations. The fundamental question for a scientist and for a service manager is the same – should the focus be on developing service operations or is it worthwhile to improve service as design, through designs, and to improve the designability of operations. The question is not only about development efforts but also about acquiring the knowledge related to service and the competence of implementing right tools and right insights.

Sampson (2012) refers to operation as performance of a practical work or of something involving practical application of principles or processes. When connected to the service context, the practical work is the work process that creates service. The application of principles or processes extends the conceptualization by Vargo and Lusch (2004) to cover also changes. Service performance describes the ability to perform, which is challenged by the ability to work as part of a team, ability to do a given job, appropriateness of the tools or technology, perceived control, supervisory control system, role conflict and role ambiguity (Zeithaml, Berry, and Parasuraman, 1988). The customer's ability to perform a role in service interaction can be characterized through effort variability (Frei, 2006). All this can be included in the concept of operations.

When practical work is produced and managed as processes, a work system is built. Alter (2008) defines a service system as a work system, or more clearly, does not see a major difference between the two concepts. "Work system is a system in which human participants or machines perform work using information, technology, and other resources to produce products and services for internal or external customers" (Alter, 2008, p. 73). While Alter may not add many new elements to existing definitions, one of his statements is interesting: "Information systems, projects, and supply chains are all special cases of work systems" (ibid). He also states that the work system view is a static view of the actual system. If there is no work, there is no work system or operations, and in the service context this means that there is not any service. Alter's approach includes an assumption that a work system consists only of pre-designed work or work processes, while the system theory approach embeds also emergent properties (Maglio et al., 2009).

What needs to be managed in a work system that creates service? Sampson (2012) characterizes service operations as producer-consumer interactive operations. Roth and Menor (2003, p. 148) define the main task for service operations management (SOM) and SOM research as "What theoretical and practical insights can be discovered that will enable firms to effectively deploy their operations in order to provide the right offerings to the right customers at the right times?" They suggest further that finding solutions requires strategic alignment of three variables: 1) the targeted market and customer segments, 2) the notion of a service concept as a complex product bundle (or "offering" to customers), and 3) service delivery system design. From the operations perspective the last variable or category –service delivery system design – is the most interesting. Roth and Menor (ibid.) introduce an architecture for Service Delivery Systems (SDS) which is organized around three interrelated and dynamic components of service delivery systems: 1) strategic service design choices including structural, infrastructural and integration choices, 2) service delivery system execution, renewal, and assessment, and 3) customer-perceived value of the total service concept. Although their framework offers a comprehensive view on elements that should be managed within services, they mainly utilize artifacts that are design decisions. They do not explain the components of service delivery system execution and do not connect the dynamic nature of operations to strategic design choices.

In order to clarify how service is created and how operations are related to it, alternative perspectives to operations need to be found. The extensive research and literature focusing on service processes offer many detailed components, artifacts and units for analysis. Lillrank (2010) suggests that when the focus is on processes, the managerial attention is directed to arranging two or more tasks in relation to each other and connecting the tasks to sequences. Lillrank also proposes that there are two types of connections: logical or functional, meaning that two phases can or cannot be connected in multiple ways (qualitative connection) or as a physical or flow-based connection (quantitative connection) where something is handed over to the next task. A typical handover in service systems is information in the form of control information or signals, in addition to service flow, which may include the actual service content or object. These flows may also have a dual meaning in the service context, for example the information signal can be seen as a referral in the health care work system (ibid.). Other managerial objects or concepts include inventories between process steps, time, results and costs (ibid.). The service process offers also a frame for analyzing service operations, but it does not increase understanding about how services or operations are executed by the resources.

The service-dominant logic domain suggests two major categories for resources in the service context: 1) operand resources that require action taken upon them to be valuable and 2) operant resources that are capable of acting on other resources to contribute to value creation (Vargo and Lusch, 2004). Another type of classification has been proposed by Maglio and Spohrer (2008): 1) resources with rights, 2) resources as property, 3) physical entities, and 4) socially constructed resources. Although the resource typology does not explain how resources act, they provide a connection to service creation. A service system co-creates value through integration of resources (Lusch et al., 2010) or as Grönroos (2011) states, the customer creates value through integration of resources produced partly or fully by the service provider. Kleinaltenkamp et al. (2012) argue that though resource integration is a central concept in value creation-oriented service research, there is a gap between how the term is used and what is actually known about resource integration. Resource production and resource integration describe *activity or work*, and therefore they form a critical link between work systems and service. However, the knowledge related to resource production and resource integration from the perspective of operations is very limited. Vargo et al. (2008) add a systemic characteristic and challenge for service operations by stating that resource integration is a potentially endless process, an aspect that has not received much attention in the relevant service literature.

Before concluding the description of the research gap, an additional perspective has to be explored: service design and designability in the service context. Kimbell (2011, p. 42) clarifies the main difference between designing and design as follows: “Designing is seen as shaped by a situated understanding of the issue at hand in contrast to a view of design in which engineers design functions in response to constraints.” The deterministic view of design sees it as a problem-solving activity that aims to work towards a desired state of affairs that can be determined in advance, whereas the exploratory view focuses on enquiry during which understanding of an issue or a problem emerges (ibid.). Kimbell’s view is illustrated in figure 1.

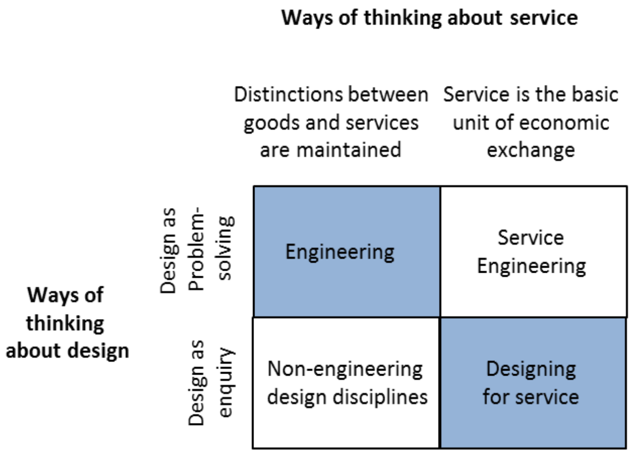

Figure 1. Ways of thinking about design and service by Kimbell (2011)

Evenson and Dubberly (2010) view designing for service as a meta-activity which focuses on conceiving and iteratively planning and constructing a service system or architecture to deliver resources that choreograph an experience that others design. Experience takes place in the experience environment which consists of physical and relational elements (Zomerdijk and Voss, 2010). These contexts can also be designed as part of service design in order to engage customers and to enable the customer to connect with the service in a personal, memorable way. Service design language consists of design elements that are combined into constructs and the principles for their combination (Evenson and Dubberly, 2010). Service design language is used to visualize, express and choreograph the resources that mediate the service experience (ibid).

On the basis of the brief examples presented above it can be concluded that service research and the existing literature offer a wide range of ideas, models and concepts for developing new services and improving existing ones. This concept and construction offering brings, causes and reveals challenges that have not been properly addressed in previous studies.

The first argument for the existing research gap is related to the aim of viewing service as a single architectural constellation while being unable to find this architecture. Outside academic developments, empirical service systems are able to provide services for their customers without using intentionally any conceptual artifacts or tools. This indicates that there are both existing architecture and related dynamics in every system including related artifacts. The existing service research approaches tend to consider the relationship between conceptual artifacts and empirical artifacts as unidirectional in a similar way as the design decisions guide the operations, but not vice versa. These dominating assumptions provide at least two challenges: 1) losing the potential (bidirectional) dynamics between conceptual developments and empirical activities, and 2) not acknowledging the information content of different artifacts. So far service research has bypassed the idea of considering the service delivery system, work system and design constructions as an information processing system which communicates through the service artifacts.

The second and more practical argument is the key role of work and operations in delivering results, changes, experiences and value, and forming the dynamics in the service system. The dominating approach related to value-creation attracts the mainstream research in the service context while disregarding an interesting field of studying what happens beyond the value creation surface. The purpose of this observation is not to underestimate the value creation approach but to add and link more operational issues into it. For example the key concepts *resource production* and *resource integration* need to have their operational counterparts, otherwise there is no point in using them. Both resource production (producing something) and resource integration (integrating something) are actions that change the state of the system as any work does. In a similar way, processing service-related information and designing a service delivery system change the state of the system, but so far information processing has been excluded from the key activities in the service context.

The third argument for the research gap has two dimensions: time and logic. Time refers to both chronological and situational components that have a role in the formalization of the service context, but also to how the work is conducted and how operations (performance related to work) can be utilized in the creation of resources. Situational components are not very common in the artifacts even if they could maintain their situational information in the abstractions. The logic part does not refer to the logic of service but to the logic of how the work system and operations are connected to the design activity and design artifacts. As Kimbell (2011) suggests, two alternatives exist, predicting behavior through artifacts as an engineering approach, as most approaches do, or exploring operations and exploiting practical knowledge and situational problem-solving in the creation of designs. This argument includes the idea that even if results in the form of service, solution or change could be provided without explicit design(s), it does not mean that designs would not be needed. In addition, to guide operations and service delivery, it is proposed that also processing the right type of service information and delivering it in the right format benefits from service designs.

These gaps and challenges are not only theoretical, they also create a significant practical requirement: design tools must have practical relevancy in a similar way that operational models and tools do. Therefore the design concepts must go through evaluation processes where they are tested and connected to operational concepts, and vice versa.

1.3 Research objectives and research questions

This study aims at connecting design activities and design artifacts with operations and the work system behind operations. The main objective is to 1) create a knowledge base for service information processing needs in the service delivery system and describe them at the architectural level, 2) develop and empirically evaluate design tools for extracting, creating and utilizing architectural level information in the service context, and 3) position new service information artifacts in relation to the value creation and service system approaches. In order to do so, the main research question of this study is formulated as follows:

Research question:

> What kind of service artifacts and information content can be utilized in transforming the static linkage between service design and service operations into a more dynamic relationship?

The main question forms a multi-perspective setting which can be observed when the research question is illustrated in the research gap setting (figure 2). Therefore the main research question has been divided into three sub-questions that can be further translated into research tasks.

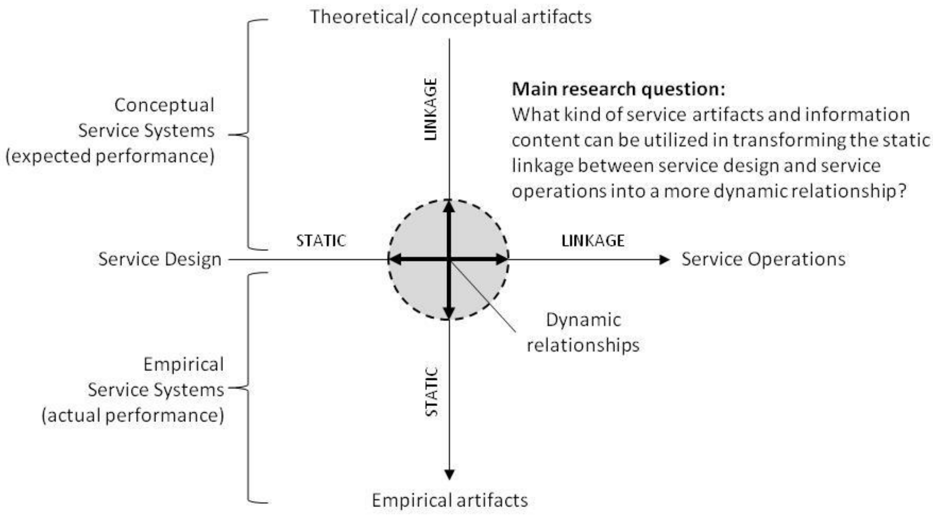

Figure 2. The main research question based on three research gaps

The first sub-question focuses on extracting information from existing theoretical service design and operations artifacts. The selected approach uses information inputs from artifacts intentionally instead of collecting information needs and "best-practices" from empirical contexts. The core idea is to connect the existing artifacts first at the conceptual level and to define information needs based on the theoretical views. The second sub-question focuses on the transformation of service information into valuable knowledge. Here it is assumed that collectable data, service information and knowledge are fundamentally different issues. The aim of the second sub-question is not to contribute to knowledge management theories but to focus on creating new insights and knowledge for service design, service engineering and service operations management fields instead. The third sub-question covers the connection between service information and service management. It is proposed that service information and knowledge that can be created through processing is valuable if a link between other service management approaches can be created and validated.

Connecting the existing service design and operations artifacts should reveal the managerial elements that service researchers and practitioners consider as most important. This approach goes beyond the traditional literature review by analyzing the information content of theoretical artifacts and their potential combinations. The role of information is taken mostly as given, and the resource category is only rarely accessed despite the significant role that information has in the service context. The first sub-question is formatted as follows:

Sub-question 1:

> What conceptual service design and operations artifacts form the core concepts in the service delivery system, and how can the connections or shared properties in the artifacts be transformed into information?

When the required, potential and available information is explored, it is possible to create connections between different artifacts based on their information content in addition to those connections that were already done when the artifacts were analysed. This study relies on the basic assumption that service does not form a system, but the service logic or value creation logic can be used to explain how service is expected to work or works. This does not make the value creation less valuable, however. In contrast, the system that actually integrates and produces resources must be tightly connected to the service logic. By using artifacts to describe a service system will potentially cause inability to see what actually makes or enables creating a service and value potential for the customer. Therefore it is necessary to create tools and capabilities to transform service information into knowledge which is meaningful in the service context. The second sub-question is formatted as follows:

Sub-question 2:

> What kind of information connections exist between service design and operations based on conceptual and empirical knowledge, and how can these connections be utilized to reveal the dynamics of the relationship and new information needs?

The approach developed in this study aims at describing architectural information that cannot be observed or extracted straight from real activities. In order to make the proposed approach complete, an understandable connection to service management concepts and also measurements has to be formed, otherwise it is impossible to say whether the extracted information is valuable or not. Forming the connection back to service management provides also a way to evaluate areas where new knowledge was created, but it also demonstrates a process of how to add new artifacts and test their information content and significance in a service system. The third sub-question is formatted as follows:

Sub-question 3:

> What kind of new information resources can be created, and through which resource production and integration activities, in order to ensure the value for service management?

1.4 Managerial challenges and development potential in service design and service operations areas

Due to the fact that service is a relevant and valuable unit only through realization, it is necessary to link the research interest and research question to practical service contexts. Despite the level of abstractness and the potential complexity of concepts from the practice perspective, the research process, the developed tools and the results are expected to have significant practical relevancy. The proposed potential and practical need for the study is introduced through four interlinked themes: 1) the value of service information, 2) extracting service characteristics that are not directly observable, 3) operationalizing designs and innovations, and 4) learning from service operations.

In the service contexts where the status of the service object is both relevant and changing constantly, special attention must be directed to managing the status information. For example in the health care service, the status information covers a much wider part of the service than just the direct or even surrogate interactions (Sampson, 2012). Not only tracking an object but also the difference between what can be traced and what forms a relevant object for service or substance needs to be understood. The first theme emphasizes the value of information through usage and usage only. It means that collecting and storing information is not meaningful, if the practical connection to work and operations is missing.

The second theme focuses on extracting service characteristics that are not directly observable. These characteristics are easily bypassed if the substance expertise in the service context such as health care, transportation or consulting dominates the communication and operations. It is possible that valuable information will not be extracted if the language does not support it. However, strong expertise does not mean that the service terminology should be implemented as is but it is proposed that through information, meaningful service characteristics can be extracted to human resources for utilization.

The third theme covers improving the quality of the development work and the designs or plans which are meant to be implemented in the service operations. In practice this means that a connection should be formed from design to operations but also from operations to design. The traditional development approach does not acknowledge situational parameters that affect operations significantly. In the worst case, the operational measurements are designed based on the static design level service knowledge, and the solution supports design well but does not provide a reliable view for operations. The direction from operations to design should support the recovery of designs, which means that even if the service had not been designed, the design form can be recovered from the operations. This would provide valuable and relevant information as the connection between operations and design would be made using operations terminology.

The fourth theme underlines the value of service operations from the learning perspective. What is work and daily routines for a service employee or normal service experience for a customer may include valuable lessons to learn. In addition to design recovery, operations consist in most cases of small or large but very practical innovations. Through these innovations the employees may not strictly follow the pre-set rules but they make the service to deliver. In a normal situation these employee-based adaptions are accepted and if no problems appear they may be taken as the dominant way of delivering the service. From the service information perspective the decision-making related to operational adaption is qualitative and usually not traceable. Even if the adaption were successful it does not create any information about the solution. For service managers, adaptions may also cause a situation where a service is delivered but not charged. Doing a little bit of this and that will consume time without any compensation.

1.5 Outline of the study

The dissertation contains two main sections: the introduction part and the publications. The introduction part provides an overview of the study in which the research background, research motivation, research questions, research design, theoretical background in the selected areas, construction and evaluation of the design artifact, and the conclusions are presented. The second part consists of five independent scientific publications with two interconnected objectives: to answer the research questions and to form, test and evaluate the components of the design artifact. The conclusions section is based on the findings and the results of publications but covers also the evaluation of the complete design artifact. The structure of the dissertation is illustrated in figure 3.

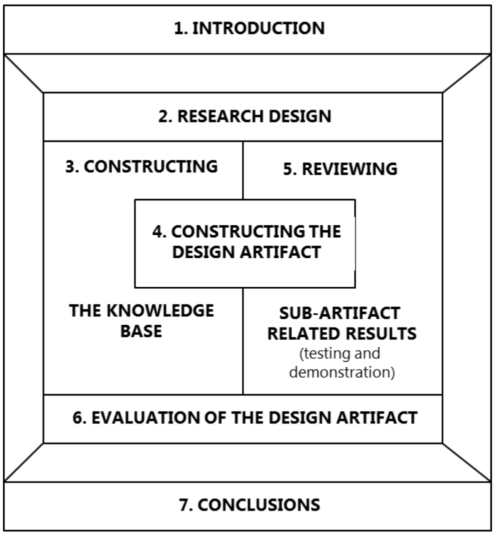

Figure 3. Structure of the dissertation.

1.6 Key concepts of the research

Service: can be viewed as a change in the conditions of a person or a good belonging to some economic unit, which is brought about as a result of the activity of some other unit with prior agreement of the former person or economic unit (Gadrey, 2002). The activity can be application of competences (knowledge and skills) for the benefit of a party, or resource integration and production (Grönroos and Voima, 2013).

Service process: is an artifact or unit of analysis which focuses on the level of routinization in the service operations and can be used in identifying, analyzing or designing services. When the focus is on processes, the managerial attention is directed at arranging two or more tasks in relation to each other and connecting tasks to sequences (Lillrank, 2010).

Service system: is a dynamic value co-creation configuration of resources, including people, organizations, shared information (language, laws, measures, methods), and technology, all connected internally and externally to other service systems by value propositions (Spohrer et al., 2007).

Work system: is a system in which human participants or machines perform work using information, technology, and other resources to produce products and services for internal or external customers. Information systems, projects, and supply chains are all special cases of work systems (Alter, 2008). A work system is a static view on real systems and operations.

Architecture: of a system is determined through two opposite processes: partitioning and aggregating. While partitioning imposes structure to the design problem by breaking it down into smaller sub-problems, too many partitions make the design intractable. Aggregating similar functions and features helps simplify the design, but too much aggregation may cause important details to be left out of the design (Rechtin, 1991). Architecture in the service context describes which components are part of the entire system and with which properties (i.e. functions) they should be endowed (Heckl and Moormann, 2009). Architecture is mainly a static construction that can be used to view the different characteristics of a system.

Architectural knowledge: consists of design or architecture (components, relationships and interfaces) decisions that have been made in the construction of the design or architecture, decisions that have been embedded in the design or architecture, and description of how the design performs and how the behaviour is dependent on the environment where the design is utilized (adapted from Baldwin, 2010 and Kruchten et al., 2006). All architectures are designs, whereas all designs are not architectures (Booch, 2008).

Artifact: is a meeting point – an interface in today's terms – between an ”inner” environment of the substance and organization of the artifact itself, and an ”outer” environment, the surroundings in which it operates (Simon, 2001). An artifact appears usually in the form of a construct, a model, a method or an instantiation (Hevner et al., 2004), indicating that design is both a process and a product (Walls et al., 1992).

Design: is used in visualizing, expressing and choreographing what other people cannot see, envisaging solutions that do not yet exist, observing and interpreting needs and behaviors and transforming them into possible futures, as well as expressing and evaluating, in the language of experiences, the quality of design (Holmlid and Evenson, 2008).

Operations: is the performance of a practical work or of something involving practical application of principles or processes (Sampson, 2012). In the service context, goal-oriented practical work is a work process that aims at providing service and value-creation potential for the customer (Grönroos and Voima, 2013).

2 RESEARCH DESIGN

This section focuses on describing the research design of the dissertation by explaining in detail all the major research-related decisions that were made. Creswell (2009, p. 3) describes research design as "plans and procedures for research that span the decisions from broad assumptions to detailed methods of data collection and analysis". The broad assumptions begin with explaining the ontological and epistemological choices which are utilized in the construction of the research methodology.

2.1 Ontological and epistemological considerations

Considerations related to the philosophy of science cannot be bypassed in management studies. What is considered as a managerial problem and as an acceptable scientific approach are influenced by the ontological and epistemological stances of the researcher. The ontology answers to the question: how the world is constructed? The ontological view influences on the epistemology which is used to describe what humans can know about the world (Fleetwood, 2004). Here the focus is on three alternative but also potentially complementary approaches: *critical realism, constructivism and moderate constructionism*.

Critical realism focuses on re-establishing a realistic view as an ontological domain while accepting the relativism of knowledge as the epistemological domain (Mingers, 2000). According to critical realism, scientific reality consists of objects, entities, and structures which generate events that we observe (Archer, 1998) In critical realism an entity can exist independently of its identification, meaning that it can exist without someone observing, knowing or constructing it (Fleetwood, 2004). Critical realism also assumes that there are deep structures in this world that can be represented by scientific theories (Alvesson and Sköldberg, 2010). In critical realism, an entity is said to be real if it has causal efficacy, in other words the entity has an effect on behavior and behavior makes a difference (Fleetwood, 2004).

In contrast to critical realism, the social constructivists hold an assumption that individuals seek understanding of the world in which they live and work, and individuals develop subjective meanings of their experiences (Creswell, 2009). Experiences are meanings directed toward certain objects or things (ibid.). Von Glasersfeld (2001) argues that a scientist's task (constructivist) consists of two alternating phases: the formation of conceptual structures and the attempt to demonstrate that experiences can be fitted into these structures. The major difference between constructivism and critical realism is in how the reality is viewed: whether there is a "real" reality or whether there are local and specifically constructed and co-constructed realities. Van Gigch (2003, p. 171) summarizes the modern constructivist view as follows: "new knowledge is 'constructed' or built in the very act of developing it".

Mir and Watson (2001) consider that critical realism and constructivism are not interchangeable but potentially compatible. In their research context, strategy research, the two approaches can be used to explain the same phenomenon in order to get a richer view on it (table 1).

Table 1. Contrasting realism and constructivism (Mir and Watson, 2001)

	Realism	Constructivism
Nature of observed reality	Partial, but immutable	Socially constructed
Role of manager	Reactor, information processor	Actor, generator of contexts
Nature of strategic choice	Boundedly rational response to contingencies	Ideological actions of sub-organizational interest groups
Organizational identity	Overt, singular	Multiple, fragmented
Theories of measurement	Replication as a key to accuracy	Context as the key to perspective

Mingers (2000) cites Bhaskar (1979), who proposes potential challenges that critical realism faces in the social systems, which service also is (Edvarsson et al., 2011), in contrast to natural systems. Ontological challenges focus on the nature of social systems (the way we think the world is): social structures do not exist independently of the activities they govern, they exist only in their effects or occurrences; social structures do not exist independently of the agents' conceptions of what they are doing; social structures are localized in both space and time. Epistemologically social systems are inherently interactive and open. Bhaskar (ibid.) proposes that while natural systems are open too, they can be artificially closed or controlled in laboratory, which is not generally possible with social systems. Openness and inability to control social systems makes it difficult to test theories since the predicted effects may or may not take place. Also measurement becomes difficult when the meanings related to phenomena are meaningful and these meanings cannot be measured or compared, only understood and described.

Järvensivu and Törnroos (2010) offer a third option, moderate constructionism, as especially suitable for management studies. They argue that moderate constructionism is fairly close to critical realism, as both acknowledge finding local, community-bounded and interactive forms of truth which are created and validated through dialogue in various communities. The main difference from the research redesign perspective is that moderate constructionism accepts that there may be multiple community-formed knowledge bases, instead of one universal truth (ibid.). Richardson (2000) argues that in the constructionist view traditional triangulation in the validation of the research findings should be replaced by a crystal form in which the various evaluation perspectives and parameters are combined. According to Järvensivu and Törnroos (2010) this means that in constructivist research there is no formal definition for valid knowledge, there are more or less valid approaches instead that help in understanding the world.

Avenier (2010) gives an example of how mainly the critical realism and constructivist approaches have been linked to the sciences of the natural and sciences of the artificial in the context of organizational science. Avenier (ibid.) proposes that the critical realist epistemological view when connected to sciences of the artificial leads to design science or sciences, whereas the constructivist view leads to sciences of design based on scientific contributions. In other words, though the original authors would classify themselves according to one selected philosophy (or do not classify themselves at all), the same type of research may be developed in both epistemological paradigms.

As this dissertation does not focus on the philosophy of science but aims at scientific results that have also practical relevancy, the philosophical considerations must be linked to the research questions as well as the steps of proceeding: selecting the methodology and creating the research process including data collection. This study takes the critical realist view and assumes that there is only one reality even if it is not observable now, but new insights can be created through constructions and models. However, it is also acknowledged that the constructivist and moderate constructivist approaches contribute to the selected approach: the social constructions and concepts embedded in the work systems that deliver service may create a relevant reality for those working in the work systems. Even if the work system is an open system, the observed reality by the actors may not cover the whole system but only single events (local reality). This is an acceptable setting, as the main objective of this study is not to provide true values, but methods for understanding and describing reality as information.

2.2 Positioning the dissertation in the field of scientific domains and approaches

The main research question links service designs to service operations through information with the objective of creating valuable knowledge about their connection and information content for service management. The ontological and epistemological considerations set relatively loose boundaries for selecting the research methodology, and therefore it is necessary to introduce the most relevant scientific disciplines and foundations that are constructed into these disciplines. Whitley (1984) states that management research is often understood as studying managerial problems with scientific methods. Here the scope of managerial problems is narrowed to four disciplines: service operations management/operations management, service engineering, science of design/design science research and service science. It should be notified that none of these approaches or domains represents theories but they are research approaches, findings, models and frameworks.

- **Service Operations Management** is defined as discovering theoretical and practical insights that will enable firms to deploy their operations effectively in order to provide the right offerings to the right customers at the right times (Roth and Menor, 2003). Schmenner and Swink (1998, p. 100) summarizes the key phenomena in the operations management as follows: “For those of us intrigued by operations, one of the key phenomena we seek to understand is why one operation (factory or service) is more productive than another.” Operations management includes also some well-accepted “laws” that also follow the productivity or optimization objective, such as the law of variability, law of bottlenecks, law of scientific methods, law of quality and law of factory focus (ibid.). Schmenner and Swink (ibid.) argue that operations management consists of insightful frameworks which can be useful tools in the generation of theory but at their current state are not theory. As an example they use the product-process matrix which is used as a law but which does not fulfill the criteria of theory.

- Bullinger et al. (2003, p. 276) define **Service Engineering** as “a technical discipline concerned with the systematic development and design of services using suitable models, methods and tools. In contrast with new service development, which is strictly marketing-oriented, service engineering adopts a more technical-methodological approach, attempting to efficiently utilise existing engineering know-how in the area of traditional product development to develop innovative services.” Service engineering acknowledges and utilizes some aspects of operations management (ibid.). Sakao and Shimomura (2007, p. 592) describe Service Engineering as “discipline to increase the value of artifacts and to decrease the load on the environment by reason of focusing service.” According to their view, service engineering also aims at intensifying, improving, and automating service development, service delivery and consumption.

- **Design science research** is defined as “research paradigm in a which a designer answers questions relevant to human problems via the creation of innovative artifacts, thereby contributing new knowledge to the body of scientific evidence” (Hevner and Chatterjee, 2010, p. 5). The key concept, artifact, is defined as describing something that is artificial or constructed by humans as opposed to something that occurs naturally (Simon, 2001). Design science research focuses on significant unsolved problems in unique or innovative ways, or solved problems in more effective or efficient ways (Hevner et al., 2004).

- **Service Science** is an interdisciplinary field that "combines organization and human understanding with business and technological understanding to categorize and explain the many types of service systems that exist as well as how service systems interact and evolve to co-create value" (Maglio and Spohrer, 2008, p. 18). Service science is not, however, a merger of two disciplines but a quest for a holistic integrative discipline (Spohrer and Maglio, 2010). Dominguez-Péry et al. (2013) describe service science as a discipline that facilities service innovation, which creates changes that impact the evolution of the service system directly.

When philosophical and research traditions are combined, the following arguments can be presented. According to the operations management view, existing operations take place in reality and productivity can only be improved in reality. One way to evaluate productivity in operations is to connect it to objectives or goals. According to the design science approach it is possible to construct artifacts that describe operations (*something)* and their connection to objectives (*solved problem or solution to the problem*), and through these artifacts knowledge creation is possible. This knowledge must be suitable at least for two purposes: improving productivity and creating innovation and changes that will have an impact on the evolution of the system. Improved productivity and changes again take place in the reality layer through action, even if they are not observable or identifiable. It is assumed that change, intended or emergent, may take place even if the measurements to capture the change do not exist. In order to contribute to the emerging field of service science, it is necessary to extend the operative view on more systemic elements. This will have an effect on the way we see the operations but also how knowledge is used in the decision-making, even though the resources in the operations would not observe or identify the systemic or service nature of operations. The potential connections between the disciplines form preliminary requirements for the research methodology and the research process which are illustrated in figure 4.

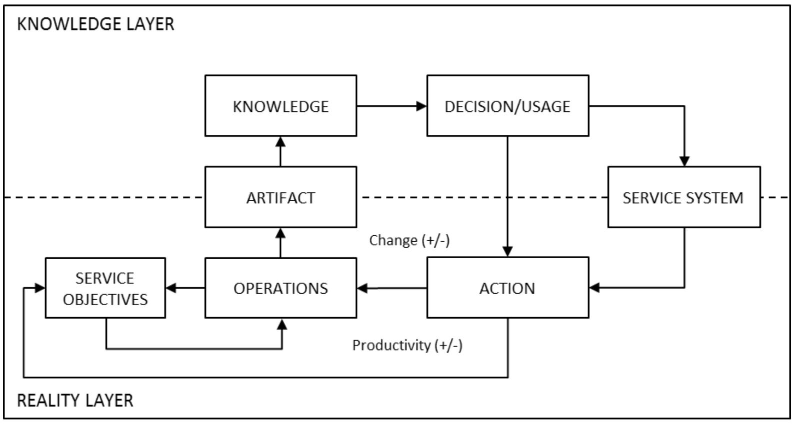

Figure 4. Preliminary requirements for the research methodology and research process in the service context

2.3 Research methodology

The methodological requirements for providing answers to the research questions were formed in the previous sub-sections. The research methodology must support transforming the service-related artifacts into meaningful knowledge that can guide activities directly and through the service system perspective. It is assumed that artifacts can be created on the basis of theoretical knowledge from the existing artifacts, or alternatively from empirical service contexts by observing operations and by making the necessary research inquiries. In this study, artifacts are considered as filters in the knowledge creation, but similar filtering is needed when the knowledge is operationalized as service information. Understanding the transformation itself at the conceptual level is not enough, it is necessary to test whether the artifacts can be actually implemented in practice and whether the new service information will change anything. These requirements are acknowledged in the following decisions:

- The design science research orientation in combination with service engineering knowledge forms a methodological frame for creating artifacts and testing them. It mainly utilizes the existing theoretical background but acknowledges also the knowledge potential that is extractable from practice.
- The empirical understanding of how the service operations actually work and why current services are operated as they are is created through a case study approach. The case study methodology supports learning from individual case contexts but it also provides well-known methods for acquiring experience throughout the project, also from the testing phase included in the design science research.

In sections 2.3.1 and 2.3.2 both methodological approaches are reviewed briefly and the requirements for implementation are introduced. In section 2.3.3 the final research approach with the mixed method approach and the research process are explained.

2.3.1 Design science research approach

In this study, design science research (DSR) is used as the basis for the research approach. Two fundamental questions are therefore: how are design artifacts created in DSR and what kind of research process supports creating and testing the design artifacts? Most design science-related knowledge and practical processes are based on the requirements and experiences in information system contexts (e.g. Hevner et al. 2004, Peffers et al., 2008), but also other disciplines such as organizational (Avenier, 2010) and management research (van Aken, 2005) are acknowledged. As pointed out in the introduction section, this study focuses on the potential related to service information. Though the interest is not in how to design information systems or information technology, the research question and sub-questions are close to the problem-solving situation in the information system context. Hevner and Chatterjee (2010, p. 5) define information as “data that has been processed into a form that is meaningful to the recipient and is of real or perceived value in current or prospective actions or decisions”.

In this study the service perspectives add potentially some new criteria for processing data but even then the core idea is the same.

Holmström et al. (2009) describe the design science (DS) approach as the process of *exploration through design* and artifacts as *solution designs*. They also state that the design science approach is more about creating problems than discovering them; discovering a symptom of a potential problem is not the same as discovering a problem (ibid.). Simon (2001) states that the artificial world is concerned with attaining goals by adapting the inner environment to the outer, and the process of design focuses on the way the adaption of means to environments is brought about. The artifact is usually in the form of a construct, a model, a method or an instantiation (Hevner et al., 2004), indicating that design is both a process and a product (Walls et al., 1992). Though Gregor and Jones (2007) criticize Walls' approach for separating the design product and design process, the separation may embed valuable experiential knowledge about the design process, although it is a different perspective from the one originally used by Walls.

Simon (2001) states that models use constructs to represent a real world situation as a design problem and its solution space, making the conceptualization even more complex. Defining solution space requires knowledge about a framing space “in where the nature of the problem to be solved is determined in relation to constraints of the situation presented, because a given problem might be conceptualized in multiple ways” (Feldon et al., 2013, p. 363). Simon (2001) argues that it is often possible to predict the behavior of a system from its goals and its outer environment, with only minimal assumptions about the inner environment, making the outer environment and goals of the system also relevant design knowledge.

> “A design science does not develop knowledge for the layman, but rather for the professionals in its field. This means that design knowledge is to be applied by individuals who have received formal education in that field.” (Van Aken, 2004)

Philosophical and conceptual discussions and arguments are needed even if all criteria cannot be translated into the research process. In order to understand how rigorous design science research should be done, three complementary alternatives are reviewed briefly below: design science research methodology by Peffers et al. (2008), design science approach by Holmström et al. (2009) and systems development research methodology by Nunamaker et al. (1990-91).

The design science research methodology (Peffers et al., 2008) for information system (IS) research provides three core elements for conducting design science research: (1) a nominal process for conducting DS research, (2) building upon prior methodological literature about DS in IS and reference disciplines, and (3) providing researchers with a mental model or template for a structure of research outputs. The methodology of Peffers et al. (ibid.) is based on seven previous studies presenting knowledge-related design science research in the information system context. Their complete model consists of six interconnected phases, presented in figure 5 and explained briefly below. The model is intended but not required to be used in a sequential order.

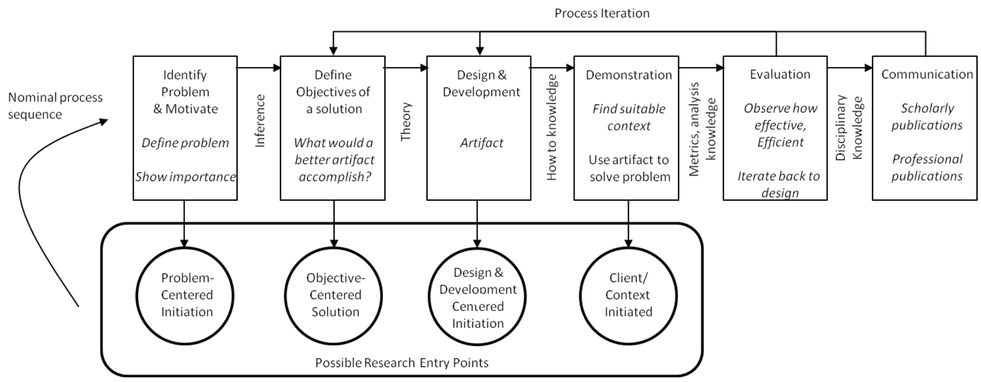

Figure 5. Design science research methodology (Peffers et al., 2008, p. 54)

The first phase, *problem identification and motivation* focuses on defining the specific research question and setting goals for the value of the solution. Peffers et al. (2008) suggest that in case of a complex problem, it is worthwhile to atomize the main research question and the related problem into smaller components. These components will assist in capturing the full complexity of the problem. Value expectations set the framing solution space for the researcher but also help the audience of the study to evaluate the results and to understand the researcher’s view on the problem.

The second phase covers setting objectives for the solution which can be described quantitatively or qualitatively but they should be inferred rationally from the problem specification. The third activity is the design and development where the artifact is created. In addition to the earlier definition of what an artifact is, according to Peffers et al. (2008) it may also be new properties of technical, social and/or informational resources, which is a valuable addition for this study. Design and development covers also determining the desired functionalities of the artifact and its architecture, as well as creating the actual artifact (ibid.).

The fourth phase is demonstration, where the use of the artifact to solve one or more relevant instances of problem is executed. This phase may include also simulation, case studies, proof or other appropriate activities (Peffers et al., 2008). In the fifth activity phase, the artifact is evaluated through observations and measuring how well it supports a solution to the problem. Evaluation depends highly on the nature of the problem and it may include several different methods and measures, but the minimum requirement is to compare the functionalities and results of the artifact with the objectives set in phase two (ibid.). The final phase in the design science research methodology is communication. This phase consists of communicating the problem and its importance, the artifact, its utility and novelty, the rigor of the design, and its effectiveness or other criteria to the research community and to practice (ibid.).

The second methodological approach, the design science approach presented by Holmström et al. (2009), focuses on linking practical problem solving to scientific research requirements and even theory creation. This aspect is not missing in the previous model, but it is explained and introduced differently and it provides a way to link empirical work to design science research. The model focused on two main phases: an exploration phase having a design science focus and explanation phase having a theoretical science focus. The model and its main components are presented in table 2.

Table 2. Design science approach by Holmström et al. (2009, p. 70)

Research type	Exploration (Design Science)		Explanation (Theoretical Science)	
Research phase	1. Solution incubation	2. Solution refinement	3. Explanation I	4. Explanation II
Objective	Development of an initial solution design	Refinement of the initial solution design; solve the problem	Development of substantive theory, establish theoretical relevance	Development of formal theory; strengthen theoretical and statistical generalizability
Means	* Identification of interesting goals, situations and possible solutions * Scanning of parallel knowledge domains * Abductive cross-disciplinary reasoning	* Implementation of solution designs * Confirmation of intended consequences * Cooptation of unintended consequences * Iteration between solution designs, implementation and evaluation * Inductive and deductive reasoning	* Theoretical reflection of the refined solution design * Linking the solution design to a research program and theoretical discourse * Inductive and deductive reasoning; hypothesis building	* Theoretical and empirical examination of relevant contingencies * Development of formal representations of the solution design * Implementation and refinement of the solution in the multiple contexts * Inductive and deductive reasoning; hypothesis building and testing
Knowledge interest and research approach	* Pragmatic * Action research * Subjective	* Pragmatic * Action research * Subjective and intersubjective	* Cognitive/ pragmatic * Evaluative research * Intersubjective	* Cognitive * Evaluative research * Intersubjective

Holmström et al. (2009) state that the strength of the design science approach is the focus on improving the practice and the capability to provide results immediately relevant to the practice. The main challenge, the ability to lead to a novel theoretical insight is not originally a main concern in design-focused research (ibid.). However, it is the key objective for more generalizable knowledge creation. The approach of Holmström et al., combined with the approach of Peffers et al. (2008) provides not only a process or procedures, but also concrete steps for separating practical knowledge creation from theoretical one. Holmström et al. (2009) also argue that exploratory and explanatory research does not necessarily lead to a trade-off between rigorous scientific research and practical relevancy. Instead they state that rigorous means set different requirements and focus in each area. Rigor in explanatory research evolves around construction and demonstration, while the exploratory focus is on the improvement of the design and demonstrating its practical relevancy (ibid.). All these aspects are further explained in the context of this study, when the final research process is formatted.

The third methodological approach is the systems development research methodology presented by Nunamaker et al. (1990-91). This methodology provides many elements that were already introduced in connection with the two previous approaches but it also emphasizes elements that are not so well described in the other models. Systems development research methodology consists of five different phases: 1) Construct a conceptual framework, 2) Develop system architecture, 3) Analyse & design the system, 5) Build the prototype system and 6) Observe & evaluate the system. The content of each phase is presented in table 3.

Table 3. Systems development research methodology (Nunamaker et al., 1990-91)

Construct a conceptual framework	* State a meaningful research question * Investigate the system functionalities and requirements * Understand the system building processes/ procedures * Study relevant disciplines for new approaches and ideas
Develop system architecture	* Develop a unique architecture design for extensibility, modularity etc. * Define functionalities of system components and interrelationships among them
Analyse & design the system	* Design the database/knowledge base schema and processes to carry out system functions * Develop alternative solutions and choose one solution
Build the prototype system	* Learn about the concepts, framework, and design through the system building process * Gain insight about the problems and the complexity of the system
Observe & evaluate the system	* Observe the use of the system by case studies and field studies * Evaluate the system by laboratory experiments or field experiments * Develop new theories/models based on the observation and experimentation of the systems usage * Consolidate the experience learned

Although the approach of Nunamaker et al. (1990-91) focuses on information systems and is perhaps slightly more practice-oriented than the other two examples, it emphasizes three significant aspects which are not present in the other models: the design artifact can be a system itself, as a system it can be extended and it has functionalities, and the design process (research process) provides an opportunity to learn, even if the evaluation of the solution shows that the solution does not work or should be improved. The system approach to the artifact adds a state variable or parameters that describe the state of the artifact. Though this type of meta-information could be considered unimportant, it is important to acknowledge that each intervention through the artifact changes also the state of the artifact, offering potential new solutions through situation awareness -oriented design (Endsley, 2013).

2.3.2 Case study approach – supporting empirical activities

The case study approach has been concluded to be useful in the critical early phases of a new management theory, when key variables and their relationships are explored (Gibbert et al., 2008; Yin, 1994). Case studies typically deal with real management situations and are conducted in close interaction with practitioners (Gibbert et al., 2008). Yin (1994) adds that a case study typically deals with situations where the boundaries between the phenomenon and the context are not clearly evident. Achieving deep understanding in this kind of a setting requires the use of multiple research methods. Woodside (2010) suggests that triangulation of methods often includes 1) direct observations, 2) asking case participants for explanation and interpretations of "operational data" and 3) analysis of written documents and natural sites occurring in case environments. Benbasat et al. (1987) add also physical artifacts such as devices, outputs and tools to be used as data in case studies, and Yin (2003) includes also participant observations.

The case method focuses on the questions of why, what and how (Voss et al., 2002) and it can be used in exploration, theory building, theory testing and when theory is extended or refined (ibid.). In this study the role of the case study approach and the actual implementation follows the proposition of Wooside (2010). The main interest is in the actors, interactions, sentiments and behaviors occurring in a specific process through time. Woodside (ibid.) states that the focus should be directed to knowledge of "sensemaking" processes created by individuals and systems-thinking, policy mapping and systems dynamic modeling, what Woodside describes as meta-sensemaking. In the context of this study, identifying the meta-sensemaking related to service thinking, designing and operations is expected to have a critical role in the creation of new knowledge. In the formation of the case study approach, also Simon (1990) is followed. Simon states that humans tend to lack the cognitive resources to maximize the meaning that they usually do not know: the relevant probabilities of outcomes. They cannot evaluate all outcomes and their memories are weak and unreliable (ibid.). Instead of considering these as research limitations, these characteristics are expected to be found when "sensemaking" is explored.

In order to gain access to sensemaking, case study requires a supporting research process or protocol to be followed. Yin (2003) proposes an approach that consists of five separate phases: 1) designing the case study, 2) preparing for data collection, 3) collecting the evidence, 4) analyzing the case study evidence, and 5) reporting of the case study. This structure was acknowledged when the integration with the design science research approach was completed in the final research process. The role of case study was significant in the empirical stream in the selected case contexts when sensemaking and general service mindsets were explored, but also in the test and demonstration phase where the design artifact components were tested in the empirical contexts. However, it should be emphasized that the main purpose of this study is not to create theory, test or refine only through case study methodology, instead of that the case study approach is used in exploring the empirical context, comparing the empirical context with conceptual knowledge and in refining the design artifact based on testing of the artifact components. The selected approach follows the criteria set for interpretive case study where the theory has a significant but different role than in traditional positivist case studies: "to create initial theoretical framework which takes account of previous knowledge, and which creates a sensible theoretical basis to inform the topics and approach of the early empirical work" (Walsham, 1995, p. 76). Walsham (ibid.) also suggests that in interpretive studies a considerable degree of openness to the field data should be maintained, and also a need to change earlier assumptions should be acknowledged.

The case study approach has been used widely in management studies (Patton and Appelbaum, 2003), but also in operations management research (Voss et al., 2002) and information system studies (Benbasat et al., 1987). In all these areas issues such as reliability and validity of the research and the overall rigor in conducting the research have been emphasized. Yin (1994) suggests four criteria for reliable and valid case research: construct validity, internal validity, external validity, and reliability. Most of these critical issues can be solved and tested in the data collection phase, but some of them also require attention in the research design phase as well as the data analysis phase. Based on Yin's (1994) classification, a solution for each criteria was formed to ensure the quality of this study (table 4).

Table 4. Reliability and validity criteria in case research based on Yin (1994) and Voss et al. (2002)

Research phase	Test	Case study tactic	Modified case study solution in this study
Research design	External validity	Using replication logic in multiple case studies	Replication logic used in multiple case studies and comparison between published case studies with similar settings
Data collection	Construct validity	Using multiple source of evidence	Direct observations, interviews, analysis of documents and artifacts (physical and artificial)
	Construct validity	Establishing a chain of evidence	The design artifact used in establishing the chain of evidence
	Reliability	Using case study protocol	Protocol by Yin (2003) adapted
	Reliability	Developing case study database	
Data analysis	Internal validity	Doing pattern matching or explanation building	The 1st version of the design artifact used in

		or time-series analysis	data analysis
Composition	Construct validity	Having key informants review the draft of the case study report	Review done but also participation in design artifact component testing

2.4 Structure of the research process

Finally, after exploring the philosophy of science, positioning the research and trying to extract research traditions, exploring research methodologies and requirements attached to them, the structure of the research process can be formed. Previous sub-sections explained in detail how and why the research design includes the specific contents. The research process structure has been constructed on the basis of the model of Hevner (2007). It consists of three main constructions: *environment construction, design science research construction and knowledge base construction.* Each one of them includes *elements* that are illustrated in figure 6.

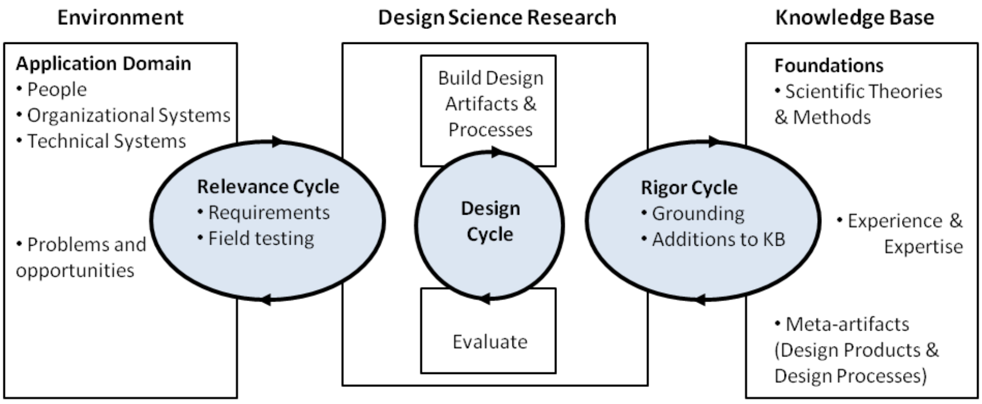

Figure 6. Design science research cycles and structural elements (Hevner, 2007, p. 88).

Hevner and Chatterjee (2010) define the processes that connect structural elements as cycles. The relevance cycle connects the contextual environment of the research project with the design science activities. The rigor cycle links the design science activities with the knowledge base of scientific foundations, experience, and expertise, which informs the research project. The design cycle in the middle of the whole construction iterates between the core activities of building and evaluating the design artifacts and processes of research. As an adaptation of the original model, the case study approach is located in both the environment and knowledge base structures. In the environment phase, it provides a well-known and rigorous method to explore the daily operations and to extract the service system requirements from them. In the knowledge base, the experience and expertise part is collected from the empirical contexts through case study data collection methods. In the field testing phase, the case study approach is utilized in exploring the test experiences, potential new expertise, and also when the potential change in the environment is analysed. The adapted research process structure is illustrated in figure 7.

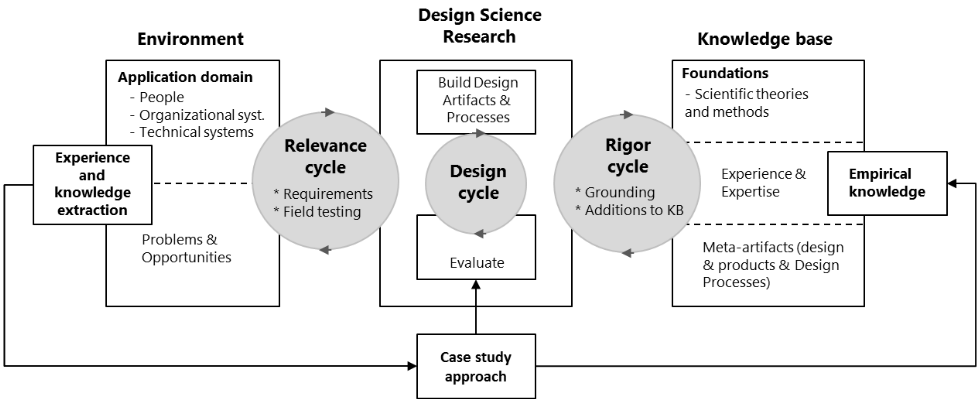

Figure 7. Structure of the research process

2.5 Application domains as test environments and related research activities

The selected research methodologies, design science research and case study, set requirements for the empirical phase of the study. The empirical contexts represent application domains consisting of people, organizational systems (including work and service systems), and technical systems (Hevner, 2007). The primary purpose was to acquire knowledge about relevant problems in the design-operations relationship and related challenges, to find out how the experience and expertise in design and operations management influence the way how problems are solved and understood, and also to evaluate the design artifact or its components in the study. Hevner (ibid.) also suggests that the application domain and evaluation will provide information about incorrect or incomplete interpretations of requirement inputs as well.

The secondary purpose was to extract service characteristics from all test environments and compare them with different systems in relation to the applicability of the design artifact and the experiences collected in the evaluation phases. It was acknowledged that testing different artifact components in individual systems would not allow making wide generalizations, but it was expected to raise issues that had not been presented previously in service research. The main requirements for the test contexts included the following characteristics: the design artifact components must be designed and evaluated in the service systems to:

- deliver centralized and decentralized services
- consist of designed and emergent services
- be technology-centered and human-centered both in design and in delivery activities

- find out where services are designed and delivered for consumers as the main customers, and also where services are provided for internal customers
- find out where service mindset(s) and competences are high and low.

However, all the characteristics would not have to exist simultaneously in all environments. The design artifact components were designed, tested and evaluated in service systems that provide health care and social care services. These system categorizations are wide concepts and as such do not express anything about service design, service operations or service delivery. Altogether four test environments were used in five publications. In three of them, the design artifact component was tested in a single test environment, and in two publications two test environments were used. The test environments, their main characteristics and the role of the author of this dissertation are introduced in table 5.

Table 5. Application domains and their utilization in the dissertation

Application domain	Environment	Domain type	Utilization in the study	Related publications	Role of the author
A. Transportation service system for a special passenger group	Decentralized service system, closed system for customers and providers	Primary	Design artifact testing and evaluation	Publication 1 Publication 5	Interviewer, artifact designer, test engineer, analyser
B1. Diagnostic center providing laboratory and radiology services	Centralized and decentralized service system for consumer-customers and internal customers	Primary	Design artifact testing and evaluation	Publication 5	Interviewer, artifact designer, test engineer, analyser
B2. Diagnostic center B1 and acute care service unit	B1 service system seen from the acute care unit perspective	Primary	Design artifact testing and evaluation	Publication 3 Publication 4	Interviewer, artifact designer, test engineer, analyser
C. Home care and mobile care unit service system	Decentralized service system providing care at home or through a mobile care unit	Primary	Design artifact testing and evaluation	Publication 2	Interviewer, artifact designer, analyser
D. A temporary service system during a large accident scenario including rescue services and hospital services	The documentation of the accident scene and related operations describe how designed operations and realized operations differ in a crisis situation.	Secondary	Design artifact evaluation through publicly available data	Publication 4	Analyser

In the all domains, the selected perspective represented the view of the service provider, and the design artifact components were aimed at improving the knowledge and competences of the main service provider. In all contexts, the customer perspective was acknowledged, and if possible, observations were also made from the customer perspective. The role of the author included data collection through interviews and other data sources, explained in each publication. The author participated in the design of the artifact as a member of the research group. The test engineer role refers to interventions where the author participated in the testing of the design artifact components in the application domains. This role did not aim at facilitating the actual change in the test environments; the main interest was in the feedback that the service employees gave to the author and the rest of the research group.

2.5.1 Integrating the design science research process and the case study research process in fieldwork activities

Combining the solution-oriented design science methodology and more objective questioning-focused case study methodology may form a paradoxical combination. As illustrated in figure 6, the case study methodology supported two design processes: 1) constructing the knowledge base related to the experiences and expertise and 2) extracting the experiences and knowledge from the empirical contexts through testing the artifacts or their components. Without proper research processes and requirements for collecting data, analysing and validating it, the design science methodology would be less valuable for scientific purposes and also for practical utilization.

The case study methodology was utilized mainly in the design and implementation of research activities and also when the unit of analysis, which is emphasized by Yin (2003) as one of the most important research decisions, was set. In this study, the main unit of analysis from the case study perspective is the service system governed by the existing service offering, existing customers and resources. In application domain A the service system boundaries were further set by a special customer group, in domains B1 and B2 by organizational boundaries as well as by service delivery -related dynamics. Application domain C was a combination of previous boundary setting guidelines: a special group of customers, organizational boundaries and service delivery -related dynamics. Domain D was bounded by the accident scene scenario (time and duration).

The integration process between the conceptual level design artifact development and the more practical case study approach is illustrated in figure 8. It should be noted that the illustrated integration process describes only how fieldwork activities are derived from the design science level and how the case study methodology is applied within this study.

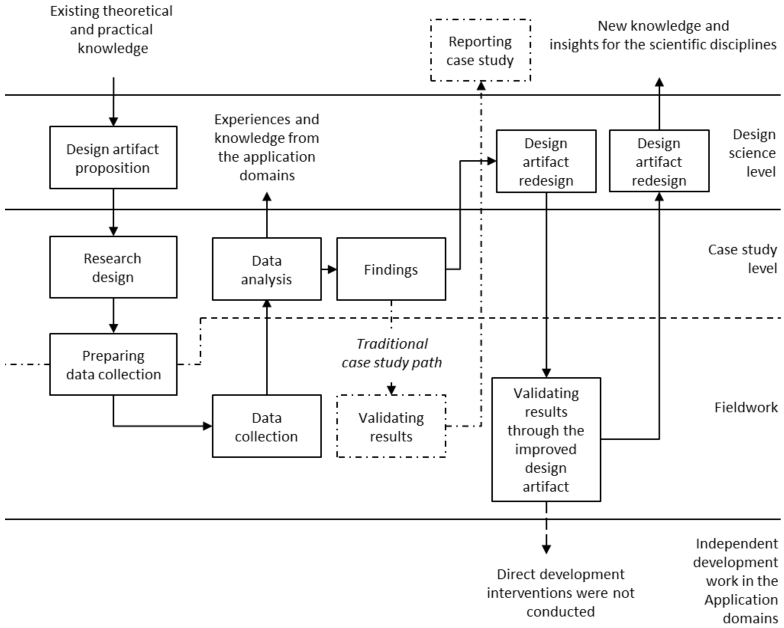

Figure 8. Integration of the main methodologies to support fieldwork research activities

The case study approach was followed in data collection, data analysis, and partly in the validation phase. The researchers did not aim at developing or changing the application domains but focused on collecting data and analysing cases as informative descriptions of application domain characteristics. The design science -related solution orientation did not dominate at the fieldwork level and in a similar way the existing operational procedures and characteristics did not restrict the solution orientation at the design artifact development level. The implemented research processes were also governed by specific research questions, research domain characteristics and situational factors. All these characteristics are described in each publication (part II).

The conducted fieldwork research is summarized in table 6, including information about the unit of analysis, data types, schedule, and detailed information about interviews in the data collection and validation phases.

Table 6. Research activities in the application domains

Unit of analysis	Data types	Data collection and validation through interviews	Research conducted
A. Transportation service system for a special passenger group	Interview data, service monitoring, documentation of earlier service system versions, performance data, technology descriptions, instructions, policy guidelines.	**Data collection phase:** 11 thematic interviews, duration 1-1.5 h, audio recorded, interviewed by 3 researchers, including the present author **Validation/ testing phase:** 9 thematic interviews, duration ~ 1 h, audio recorded, interviewed by 2 researchers, including the present author	2010-2011 2011-2012
B1. Diagnostic center providing laboratory and radiology services	Interview data, performance data (visits, customers, utilization rates, flows), structural data (processes, service system, organizational responsibilities), information system descriptions (usage instructions and system-related process descriptions)	**Data collection phase:** 23 thematic interviews, duration 30 120 min, audio recorded, interviewed by 4 researchers, including the present author **Validation/ testing phase:** 13 thematic interviews including visualized descriptions (12 interviews were audio recorded), duration ~30 min-1 h, interviewed by 2 researchers, including the present author	2010-2011 2011-2012 (in the validation phase interviews covered also employees from the acute care service unit)
B2. Diagnostic center B1 and acute care service unit providing acute care services	Interview data, performance data (visits, customers, utilization rates, flows), structural data (processes, service system, organizational responsibilities), information system descriptions (usage instructions and system-related process descriptions)	**Data collection phase:** 34 thematic interviews (32 utilized in publication 4), duration 30-120 min, audio recorded, interviewed by 4 researchers, including the present author **Validation/ testing phase:** 13 thematic interviews including visualized descriptions (12 interviews were audio recorded), duration ~30 min-1 h, interviewed by 2 researchers, including the present author	2010-2011 2011-2012
C. Home care and mobile care unit service system providing mainly care but also some cure services	Interview data, development and analysis reports, detailed information and service system descriptions, performance data (visits, service offering, utilization rates, resources, customers)	**Data collection phase:** 15 thematic individual interviews + 8 group interviews with 2-5 participants = 40 interviews, duration 30-120 min, interviewed by 3 researchers, including the present author **Validation/ testing phase:** Utilization of a web-based innovation tool where the service system employees evaluated the findings made by the researchers	2010 2011 (the validation phase was acknowledged in publication 4 but not used as data)
D. A temporary service system during a large accident scenario including rescue services and hospital services	Investigation report by Finnish Accident Investigation Board Finland	**Data collection phase:** The data collection was conducted by the accident scene investigators. The methods and research process are publicly available (see the reference section in publication 4).	2004-2005

3 CONSTRUCTING THE KNOWLEDGE BASE

The main functions of the knowledge base section is to guide the design artifact construction based on existing knowledge related to the selected research themes and research questions, to introduce the way of thinking in current management literature related to the selected themes, and also to provide a basis for comparison and evaluation of the achieved results. This section does not aim at reviewing all relevant aspects in the literature or providing a summary of the literature utilized in the individual publications included in this dissertation. In addition to providing the functions mentioned above, this section focuses on explaining why the gap explained in the introduction part exists and why there are so few attempts to solve it. Instead of trying to identify and define the truth, the power of the new knowledge and applicable artifact, as well as the service information are included in the selected multi-perspective view. The author makes also the assumption that it is possible to construct new artifacts based on accepted concepts, models and constructions existing in the service literature. This may create limitations from the theoretical perspectives governing the original models, but the potential value embedded in these concepts requires making this type of a core assumption.

This section consists of five areas which are merely views on architectures, service design, operations management and information management fields rather than theoretical perspectives. These views include different types of conceptualizations of design and operations, but in each case the connection to either of them is made visible. As an extension to how design and operations are usually defined, in this section they are seen as activities and objects, which is closely related to the earlier discussion between static and dynamic characteristics. After this brief introduction, this section continues with the analysis of architectures and architectural knowledge. The second sub-section focuses on service design drivers and service design space. Instead of repeating what service design is or is not, this sub-section extracts definitions for existing models and tools. The third sub-section covers operations using a similar approach as in the previous sub-section. The fourth sub-section focuses on the role of information in service systems and it relies on both service literature and information system literature. The final sub-section summarizes the construction phase of the knowledge base on the architectural level and from the service information processing perspective. The knowledge base is utilized in the next section, when the first conceptual version of the design artifact is constructed.

3.1 Architectures and architectural knowledge

Architectures and architectural knowledge are introduced through four fundamental or core properties. The first fundamental issue when an object or a system is approached from the architectural perspective is to understand that systems can and do comprise more than one structure, and none of these structures can irrefutably claim to be an architecture. This means that when there are more than one structure, there are also more than one type of elements, more than one type of interactions and also more than one type of context

(Bass et al., 2003). In other words, there is no single service architecture or even information system architecture; there are architectures from different perspectives instead. The second fundamental property of architecture is related to its existence independently from its descriptions, and the third the behavior of each element as part of the architecture insofar as that behavior can be observed or discerned from the point of view of another element (ibid.). This aspect was already introduced in the first section of the dissertation by stating that architecture describes the public side of the system, but hides the internal logic. Bass et al. (2003) propose also a fourth property by stating that when the architecture for a system is a good one or a bad one, it will allow or prevent the system from meeting its behavioral, performance, and life-cycle requirements. These software-oriented definitions highlight the design tradition in the software context: architecture is a well-known step in a software design project.

Booch (2008) repeats the common slogan in the architectural field by which all architectures are designs, but all designs are not architectures. The relationship between two artificial but widely used elements is partly misleading and inconsistent in different fields of literature. In a similar way that architectures and designs are mixed in the literature, architectures are often conceptualized by a very narrow focus as design objects and end results. Baldwin (2010) explains the concept of architectural knowledge as knowledge about the components of a complex system and how they are related. This knowledge can be further divided into three categories: how the system performs its functions, how the components are linked together, including the interfaces, and how the system behaves in both planned and unplanned ways in different environments (ibid.). Henderson and Clark (1990) use the term architectural innovation to describe a change in a product which is based on changing the way the core components of a product are linked together and simultaneously leaving the core design concepts behind the product untouched. They state that though this kind of innovation may destroy the usefulness of the architectural knowledge, it preserves the usefulness of its knowledge about the product components. Kruchten et al. (2006) argue that architectural designs are only one part of architectural knowledge which is used in four core activities: designing a system, guiding a multisite development team, exploited out of system in order to create a new one, and evolving a system. Their conceptualization of the architectural knowledge is design decisions + design. The design decisions can be implicit and undocumented, explicit but undocumented, explicit and explicitly documented (reasoning is missing), and explicit and documented.

In the service context, the research focusing on the architectural perspective is a mixture of elements extracted from the manufacturing context and aspects that are expected to be valid also in services. The aspects that have been reviewed also in the service context (Voss and Hsuan, 2009) consist of the following arguments: Sanchez (1999) takes a systems view by defining an architecture as a system for which designers have specified (i) the way the overall functionalities of the product or process design are decomposed into individual functional components (Baldwin & Clark, 1997) and (ii) the ways in which the individual functional components interact to provide overall functionalities of the system design. Component interactions are generally described in terms of specifications that define the inputs and outputs that cross the interfaces between interacting components. Fixson (2005) sees architecture as having six dimensions—product modularity, component complexity, product platforms, loosely coupled interfaces, component commonality, and the number of components—in process and supply chain domains.

Rechtin (1991) proposes that the architecture of a system is determined through two opposite processes: partitioning and aggregating. While partitioning imposes structure to the design problem by breaking it down into smaller sub-problems, too many partitions make the design intractable. On the other hand, while aggregating similar functions and features helps simplify the design, too much aggregation may cause important details to be left out of the design. Heckl & Moormann (2009, p. 3) define architecture in the service context as follows: "The architecture describes which modules are part of the entire system and with which properties (i.e. functions) they should be endowed." When these views are compared with the arguments presented by Bass et al. (2003) in the software field, service researchers tend to use the architecture concept in a way equal to the one Bass et al. use architectural structures and views. It is potentially an acceptable way, but most of the studies conducted in the service context do not acknowledge that architecture may be viewed by using different core assumptions, and the fact that there is no single architecture.

A potential limitation in the existing studies has been identified by Frandsen (2012, p. 19) who explains how a pre-designed architecture may not be a relevant concept in the service context: "the architecture rather than being a fixed entity established a priori was indeed described as something which had been subject to major changes during the course of developing and implementing the new processes and systems." Whether these changes are possible or not, can be characterized through the concepts of open and closed architecture. According to Baldwin (2010), in a system which is governed by an open architecture, the key modules of the system can be imported by external agents, which means that the architecture itself does not have to be redesigned each time when a component or module is imported or removed.

Out of the many aspects that could be explored under the architectural theme, one of the most important elements requires attention: the scope and usage of the architecture. The scope should answer the question: what are the dimensions and boundaries of the architecture? The usage perspective should provide an answer to the questions: who will use the architecture and how will it be used? Voss and Hsuan (2009) propose a layered service architecture with four layers which could be described as a business-oriented service architecture. It consists of an industry layer, a service company/supply chain layer, a service bundle layer and a service package/component layer, and all these layers are architectural views on services. The approach of Voss and Hsuan (2009) shows that even though there is no single architecture in any system, the selected architectural view with its components and interfaces must be positioned somehow in the context where the architecture is applied. Product-level components may include the industry-level interface characteristics but they can hardly be explained using a single-level architecture. This is also how the scope of the architecture is used in this study. The usage aspect is much more difficult to capture. From the usage perspective, considering potential architectures as hierarchical (the same perspective but different level of details) and complementary views (different perspective but the same level of details) offers a potential way of collecting previously separate domains and experts together (Lankhorst, 2005), though it is not an easy task as each domain has its own culture, own models, own guiding principles, and of course its own objectives. Ross et al. (2006) argue that higher-level architectures often cause a feeling as if someone is doing something about complexity without any link to real activities. This argument provides at least two important insights: using architectures and understanding them is not the same as trying to understand visualizations of architectures, and architectures can be used to hide the real logic behind activities which can be used in positive and negative ways. In the service literature the usage perspective related to architectures is even less acknowledged, and even though the researchers apparently have always an idea of a potential user, it is not expressed. Similarly to service design, also architecture or any other system description should not be used too lightly.

In this sub-section the concept of architecture and architectural knowledge were explored and as a result, definitions for further utilization in this study were created by combining the definitions by Baldwin (2010) and Kruchten et al. (2006): *architectural knowledge consists of a design (components, relationships and interfaces), decisions made in the construction of the design, decisions embedded in the design, and description of how the design performs and how the behaviour is dependent on the environment where the design is utilized.* This conceptualization is rather long but it covers aspects that have been concluded or proposed in the existing literature. In the rest of this study, architecture is used in two different ways: i) to describe the structure of architectural knowledge (information object) and ii) to describe the meta-design level object which is used to create architectural knowledge (information processing logic). It is proposed that this type of construction is necessary, as otherwise it can be difficult or even impossible to distinguish the information flows related to service delivery (contextual and substance focused) from the information flows used between service design and service operations.

3.2 Service design drivers and service design space

This sub-section focuses on exploring and extracting service design drivers from the service literature. The design drivers are expected to reveal the current understanding related to the need of creating designs. These potential design drivers and the design objects embedded in them form the basis for the service design space. The design space is a working concept in this study, but it is close to the idea of framing space in the design science research methodology- in other words it answers the following questions: what is being designed, through which tools or artifacts, in order to achieve which objectives? The propositional logic behind the design space is that when a design object is added to the artifact construction, new constraint is added to the design space, and the design space can be used to describe the scope of the artifact.

Kimbell (2011) proposes two alternative approaches for service design: problem-solving and designing for service. The first one focuses mainly on designing new services through which problems can be solved and is based on engineering tradition. Kimbell (ibid.) argues that in the latter approach it is accepted that designing for service remains always incomplete. “Designing for service, rather than designing services, points to the impossibility of being able to fully imagine, plan or define any complete design for a service since new kinds of value relation are instantiated by actors engaging within a service context” (ibid., p. 45). Tax and Stuart (1997) define the novelty of a service through the degree to which the new process, skills and knowledge or physical facilities (layout, flow of people, physical surroundings, required space and ambience) are fundamentally different from the existing process. The field of interest in new service design have expanded since Tax and Stuart (ibid.): today understanding the users and their context, understanding the service providers and social practices, and translating this understanding into the development of evidence and interactions are included in service systems (Patricio et al., 2011). These translations and potential complexity of service systems cause a need to think through models in order to connect the problem and potential solutions (Dubberly and Evenson, 2008).

Though the service literature does not offer a unified view on service design, it provides lots of parameters and dimensions that form the main drivers for designing. Collier and Meyer (1998) have reviewed service literature from 1986-1995 and list the following service system dimensions: labour intensity of the process, equipment/people, contact time, customization, employee discretion, value added, product or process focus, type of channel of access to the services, and service package structure covering the degree of customization or customer discretion. Patricio et al. (2011) propose a multilevel service design with two understanding tasks (the customer experience and the service offering) and three designing tasks (the service concept, the service system, the service encounter). The complete model is illustrated in figure 9.

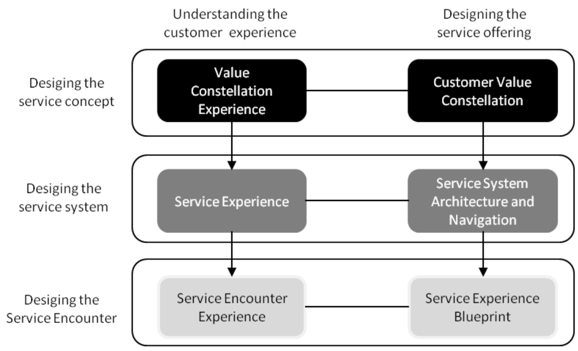

Figure 9. Multilevel service design model by Patricio et al. (2011, p.183)

Patricio et al. (2011) criticize the narrow view in many existing design frameworks: the higher and lower levels of design are not connected. Wemmerlöv (1990) categorizes services based on the degree of routinisation into two groups: rigid services and fluid services. Wemmerlöv (ibid.) proposes that fluid processes dominate in service organizations where the major activities are directed towards clients and customers, whereas in the rigid processes the major activities are directed towards customer possessions.

> **A rigid service process** exhibits a relatively low level of task variety, low level of technical skills and low level of information exchange between the service worker and the customer, the service worker makes few judgemental decisions, the process is narrowly defined, the volume of objects being processed is relatively high, the arrival rate of customers is predictable or controlled by the service system, the process can involve several customers and objects simultaneously, and the response time is relatively short.
>
> **A fluid service process** exhibits a low to high level of technical skills, the process requires high technical skills, a large amount of information is exchanged between the actors, the service worker often goes through unprogrammed search processes and makes several judgemental decisions, the process is not well defined, the volume of objects being processed is low, workflow uncertainty can be high, the process includes only one customer per time, and the response time to a customer-initiated service request is often long.

Previous extractions from the service literature provided an extensive list of service parameters from the service provider's perspective but relatively fewer from the customer's perspective. Even though it was not explicitly highlighted in the extractions it is proposed that the provider-centric view states the following: 1) a service can be delivered (produced), 2) customer-related parameters and characteristics are or create potential challenges for service delivery, and 3) service providers have skills and competences to understand customers' needs and to provide a valuable service for them. If the design space view were formed on the basis of these traditional approaches only, the view would be a linear manufacturing system with inputs, processes, outputs and controls.

Recent developments in the service research propose also an alternative view. The so-called service-dominant logic view has attracted researchers since 2004 through the statement "fundamentally all exchange is service". In this field service is defined as "the application of specialized competences (knowledge and skills), through deeds, processes, and performances for the benefit of another entity or the entity itself" (Lusch and Vargo, 2006, p. 283). Vargo and Lusch (2008) highlight that the Service-Dominant Logic represents a shift in the logic of exchange, not just a shift in the type of product, and that there is no value until an offering or service is used – experience and perception are essential to value creation. This study does not intend to review or reshape the Service-Dominant Logic contributions but instead the aim is to translate them into design parameters and consider their effects on the design space specification. Perhaps the most significant change if compared to the manufacturing approach is in introducing value co-creation between two different service systems (Vargo and Lusch, 2008). The idea of creating value through exchange, access, adaption and integration of resources changes the position and role of a customer. Grönroos and Ravald (2011) have analyzed the co-creation and value creation through logical reasoning further. They argue that it is important to understand that production and value creation are different constructions. Production is the process of making a resource for the customer whereas value creation is the consumption or usage process of these resources. Grönroos and Ravald (ibid.) keep on the difference between the service provider or supplier and the customer. They also state that only the customer can create value for himself but "during interactions with customers, the supplier gets opportunities to influence the process of value creation, in the best case enhancing the level of value the customers create out of a service activity or a good (op.cit. p. 10). From the design space and driver perspective, value creation reveals also additional elements: firstly the roles in the service context can be dynamic, the same actor can act as a provider or a customer, and secondly if both the provider and customer are service systems focusing on configuring and integrating resources, it indicates that both of them can be seen as production systems. Translating this finding into more practical directions is one of the main challenges in this dissertation.

Sampson and Spring (2012) suggest an even more radical approach to reframing the role of a customer. They propose that if the role of a customer is analysed as a service supply chain, similar roles as are identifiable in goods-dominant supply chains, may provide valuable insights into the service context. The customer role categories in the supply chain include: component supplier, labor, design engineer, production manager, product, quality assurance, inventory and competitor. Sampson and Spring (ibid.) consider the role definitions as an adjustable or redesignable variable in each category: the role of the customer can be basic or typical but also enhanced or reduced in relation to the basic version. If the customer-perceived reality is further extended, the significance of the social context increases. Edvardsson et al. (2011) utilize social construction theories to interpret and enhance the understanding of how actors at the societal, group and individual level create, realize and reproduce social situations and structures. They state that value (co)-creation necessarily follows social structures and takes place within social systems in which the actors adopt certain social positions and roles as they interact and reproduce social structures. Edvardsson et al. (ibid.) also propose that service exchanges and the actors' roles are dynamic in adaptive service systems, referring to the ability of an organization to adjust them according to changing circumstances in its environment.

In order to link the internal and provider-centric design drivers and the external and customer-centric design drivers into a coherent design space, there is a need to identify also design processes which potentially include also the most common objectives and procedures for creating design artifacts.

Linking the design drivers and design processes follow the concept of Edvardsson and Olsson (1996) where service is defined as customer outcome, customer process and prerequisites for service. The customer outcome refers to the role of customer as the recipient and judge of the service in terms of added value and quality, the customer process refers to the customer as a co-producer of the service in his partially unique manner, and prerequisites to the customer outcome to the form of resources which have been built to provide the service or to make the service possible (Edvarsson and Olsson, ibid.). The prerequisites are the end results of the service development process, and they include the service concept or the prototype of service, the service company's staff, the customers, the physical/technical environment and organization, and control, which together form the service system. Although recent studies have extended the field where services are studied and the perspectives used, it is proposed that the key construction of Edvardsson and Olsson (ibid.) is still relevant and provides a scalable basis for constructing the design artifact as planned in research design.

As Voss and Hsuan (2009) suggest in their service architecture and modularity study, and later Patricio et al. (2011) in their multilevel service design model, there is a need to link different levels of service designs together. Though the reviewed approaches provide an extensive library of parameters and partially also the drivers behind them, the level of abstractness is quite high, and therefore the relevant question would still be: are these parameters measures, observed characteristics rather than designable objects? The term designability has not been systematically used in a large scale in the service literature, but in this study it and the term operability are used in the search of more concrete design elements in all three areas of the design space: customer process, customer outcome and prerequisites.

3.2.1 Designability and operability of artifacts in the service context

Holmlid and Evenson (2008, p. 341) define service design and collaboration within it as "visualize, express and choreograph what other people can't see, envisage solutions that do not yet exist, observe and interpret needs and behaviors and transform them into possible service futures, and express and evaluate, in the language of experiences, the quality of design". This is a somewhat different approach to service design that can be extracted from the typical service design publications, but it is a definition that supports separating *designability* and *operability*. Designability should be considered as a skill and competence to form designs, transform reality into designs or create designs for a reality that does not exist, processes that do not necessary have to lead to operability. Operability, on the other hand, describes the assumptions and logic of how the artifact is aimed to be used and what it aims to do.

Instead of focusing on the designability of service, service system or service experience, the focus in this sub-section is directed at the designability and operability of service artifacts, or in other words how services are designed. Though this might be considered as a semantic difference or meta-analysis, it is argued that the difference really exists and it is significant. It is further assumed that service artifacts embed the logic of how a service and the operations related to it are perceived. Three main research streams, New Service Development (NSD), Service Design (SD) and Service Engineering (SE) focusing on the design and development of services are here explored briefly.

New service development literature aims at covering the whole chain of activities from idea generation to market launch. It originates from the marketing discipline and even though the literature is rich of models, a widely accepted reference model is still missing (Cavalieri and Pezzotta, 2012). Papastathopoulou and Hultink (2012) have reviewed 27 years of new service development research by analyzing altogether 145 scientific publications. Their study points out that the dominating research domains in NSD are service innovation and service marketing research, but for some reason the operations management perspective is not evident in NSD research, indicating that there is a gap between design and development and operations. Zomerdijk and Voss (2011) found empirical support for domain gaps in the implementation of NSD processes and procedures in the experiential service context. Their results indicate that the people responsible for delivering the service are also responsible for developing it, and the designs become easily "silent designs". Zomerdijk and Voss (ibid.) also found that though there are benefits in the formal design processes, several respondents argued that there was a strong need for flexibility in the new service development which could be lost in a formal process.

Stevens and Dimitriadis (2005) summarize three major limitations for new service development methods: 1) first, Cooper (1994) recognized that the implementation of a staged process will lead to time-consuming and overly bureaucratic processes that slow projects down, 2) the description of the stages does not integrate the way firms organize development teams and 3) sequential models do not help to define what must be produced during each stage. Johnston et al. (2000) suggest a new service development model which does not follow the linear process logic but is a circle where the design is an independent phase but also a tool in the development phase (figure 10).

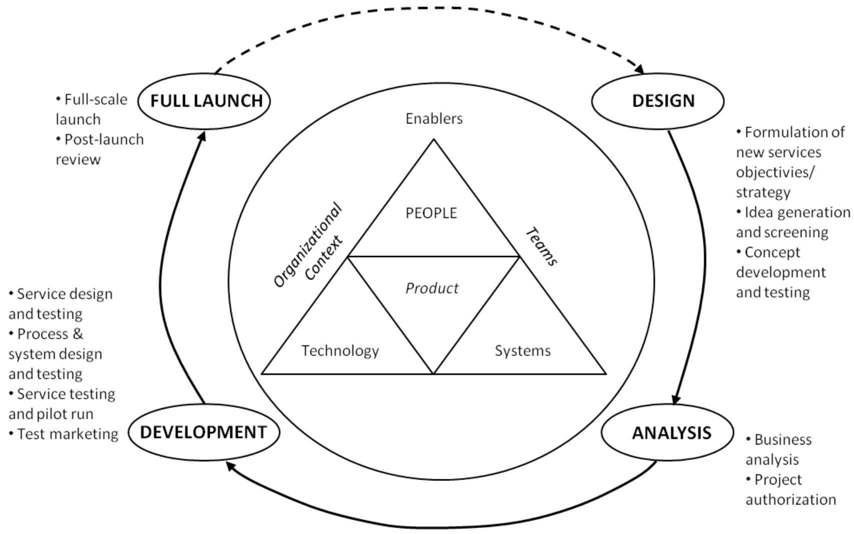

Figure 10. NSD process cycle (Stevens and Dimitriadis, 2005, p. 178), adapted from Johnston et al. (2000)

To add another definition for service design, Papastathopoulou and Hultink (2012) define it as a set of activities blueprinting a new service idea in drawings, flowcharts, and specifications. In this context, service design depicts the service production and delivery systems that must be put in place in order for the new service to reach its target market. Depicting implicates that design decisions are made before the actual service design phase. Papastathopoulou and Hultink (ibid.) also state that service design is a rather neglected research area within NSD and adding multidisciplinary approaches is needed. Lin and Hsieh (2011) identify also more a general gap which characterizes new service development models: a linear progression of discrete and consecutive stages as a waterfall model. Each stage should be performed to 100% completion before moving on to the next stage. As a response to existing models, Lin and Hsieh (ibid., p.146-148) define their own version where the stages and activities are defined but the processing order can be sequential or simultaneous.

- **Stage 1**: Service identification (**activities:** trend analysis of social economy and technology, scope analysis of the supply side and the demand side, service needs analysis and service conceptualization)
- **Stage 2**: Service value net formation (**activities:** business model analysis of the potential service concept and service value net analysis and formation)
- **Stage 3**: Service modeling (**activities:** product model, process model, resource model and marketing concept)
- **Stage 4**: Service implementation (**activities:** service prototyping and testing)
- **Stage 5**: Service commercialization (**activities:** service rollout, marketing and monitoring).

For this study, the main lesson that can be learned from the new service development approach is the fact that design is not a single phase, it is an activity that is used in several phases. Edvarsson et al. (2013) argue that while new service development is rich in development methods, the missing link in NSD research is a service development strategy. Such a strategy should fulfill the following requirements (op.cit. p. 37):

- It should fit the business context of existing services (and/or products), including value in use in the customer's context, internal resources and capabilities in the service system, and the image and overall business strategy of the firm.
- It should fit the degree to which the resources and expertise required for the new service and the available delivery systems for existing services fit the firm's other resources and offerings.
- More importantly, how well the new service addresses important customer needs and creates value in use as perceived by the customers, is central.

Edvarsson et al. (2013) offer the information perspective by arguing that in the service context the question is not only about collecting information from and about customers, but also what the information is, how it is collected, as well as the ability to integrate and use often "sticky" customer information are important throughout the NSD process.

The second research domain, service design research (SDR), specifically addresses the structure and content of service operations through focusing on interaction design in terms of perceivable elements in the service context and interaction with the customer (Cavalieri and Pezzotta, 2012). Here service design research refers to a research domain that draws on the broader arts and communication, industrial and interaction design (Holmlid and Evensson, 2008). Cavalieri and Pezzotta (2012) even argue that the service design field looks at services from outside in, whereas in other research domains focusing on service development, the direction is the opposite. The research field has expanded rapidly mainly in practice, which indicates that service can be designed and implemented through exploring service reality as suggested by Kimbell (2011).

Clatworthy (2011) adds a new point of view to the design of services by describing it as design for experiences that happen over time and across different touchpoints. Touch-points have a central role in service design (research), in practice they are contact points between the customer and the provider, and the touchpoints form the use scenario of the service. The practice-based example provided by Clatworthy (ibid.) introduces a method where the content reflects the way of thinking in service design research: 1) new combinations of actors who together can provide improved services, 2) orchestration and development of touchpoints to provide innovative services, 3) developing new offerings that are aligned to brand the strategy 4) understanding customer needs and how new services can satisfy them, and 5) designing customer experiences that impress the customer.

Designing services as experiences is acknowledged also in more traditional approaches. For example Shostack (1984) has proposed a similar approach in the 'Service

Blueprinting' model, where the path of the customer and the related provider actions are connected in a blueprint. Zomerdijk and Voss (2010, p. 68) have constructed a model for 'Service Design for Experience-Centric Services' and provide a valuable perspective for service design by stating that "because experiences are constructed by customers based on their interpretation of a series of encounters and interactions designed by a service provider these experiences cannot be fully controlled by organizations". A similar strategy in design is to use customer scripts in the control of service experience and to evaluate whether the customer could learn new activities (Eichentopf et al. 2011). As a practical solution, Eichentopf et al. (ibid.) suggest an extended service blueprint approach where the original activity space is extended to cover also the backstage and supportive activities of a customer (figure 11). Though the authors admit that implementing the extended model could be costly to the firm side, it provides a valuable scheme for the interaction section between the service provider and the customer.

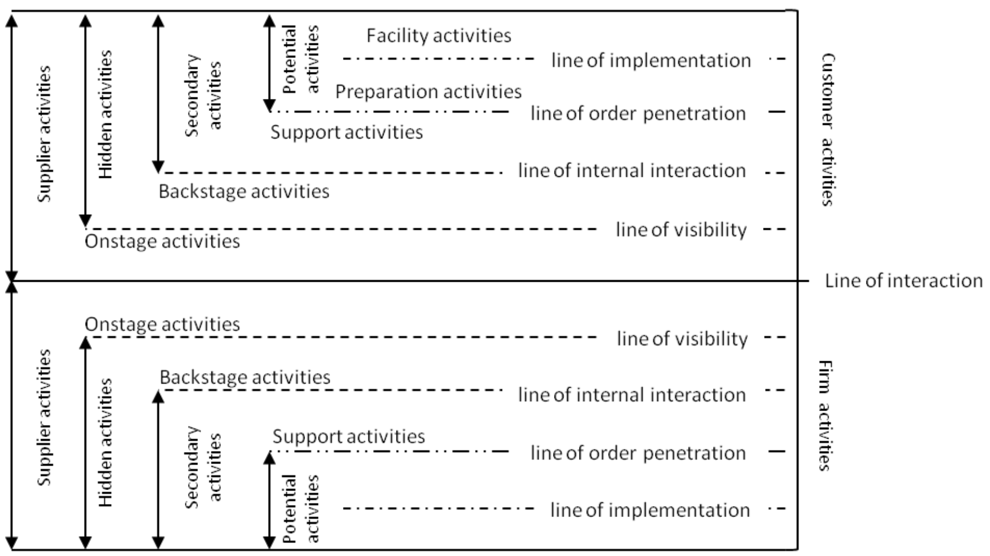

Figure 11. Extended service blueprint model (Eichentopf et al. 2011, p. 653)

Cavalieri and Pezzota (2012) describe service engineering as a rational and heuristic approach based on the discussion of alternatives, goals, constraints and procedures, through the adoption of modeling and prototyping methods, whereas Aurich et al. (2010) define it as systematic development and design of services using suitable models, methods and tools as well as the management of the service development process. One of the most concrete models introduced under the topic of service engineering is the methodological framework and basic service model by Büllinger et al. (2003), illustrated in figure 12.

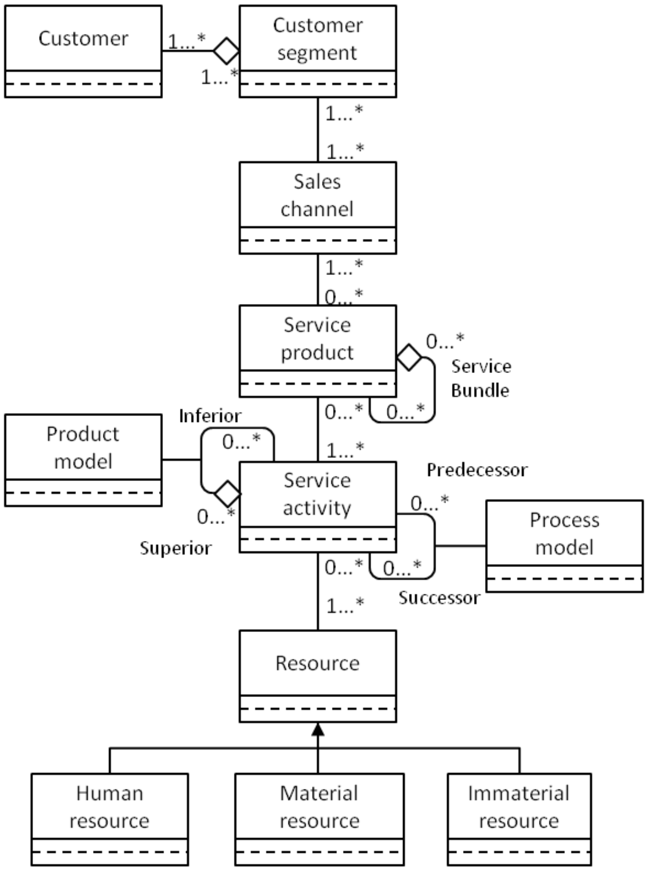

Figure 12. Basic service model expressed in Unified Modeling Language (Büllinger et al., 2003, p. 278).

The key elements in the model of Büllinger et al. (2003) consist of a structure dimension, process dimension and outcome dimension where the structure determines the ability and willingness to deliver the service in question, the process describes the service performance on or with the external factors integrated in the process, and the outcome the material and immaterial impacts on the external factors. In the service engineering field, the system perspective including the life cycle (phases and iteration), entities (content and channel), actors (society and environment, customer and user, and channel), and the system engineering perspective consisting of the process (frameworks and models) and practice (methods and tools) (Cavalieri and Pezzotta, 2012) is highlighted. Two fundamental differences can be seen in the life cycle and actor perspectives. Introducing the life-cycle component into service design means that organizations must shift their focus from merely designing and selling products or services to supporting and accompanying their usage and end-of-life. In a similar way, Cavalieri and Pezzotta (ibid.) reframe the aim of service development as creating prerequisites for long-term profitable customer relations and to attract and keep customers who are satisfied and loyal along the different life cycle phases.

3.2.2 Defining the service design space

The designability and operability of artifacts revealed three potential categories for embedded logics: process logic, component logic and actor logic. Process logic refers to a chain of activities that are performed in pre-specified order leading to predicted results; component logic refers to elements that are integrated or used in an activity but where the process of integration remains as a black box; and actor logic refers to roles and positions and their behavior. All these characteristics are identifiable in the main research streams of new service development, service design and service engineering. Ponsignon et al. (2011) state that theoretical models of service design provide only little assistance in specifying the actual service design characteristics. They also propose, by using front-office-back-office configurations as an example, that service organizations have difficulties in executing different design solutions or change solutions based on relevant decisions.

The existing literature shows why there are practically no previous attempts to connect service design artifacts together to form a more comprehensive view: creating a more systemic view will easily lead to an excess of parameters and unnecessary complexity. This is a relevant conclusion if creating a comprehensive view is only seen as problem-solving, as Kimbell (2011) explains. This is the first embedded but revealed property in the field of service design – there is a tendency to create descriptive models and frameworks that aim at solving designability and operability at the same time. The second embedded property deals with acceptable realities – creating a model frames the acceptable reality where it should fit, but reversely, how the model changes if the reality changes is not discussed or explained. Models are intended to create order in the chaos but they focus mostly on explaining what has already happened. The third embedded property is neglecting the fact that activity always causes a change. When the change processes or activity chains are proposed, in fact the researchers and practioners mean connecting changes together. The reason for emphasizing the role of change is the underlying phenomenon where an individual stage creates a change in the context where it is implemented. The next step is most often defined as activity but whether it acknowledges the previous changes in the process remains unknown.

The main objective in framing the design space is to highlight nine different changes that are proposed to be valid across the disciplines, and when the term design is used, these changes are created, modified, avoided or deleted.

- **Change 1:** Combining resources to form a work system for meaningful activity
- **Change 2:** Transforming resources (physically, virtually, logistically….)
- **Change 3:** Interactions, direct or surrogate (Sampson, 2012), are required in order to have service
- **Change 4:** Creating experiences through interaction
- **Change 5:** Changing the state of a service object (problem, human….)
- **Change 6:** Changing the reality of an actor who created value through using the service

- **Change 7:** Changing the reality of an actor who provided potential for value-creation
- **Change 8:** Changing the social context and the environment
- **Change 9:** Creating value or perceiving value.

This list above is not meant to be a comprehensive list of all possible or even potential changes. Numbering the changes does not refer to sequential or chronological order. As illustrated in the figure 13, there is a propositional connection between change elements according to the existing literature. In addition to changes, the design space includes also a service system artifact as an information processing artifact, service offerings as an artifact, and some of the development functionalities extracted from the previous sub-sections.

The design space is an architectural artifact but as it has been abstracted from the literature, it mainly represents the existing knowledge in a new way. The artifact will be used both to guide the next sub-section where the operations and especially service operations are explored, and also in the next section where the core design artifact of this study is constructed.

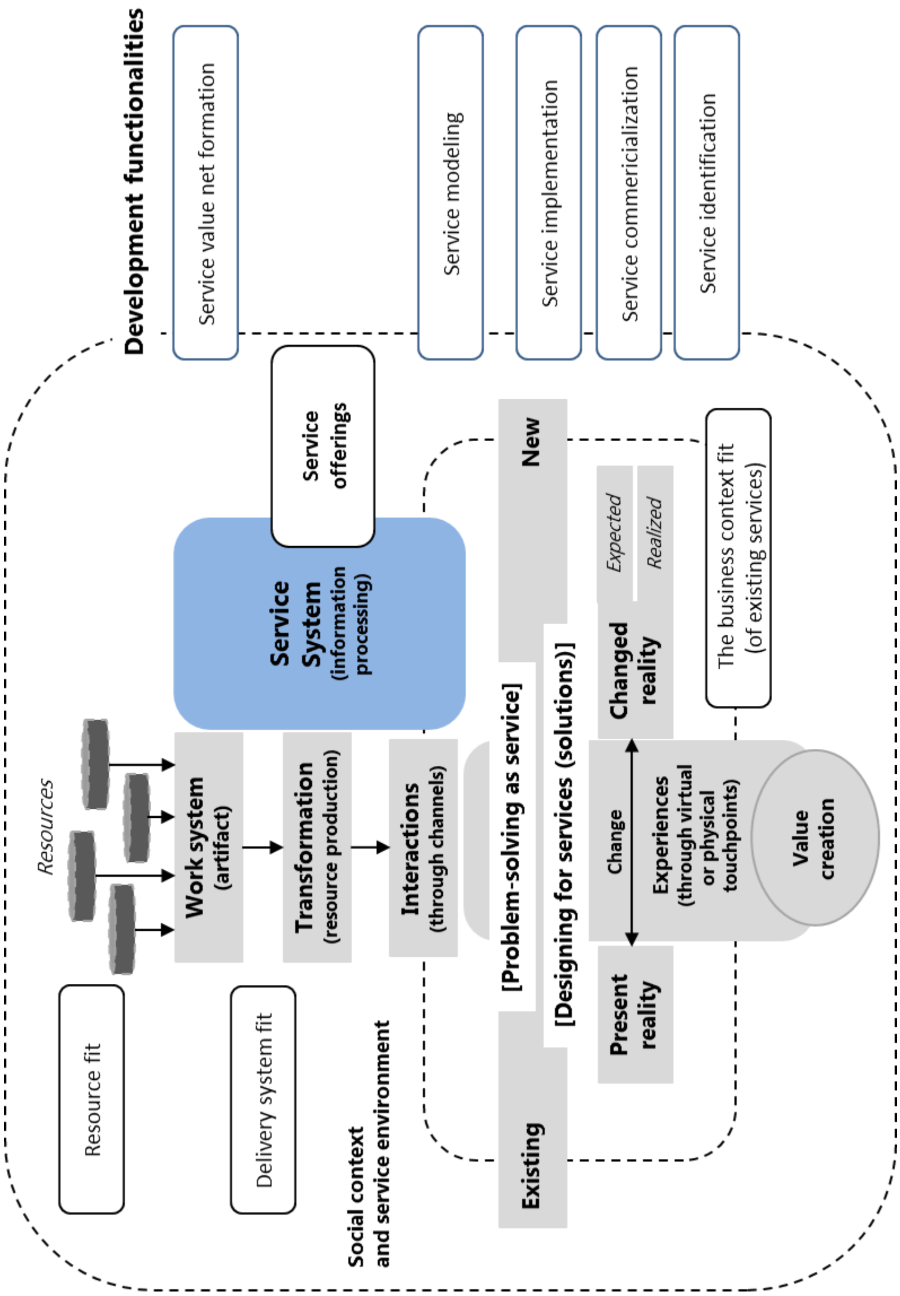

Figure 13. Design space formed on the basis of the service design drivers and designability and operability characteristics presented in the existing literature.

3.3 Service operations as changes

In a similar way as in the previous sub-section, it is assumed that revealing interest in the existing literature related to operations and operations management in the manufacturing and service context will have an effect on how operations in the respective contexts are seen. Heizer and Render (2011) define operations as creation of products. They differentiate production from operations by defining it as the creation of goods and services. Operations management covers “activities that relate to the creation of goods and service through the transformation of inputs to outputs” (Heizer and Render, 2011, p. 36). Sampson (2012) refers to operation as the performance of practical work or of something involving practical application of principles or processes, and in the service context service operations cover interactive producer-consumer operations. Again, the purpose of this subsection is not to focus on semantics, but to explore and extract how operations are conceptualized, understood and used in the existing service literature.

Chase and Apte (2007) provide an extensive view on what they call ‘big ideas’ in service operations management. They identify 18 big ideas starting from Walt Disney’s industrial fantasy (1900) ending at emerging experience economy. Chase and Apte (ibid.) summarize their work in three groups by analyzing what ideas still stand and what are ready to retirement: 1) transference of industrial management concepts to service industries, 2) frameworks for service design and management and 3) tools and techniques of service operations to improve productivity in services. In the first group developments in the information technology have increased the potential and solutions in service rationalization, but the variation inherent in human interactions still challenges rationalization. In the second category Chase and Apte argue that technology has changed or made some of the design and management models outdated. Models that acknowledge potential opportunities through technology have emerged, but non-technological models seem to dominate still. In the third category, tools and techniques aiming at improving service productivity are divided into two groups: analytical models for capacity planning and empirical tools for service quality. Although these models require additional research, most of the existing tools are still valid, such as revenue management, service quality measurement tools such as SERVQUAL, a multiple-item scale for measuring service quality (Parasuranam et al. 1988) and mistake-proofing tools such as Poka-Yokes (Shingo, 1986).

In this study, operations are considered as activities that can be connected to some end results, and these end results are created through single or multiple transformations. In Merriam-Webster (2013), transformation is defined as an act, process, or instance of transforming or being transformed, but also as the operation of changing (as by rotation or mapping) one configuration or expression into another in accordance with a mathematical rule. A connection to identified changes is established, and operations are ways of conducting or achieving changes. However, it should be emphasized that operations as transformations do not need to be caused or operated by humans, changes take place constantly also due to other reasons. When the review of Chase and Apte

(2007) is seen through the lens of transformations, the following propositions can be made: the service operations management field is interested in identifying phenomena that remind, fulfill requirements or can be seen as manufacturing systems, design and create designs that help in managing transformations in a way that objectives can be achieved while aiming at effective service delivery, service productivity and required service quality. Based on the figure 12 describing the design space and reasoning above, all eight changes are briefly explored and analyzed below as transformative operations in the existing literature.

3.3.1 Resource integration

The first transformation introduces resource integration, which has been defined as a key construction in value creation (Edvarsson et al., 2012) and therefore also in service delivery. Hilton et al. (2013) use resource integration and co-production as synonyms and state that co-production is related to task performance within the service process. These tasks are performed by the actors by drawing upon their resources. Vargo and Lusch (2004) define two resource classes which are relevant in resource integration. “Operand resources which are resources on an operation or act are performed to produce an effect” (ibid. p.2) and these resources are typically tangible and passive, requiring an input (act) from an active agent in order to realize its value potential. The other class includes operant resources that are employed to act on operand resources and other operant resources in order to create value. Operant resources are typically intangible resources such as knowledge, skills and labor (ibid.).

Maglio and Spohrer (2008) state that technology plays a central role in the integration process, and therefore people interacting with technology is a key issue within service system research. Kleinaltenkamp (2012) argues that although there are some theoretical approaches, such as effectuation theory and configuration theory that might help in understanding resource integration, there is still much to learn about resource integration practices and especially how to design and configure the integration process.

3.3.2 Transforming resources and resource production

Although resource integration as a process may transform resources, this type of activity is more often called resource production (Grönroos and Ravald, 2011). The resource supplier’s task is to produce resources as inputs into its customer’s processes of value creation (ibid.). Customers need to have resources to integrate, otherwise value cannot be created. Even though the resource supplier cannot create value for the customer, it may facilitate the value creation through resource inputs. Apart from the value creation discussion, resource production has not been studied widely, and therefore there is no reason to see it as differing from any other production process with inputs, process and output.

Although the resource integration and resource production approach provides a new way of thinking for service management (Hibbert et al., 2012), there still remain some unnecessary presumptions. First of all, resource integration and production can be seen as different sections of activities from the value creation perspective, but are they the same activity if seen purely as operations? Secondly, for some reason for example in the model of Grönroos (2011) and in many other studies as well, the provider is set on the left side (where the action starts) and the customer on the right side (where value is created and the action ends). Resource integration and resource production may embed producer, facilitator and customer roles that are different from those revealing who is the end customer and who is the main service provider?

3.3.3 Interactions

The third category in transformative activities is interactions. In Merriam-Webster (2013) interaction is defined as "mutual or reciprocal action or influence". In other words, interaction takes place if there is an input and a response as output. Sampson (2012) divides interactions into two categories: direct interaction and surrogate interaction. In direct interaction people interact with people in some way, negotiating contracts, taking orders and so forth, whereas in surrogate interaction an entity performs process steps that involve a nonhuman resource of another entity. Glushko (2010) has identified seven contexts of service systems where and how interaction can take place: 1) person-to-person service encounters, 2) technology-enhanced person-to-person service encounters, 3) self-service, 4) multi-channel services, 5) services on multiple devices or platforms, 6) "back stage -intensive" or "computational" services and 7) location-based and context-aware services. Interaction is about interacting for specific reasons with inputs, a process and output, but interaction cannot take place without a context and a channel.

It is not common to analyse internal interactions within service organizations. If the traditional roles of the provider and customer are extended and revised based on resource integration and production models, then interactions should be acknowledged throughout the service organization. Malone and Crowston (1990) define coordination in a work system as the act of working together harmoniously, including components of coordination and associated coordination processes. Malone and Crowston (ibid.) propose four main components for coordination: goals, activities, actors and interdependencies. Goals require identifying the goals, activities connection to the goals, actors require selecting and assignments to proper activities, and interdependencies require management. Working together is interacting, and therefore interaction has potentially much more significance than just having contact with another actor.

3.3.4 Experiences

Helkkula (2011) has analysed service experience conceptualizations and views in existing research and service literature by using a three-dimensional approach: 1) service experience as "phenomenological" characterizations, 2) service experience as "process-based" characterizations and 3) service experience as "outcome-based"-characterizations. The phenomenological characterization of the service experience revealed that a typical focus is on the individual experiences –which are normally internal, subjective, event-specific, and context-specific. Most of the articles that approached service experience as a phenomenon referred to the customer as the subject of service experience but also service representatives were used as the subject (ibid.) From the process perspective, service experience was seen as architectural elements of the service-experience process, referred to as phases or stages mostly in chronological order. Helkkula (ibid.) also found that service experience is often considered as transformation or change. Finally, the outcome-perspective -focused studies considered service experiences as an element in a service model that links a number of other service variables and attributes to service outcomes. Helkkula (ibid., p. 382) lists the following links between three dimensions and how service is viewed:

- Phenomenological characterization refers to the value discussion S-D logic and interpretative consumer research
- Process-based refers to service as a process
- Outcome-based refers to understanding the service experience as one element in a model linking a number of variables or attributes to the outcomes.

Meyer and Schwager (2007) define service experience as customer experience which is the internal and subjective response customers have to any direct or indirect contact with a company. The idea is aligned with Sampson's (2012) interaction variants. Meyar and Schwager (2007) continue by stating that people (not customers) are set in part by their previous experiences with a company's offerings and customers tend to compare each new experience (positive or negative) with their previous ones and make a judgment based on this comparison. If experience creation is not a property of a customer but as suggested above, a property of a human being, then operations as interactions and responses create experiences for all participants – shared or hidden, which could provide a valuable source for creating information.

3.3.5 Change in the state and reality of the object

By combining all change-focused views on operations, it is possible to analyse common and diversifying characteristics based on the object and the subject of the change. Tomiyama (2001) combines change and service by defining service as an activity by a provider that causes a receiver, usually with consideration, to change from an existing state to a new state (that the receiver desires). Service contents and channels are means to realize the service and the change (ibid.). Godsiff (2009) uses a similar but more systemic approach by applying Ashby's Law of requisite variety in the service context. According to it, the only way to transform anything is to cause a disturbance and try to regulate the transformation in order to get the desired outcome as Tomiyama's (2001) definition required. Gadrey (2002) extends the view on what can be changed as a result of a service with four elements: goods and material systems, coded information, individuals (for certain dimensions) and organizations (for certain dimensions). Gadrey (2002) generalizes the change context by stating that it is the reality which is transformed or operated by the service provider for the sake of a customer.

Change in the state or reality of the object is a property of all activities performed in the service system and also outside it. The challenge in using change is that it can be identified only afterwards: change need states of the object to be measured, and measuring needs parameters. Godsiff (2010) argues that while increasing state parameters adds to the possible dimensions of the system, analysis begins to suffer from the curse of dimensionality.

Spohrer et al. (2008, p. 6) reveal important dimensions about state and resource production: "An observer can interpret every physical resource as a physical-symbol-system, with the sequence of symbols associated with the physical resource a description of the internal states of the resource as well as a description of the external relationships (external state)." This means that state information describes the state of an object but also forms a resource. Although the following argument may sound trivial, on the basis of evidence presented in the literature it is not: observation can be seen as resource integration but also as resource production if the integrated observation is further offered for some other resource integration activity.

3.3.6 Creating value and perceiving value

The final part of the operations sub-section focuses on value creation. The analysis of value creation follows the critical analysis of Grönroos and Voima (2013). They introduce traditional views on value creation where the provider controls the value creation: supporting the customer's peace of mind, making life easier for the customer, solving a customer's problems, letting the customer achieve more than the sum of the individual components/resources, satisfying customer needs or relieving the customer of some responsibility. The alternative view challenges the traditional view by considering value creation as a process that increases or decreases the customer's well-being, where decreasing is not necessarily intentional but a state or situation where unsuccessful service may lead (ibid). The model of Grönroos and Voima (2013) is presented in table 7.

Table 7. Direct and indirect interactions and roles of provider and customer, adapted from Grönroos and Voima (2013)

Provider sphere	Joint sphere		Customer sphere	
Provider	Provider	Customer	Customer (individually)	Customer (collectively)
Potential value-in-use	Value-in-use	Value-in-use	Value-in-use	Value-in-use
Indirect interaction	Direct interaction		Indirect interaction	
Value-facilitation	Value co-creation	Value co-creation/ value creation	Independent value creation	Independent social value co-creation
The service provider facilitates (e.g. produces and delivers) the customer's value creation with resources/ processes that are used and experienced in the customer sphere	The service provider's resources/ processes/ outcomes interact with the customer's resources/ processes in a merged dialogical process	The customer's resources/ processes interact with the service provider's resources/ processes/ outcomes in a merged dialogical process	The customer's resources/ processes/ outcomes (visible and/or mental) interact with the service provider's resources/ processes/ outcomes in an independent (individual and/or social) value creation process (indirect interaction)	Other actors/ activities/ resources interact with the customer's resources/ processes/ outcomes (visible and/or mental) in a collective/ social value creation process

From the information content perspective, the following characteristics related to value creation have been extracted from Grönroos and Voima (2013):

- Value-in-use is a subjectively experienced benefit derived from a thing's or a service's capacity of being productive of a person's good, where demand is a function of value-in-use, and value-in-exchange is derived from value-in-use.
- Value as value-in-use cannot exist before it is created (or emerges) from the usage process, where it is accumulating, and therefore cannot be assessed before usage.
- The value creation process by the customer is not linear, nor does it automatically follow the provider's activities.
- The firm controls the production process and can invite the customer to join it as a co-producer of resources; the customer controls the experiential value creation process and may invite the service provider to join this process as a co-creator of value.
- Value is realized through possession, usage, or mental states.

In contrast to Grönroos and Voima (2013), the service dominant-logic approach suggests seeing services as actor-to-actor (A2A) networks, in order to avoid predefining the roles of customers, providers, firms and organizations with embedded assumptions (Lusch and Vargo, 2012). However, Vargo and Lusch (2011) further point out that though the resource configuration network-view apparent in service dominant logic provides new insights, researchers as well as managers should not forget that networks as constructions take place in systems, in other words they have systemic characteristics. Vargo and Lusch (2011) argue that these systems are dynamic and potentially self-adjusting and thus simultaneously functioning and reconfiguring themselves. Wieland et al. (2012) propose that the combination of systemic thinking and actor-to-actor networks challenge existing models and conceptualizations, assuming linear, sequential creation and flow towards more a dynamic system. They also state that value creation in such a network is relational, and even the context of value creation is created through the involved actors.

The question is whether value creation forms transformative operation like resource configuration or interaction that can be observed and validated - perhaps not. The main insight that can be learned and extracted from the value creation literature is the idea of practically continuous activity - resource integrations and production do not follow boundaries set by organizations, designs and roles. From the information perspective, the most relevant question is therefore how to acknowledge the value creation aspect, extract relevant information from the value creation perspective, and create information for value creation that is beneficial for the actor that aims for value creation.

3.3.7 Conclusion of service operations

In this sub-section, service operations were explored as transformative operations that cause some form of change in the service system. Eight change types introduced in the form of design space were reduced into six transformations: 1) resource integration, 2) transforming resources and resource production, 3) interactions, 4) experiences, 5) creating change in a state or reality of an object and 6) value creation and perceiving value. Resource integration and production require more attention. At least interaction represents an example where both resource integration and resource production may both take place. The argument that they are always the same activity should not be made, but combining interaction characteristics with resource integration and production may provide additional insights.

Experiences and value creation represent mostly intangible elements, but from the information perspective an interesting challenge is to convert these elements into observable and tangible information. In this study, creating experiences and value are expected to be properties of human beings, not only rights of pre-specified roles. Also this perspective requires more attention. Creating change provides even richer potential in terms of service information. An intention to create a change indicates that both the direction of the change and the difference between the start and end states are known or estimated. It also implicates that the activities, resource integration or resource production, are well-known or in some cases even alternative ways of providing a change in a state of object or reality or both are known.

Exploring operations from the selected perspectives in the service context raises some challenges and concerns. As concluded in the earlier subsection, design is both an end result and an activity. Design as activity represents resource integration and production, and it also has the resource producer's role when some actor or actors aim at creating value through designs. The main point in this type of reasoning is that designing has less concrete boundaries than most design models and abstractions show, and that creating designs will actually take place in a moving train, as there are resource integration and productions involved in those resources that are used as drivers for creating a design. Again, from the service information perspective, it can be proposed that valuable information could be created if the usage (value-in-use) of designs could be traced.

In a similar way as in the design space, also existing knowledge from operations was transformed into an illustration called the operations space (figure 14). At this stage, the illustrations are not combined; they used as separate inputs for the construction of the design artifact instead.

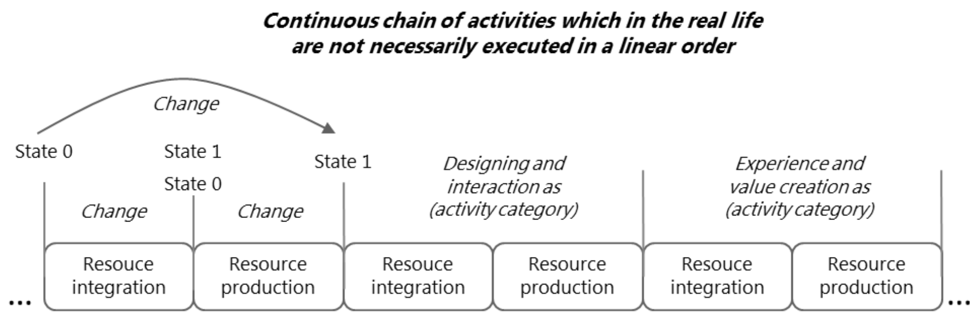

Figure 14. Transformative nature of different operational variants.

3.4 Information design

"Information design consists of defining, planning and shaping of the contents of a message and the environments it is presented in with the intention of achieving particular objectives in relation to the needs of users" (Petterson, 2002, p. 18). The fourth perspective in the construction of a knowledge base is formed through exploring information design and management principles in the design and operations context. The aim is not to review existing literature in detail, but to explore new opportunities and ways of creating and utilizing information. In order to achieve a more comprehensive insight basis, in this sub-section design and operations are framed more extensively, including also activities in production and manufacturing systems, information systems, and service systems.

3.4.1 The role of information in the service context

Information can be defined using different theoretical approaches, but in this dissertation the following definition is used: "collection of data, which, when presented in a particular manner and at an appropriate time, improves the knowledge of the person receiving it in such a way that he/she is better able to undertake a particular activity or make a particular decision" (Galliers, 1987, p. 4). The service literature outside information systems usually considers information as a vital resource, but how it should managed, what is the most relevant information in the service context and what can be translated into information are less known areas. Service orientation refers to a way of thinking which consists of service design, service systems, service encounters, service leadership, human-resource management and change management (Åkesson et al., 2008). These elements have already been explored above.

In information system research, the concept of service-orientation is understood slightly differently. One of the key constructions related to service orientation is service-oriented architecture, which addresses the requirements for loosely coupled, standardized or standard-based and protocol-independent distributed computing as services (Papazoglou and van den Heuvel, 2007). It aims at mapping enterprise-wide information systems appropriately to the overall business process flow (ibid.). In service-oriented architecture literature, service information consists of two partly overlapping types: design (time) service information and runtime service information (Rosen et al. 2008). These two types of information are briefly discussed in the next sub-sections.

3.4.2 The role of design information

Design information describes the product or component to be designed and the design specifications. These specifications include functions, performances, material selections, manufacturing process, and environments (Zhanjun and Karthik, 2007). Generating design information takes place in two general contexts: 1) when something new is created and 2) when design information is reused. Bruch (2012) argues that in order to use the potential of design information fully in the manufacturing context, organizations need to have the capability to manage design information as efficiently as possible. Shooter et al. (2000) describe the relationship between accumulation of design information and narrowing of the design space as illustrated in figure 15 below.

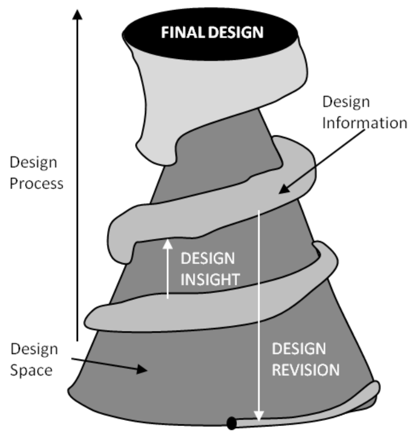

Figure 15. Design information development by Shooter et al. (2000, p.180).

In the case of creating new design information, neither design nor information come out of nowhere, especially when the designer's view is significant. Kim et al. (2010) propose a process that begins with numerous mental images, memorized design briefs and other information derived from the earlier design projects. During the earliest generating phase, certain parts of the mental images can be expressed through sketches (ibid.). These sketches can be used as external representations that allow "a conversation" between the designer and product that is being designed. In the case of design information reuse, the information provided by the earlier design phases and project is used for example in the design reviews, product improvements, revisions, and product line expansions (Khadilkar and Stauffer, 1996). Design reuse is often challenging because design documents fail to provide a comprehensive record and reveal only a small fraction of the evolution of the design or product (ibid.), causing information gaps and eventually poor understanding of the product.

Bruch (2012) has summarized the main reasons why design information is not incorporated in the design process: 1) design information is not acquired, 2) information is not shared among different specialized functions, and 3) information is not used in spite of being acquired and shared. James (2005, p. 663) proposes that "the failure of an engineering component or structure can be due to incomplete, inaccurate or inappropriate information related to one or more stages of the design process or to poor management of the design process itself." Erl (2005) adds a potential reason by describing "stovepipe" architecture as being solely tied to one and only one application and typically relying on a finite number of resources tied to that one application.

Daft and Lengel (1986) state that organizations process information to reduce uncertainty and equivocality. Instead of just processing information, the reduction of uncertainty requires the provision of new but target-oriented information (Moenaert et al., 1995). Galbraith (1977) characterizes these information imbalances as the difference between the amount of information required to perform a task and the amount of information that the organization already possesses. In situations of high equivocality, the participants in a decision-making situation acknowledge that simple yes-no questions cannot be asked, but they do not know what questions should be asked instead (Daft and Weick, 1984). The key is therefore to construct or enact a reasonable interpretation that makes previous action sensible and suggests how to proceed (ibid). Equivocality, on the other hand, is primarily associated with ambiguity, i.e. multiple and conflicting interpretations among project participants (Weick, 1995).

Creating new information and reusing or sharing existing information cannot be done effectively without considering the quality of information. In general, information can be evaluated through the accuracy, timeliness, adequacy and credibility of information being shared (Li and Linshan, 2006). Eppler (2006, p. 67) proposes four detailed categories for evaluating the quality of information:

- **Relevant information** (comprehensive, accurate, and clear enough for the intended use, and whether it is easily applicable to the problem at hand),
- **Sound information** (the intrinsic or *product characteristics* of information, such as whether it is concise or not, consistent or not, correct or not, and current or not),
- **Optimized process** (the content management process by which the information is created and distributed and whether that process (or information service) is convenient for users and whether it provides the information in a timely, traceable (attributable), and interactive manner),
- **Reliable infrastructure** (infrastructure on which the content management process runs and through which the information is actually provided).

3.4.3 Run-time and operational information

Reichert et al. (2009) propose three drivers why run-time environments and process-aware information systems should be developed: 1) ability to deal with uncertainty where descriptive systems with rigid processes do not succeed, 2) ability to adapt processes through reacting to exceptions, and 3) ability to evolve processes when for example the business model changes. In the supply chain context, operational information is referred to as short term information (daily or weekly), which is mainly related to sales or logistics activities, including shipment notices, order status, production schedules and inventory levels (Ramayah and Omar, 2010).

In the military context, the pre-assumption in the management of operational data is continuous running of operations (Singh, 1988). Operational data is usually processed into design information for creating design decisions (ibid.), but instead of single cause-and-effect relationships in the decision-making, it is vital to acknowledge that there are multiple decision loops and also multiple stakeholders aiming at processing operational data and information (figure 16.)

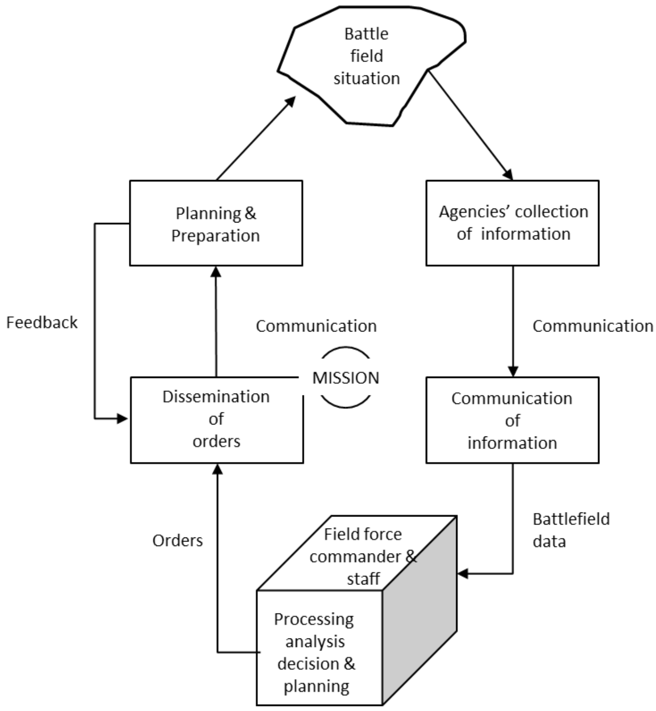

Figure 16. The role of operational data in the military context (adapted from Singh, 1988)

Run-time and operational information can also be approached from the production planning perspective. In a real-time production system model, Laursen et al. (2010) propose an approach where in an empirical case example, the production control in a run-time system is constructed through production control system variables. In the context of physical products they present three models for a control production system: 1) a product model of a product which includes information about the product design (geometrics, sub-parts, assembly rules assembly processes and production sequences), 2) a shop floor model of the physical production system which includes information about the geometrical layout, functionality and constraints of the physical shop floor system, and 3) a model of the manufacturing operations needed including the process description of the process used in the production of the product (the physical execution of the production tasks). The previous categories could also be viewed as design information, but the process of using them during the operations makes the information run-time information.

3.4.4 Using design information and operational (run-time) information in the service context

Both design information and operational information seem only be valuable if the information processing leads to knowledge creation. Exploration of existing knowledge in these areas provides valuable insights, but as they have been mainly extracted from the context of physical products or information systems, some additional perspectives must be covered. The first perspective focuses on the timing and process nature of operations. Eppler (2006, p. 61) proposes that critical process knowledge consists of three types of intellectual assets:

1) The know-how regarding the management of business processes or knowledge about the process,
2) Knowledge regarding the contents of a process or knowledge that is generated **during** or **within** a business process (know-what),
3) Insights gained from a completed process or knowledge derived from a process (know-why).

The first asset type is close to design information, the second covers run-time and operational information, and the third the integration of design information and operational information while looking backwards (what has been already done). According to Eppler (2006), relevant knowledge in three process contexts can be created through answering the following questions (table 8):

Table 8. Extracting relevant knowledge in three process contexts (adapted from Eppler 2006)

Knowledge about the process	Knowledge created during or within the process	Knowledge derived from a process
How is the process organized? What are the main steps, problems, responsibilities and deliverables? Which are the main and which are the sub-tasks and how are they coordinated? Which resources (time, expertise, staffing, money) are necessary for the process? How are they allocated? How is the quality of the process assured?	What has to be documented during the process? Who has done what at what time? What has happened at what point in time? What data has been gathered during a process step? What are the outcomes? What is going on right now in the process? What are deviations and critical situations at the present state?	If we were to do the process all over, what would we tackle differently? Are there successful (or best) practices to be deduced from the project, that is to say can we transfer the methodology to other domains? Are there critical success factors to be isolated? How can we further improve the process? Who was able to gain what kind of experience?

The second perspective focuses on seeing activities as information processing and information exchange – even the reality would be only interaction between humans. Glushko and Nomorosa (2013) argues that new opportunities could be created for service design and interaction within services, if interaction were seen as information exchange. He proposes a framework which "… applies when the information needed to create value in a service system accumulates incrementally through customer interactions or transactions with human service providers, with automated ones or in combination" (ibid., p. 21). Glushko's model consists of (1) a service model manager that stores information about how service is requested, (2) a customer model manager that stores information about customers and their preferences, (3) a recommendation system manager that uses service models, customer models, and contextual information to adapt the service at delivery time (run-time), (4) a learning system that analyzes previous service encounters to refine service and customer models, and (5) a service monitoring system that monitors the status of service delivery. If the model (figure 17) is turned around, it means that these activities and information are embedded in the service delivery system or could be included in the management with or without technology.

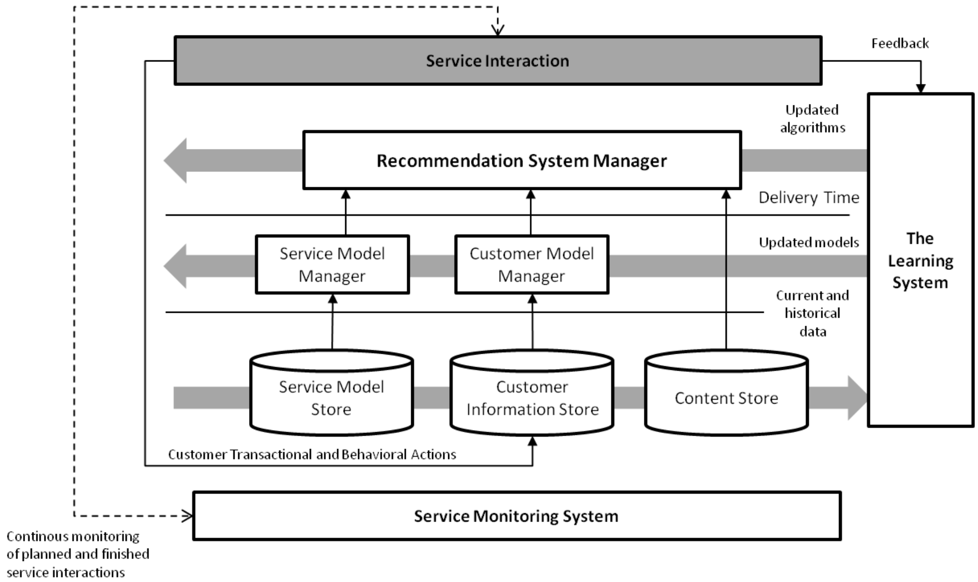

Figure 17. A conceptual model for personalization through service information (Glushko and Nomorosa, 2013, p.25)

The third perspective covers the situation where the design information, run-time information and information derived from the process (outcome) describe different phenomena. Customer experiences (Patricio et al., 2011) and value creation (Grönroos and Voima, 2013) cannot be designed or created by the organization, but operationalization can be designed for the customer experience or the value creation, even though these elements cannot always be extracted as information. This represents a special type of an interface between design and operations that sets additional requirements for the information perspective on the architectural layer and the artificial designs (artifacts).

3.5 Summary of the constructing knowledge base -section

The construction of the knowledge base has been set as a requirement in the design science research methodology (Peffers et al., 2008). In the research design section the construction of the knowledge base was divided into two sub-groups: 1) constructing a theoretical knowledge base by exploring the current scientific literature before creating the design artifact, and 2) exploring and extracting experiences and perceived insights in the empirical context during the design artifact test period. Here the content of the first sub-group is summarized for utilization in the next section: constructing the design artifact. The theoretical knowledge base was constructed from four different views and the research literature within them: the architectural view, the design view, the operations view, and the information view. The following contents for the next section were provided:

Architectural view: The architectural approach and techniques provide an ability to form artificial descriptions, artifacts that focus on representing and visualizing structures and relationships of the target object, which can be anything from complete systems to a limited set of tasks or resources. The architectures can be organized hierarchically through which the scope and level of detail can be adjusted. Since there is no single architecture in any system or context, architectures illustrate only a selected perspective. The architectural approach therefore provides also the opportunity to move between different perspectives in the same layer of details.

Design view: The design view provides an approach and techniques for transforming real elements into artifacts and also for defining the scope of the design. In this study the scope and level of details form the design space. The existing literature and models in it provided altogether nine types of changes that characterize services in the design space. The design space was limited to cover the design phase, the operations phase and the information linkages between these two phases. Though the design space was illustrated as a static composition of change elements and service development functionalities, the design space does not limit or even clarify how different elements interact and how they are actually organized.

Operations view: The operations view focuses on analysing the changes identified in the previous section from the information perspective. Nine changes were aggregated into six change types: 1) resource integration, 2) transforming resources and resource production, 3) creating interactions, 4) creating experiences, 5) changing the state and the reality of the object, and 6) creating and perceiving value. These changes and the information contents provided a view where the operations are a continuous activity from the information creation and processing perspective. A close connection between resource integration and production was identified, but also value creation and experience creation, as well as designing and interaction can be potentially seen as resource integration and production. If the integration and production of a resource can be analysed without limiting role description, the potential value of operational information can be increased.

Information view: The information view focuses on exploring the information design, and design information and run-time information are used in and outside services. Since the literature focusing on the role of information in non-technological service systems is scarce, the exploration was extended to cover manufacturing and information systems as well. Design information focuses on two main functionalities supporting and representing information about new designs and also reusing the existing design information. The runtime or operational information plays an important role in the context where the situational awareness of operations and related knowledge is important. In general organizations need both design information and operational information to reduce uncertainty and equivocality. Finally, the information view provides insights into process knowledge creation before, during and after process execution and how the interface between design and operations and the main object or artifact that is used as a central unit in information extraction and analysis can change the view on activities in different process contexts.

The construction of the knowledge base provides already now potential for new knowledge creation and valuable insights, but still only through loose and mainly abstract levels. Considering the activities of an organization as information processing (Tushman and Nadler, 1978) is not a new idea. The knowledge base proves that by accepting the information nature of design and operations, the aim at connecting design and operations and transforming this information linkage into applicable tools on various abstraction levels forms potentially a combination that could close the identified gaps in the research. At the same time, by following the resource integration and production logic, it is clear that creating new knowledge will create also new gaps.

4 CONSTRUCTING THE DESIGN ARTIFACT

"As an airplane example shows, the ominous term 'chaotic' should not be read as 'unmanageable'. Turbulence is frequently present in hydraulic and aerodynamic situations and artifacts. In such situations, although the future is not predictable in any detail, it is manageable as an aggregate phenomenon"

(Simon, 2001, p. 179)

The primary task and objective of this dissertation is to create new type of service information, knowledge and tools for connecting service design to operations management through an architectural level design artifact. The aim of the design artifact aims is to create new properties of a system which do not have place in the existing system components while accepting the notification by Simon (2001) that mechanistic emergence of properties is no emergence. In this section, the researcher takes the role of a problem-creator and solver while maintaining a link to what is already known and acknowledging the requirements set for rigorous scientific research. The documentation of the construction phase is very detailed and reports all decisions that have been made throughout the construction phase.

Peffers et al. (2008) state that a design artifact can be any designed object if the research contribution is embedded in the design. The construction of the design artifact phase includes two main steps: 1) determining the desired functionality of the artifact and its architecture and 2) creating the actual artifact (ibid.). The construction phase is organized as follows: the first subsection focuses on explaining the layout of the design artifact, where the layout refers to illustration of reality. The second subsection introduces the logic of the design artifact on two architectural layers: a logic layer and a process layer. The third subsection consists of the functionalities of the design artifact, and finally, the fourth sub-section consists of formulating sub-artifacts for testing purposes, including research propositions and tasks for the sub-artifacts. In this section references, if the source or topic is not totally new, are not cited as the theoretical background was explained in detail in the previous section. The existing and extracted theoretical definitions are acknowledged, but in this section some new definitions are made solely for the design artifact.

4.1 Structure of the design artifact – turning an intangible idea into a concrete construction

In practice, a design artifact in the service context may refer to the intention to describe through a construction how people think or what kind of a mental model they have. Focusing on the information perspective in the design artifact makes the whole construction even more complex: it includes also playing with human imagination. In this study, these characteristics are accepted and the detailed documentation should explain all major decisions throughout the construction phase. As in tangible construction projects, there is a need to form a common image or illustration of what is being constructed. Here the common image is illustrated as a layout of the design artifact which aims at explaining the general arrangements of the design artifact.

As a starting point and as a central component in the layout is the work system. The work system as a term does not describe the systemic elements of work; it is a basic artifact describing the resource constellation which is able to create changes in the work system through actions or work. As mentioned above, purposeful work can be organized as sequential or simultaneous activities that describe the working arrangement and potentially also its components. This arrangement forms the other main component in the design artifact which is named as operations. In other words, operations are performed by resources, and if there are resources able to perform work activities there are also operations. However, this does not directly mean or cause purposeful operations. Operations are always performed in a specific context where the definition of the context is dependent on the level of details and scope of the context perspective. Purpose as a term indicates that work or performance has some kind of direction or goal which can be pre-set for the operations but which can also emerge through the operations. Though operations consist of performance, it is proposed that operations can also be viewed as information through proper constructions.

The second main component is the design which is here defined as a specified form. A construction or model represents a form but also a walk-through demonstration by a human creates a form. Designs can be presented through illustrations, sketches and formal definitions which include and present a purpose for the work or performance, or explain which inputs are used as components in the creation of purpose for the work or performance. Design is information which has its own structure and processes that are utilized to create, modify and delete design-related information. Design information refers to components of design which can be used as standalone components or combined together as modular information components. Designs can be created through reference models, extracting designs from reality, or as a result of intuitive processing.

Traditionally the two components presented above are connected through a logic in which designs are decisions made by designers and used to explain reality and guide work system performance. Work performance can be measured directly or indirectly, and the results can be further transformed back to information to be used in the designing processes. The traditional logic is based on the idea that transforming design into information, transmitting it to guide operations, using it in operations and when transforming operations through measurements into information does not the affect the view of how the reality is understood. As the contextual elements or factors are mainly acknowledged in the case of interaction with customers, it can be assumed that the traditional view does not acknowledge or question the contextual differences between the design context and the operational context. Simon (2001) states that artifacts can be used to increase understanding in the interfaces between the inner and outer environment. For a designer, the inner environment is the design context, whereas an operations manager may consider it as the outer environment.

The traditional logic can be questioned in many ways, but here the focus is in improving both the main components and contexts through the following questions: how to improve the quality of design decisions and designs through operations, and how to improve the performance of operations through designs? A potential solution would change the way of thinking both in research and in practice. In the traditional logic, designing is merely seen as one time activity, except in models that acknowledge the power of operations and experience in the development of designs, such as that of Kim and Meiren (2010). When the design is finished, the operations know what to do and can perform until new designs are created and ready for implementation. Similarly, the ways of using design knowledge or information as a part of service operations management are not a well explained or explored area in the research literature.

The third main component used to explain the layout of the design artifact is called a service information engine. Engine refers to both the logical and mechanistic view of performing information processing tasks in the service context, but it also aims at separating the design artifact from the information processing systems studied in information system science. The service information engine is used to connect the design context and the operations context, and also to manipulate information for design and operational tasks. The information perspective offers an opportunity to separate the design-operations interface into two interfaces: 1) design to service information engine (design interface) and 2) operations to service information engine (operations interface).

This component does not change the reality as is, and as a construction it does not affect either the design or the operations, but as a conceptual construction it breaks the traditional logic. Processing service information and constructing a problem around it as part of the design artifact construction offers an objective view with the ability to create subjective controls. Controls refer to solutions that can be created, tested and modified as service information engine functionalities, offered for design and operational needs. Changing existing constructions, processes and behavior is not an easy task, and therefore the traditional way of connecting design to operations and vice versa is acknowledged in the layout. The general layout of the design artifact is illustrated in figure 18.

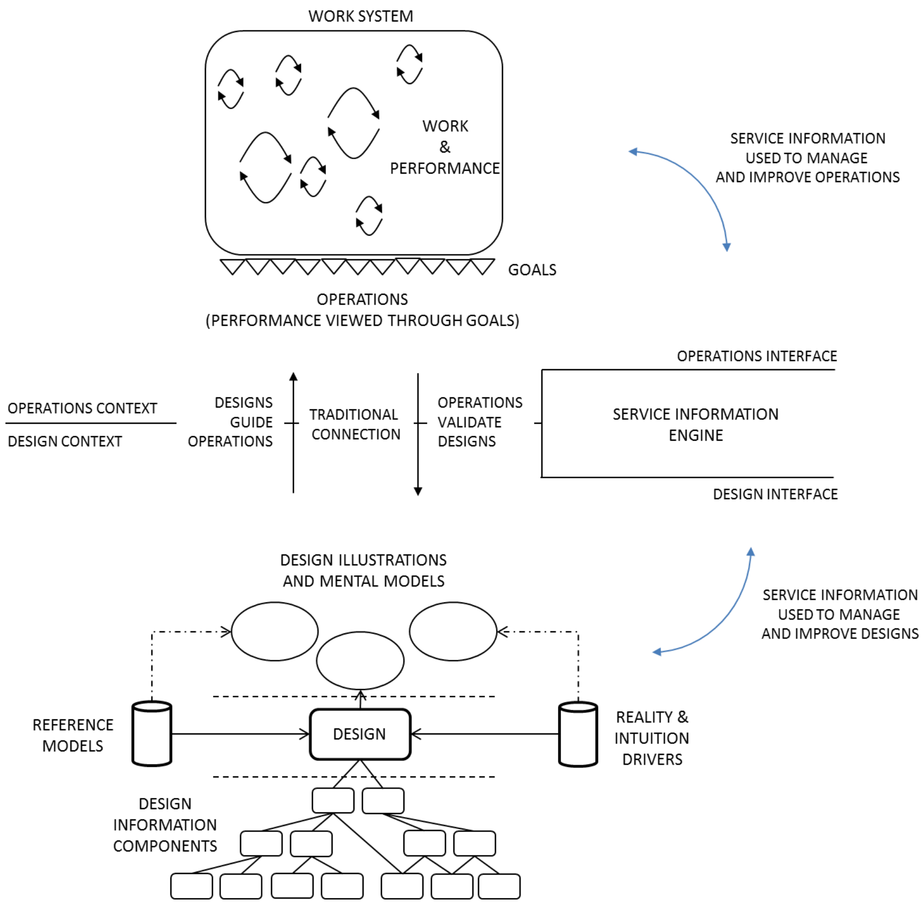

Figure 18. Layout of the design artifact.

4.2 Logic of the design artifact: logic layer and process layer

The general layout of the design artifact provides an architectural description as the components as such are not directly observable in reality. However, a construction is only a construction and as defined by Grönroos and Voima (2013), value can only be created by an actor who is able to integrate resources through usage. The next logical step in the construction of the design artifact is to create activities that can provide functionalities for usage. The activities are explained through dividing the layout of the design artifact into two layers. The logic layer is used to explain the general logic of the service information engine and how the interfaces are managed, and the process layer describes how the logic layer can be transformed into practical activities. Here the focus is again on the process principles, not on how and what kind of information systems should be created.

The logic of the design artifact is based on a traditional process model: inputs, outputs, transformative process and controls (Batista et al., 2008). The proposed inputs in the design artifact consist of low-level data, processed and meaningful middle-level information, and high-level knowledge where several sources of information are integrated by mixing accurate and experiential information. Outputs have all the same dimensions as inputs but creating data is excluded in the construction. The main processes on the middle level include transforming data into information, offering information for the knowledge creation and processing information into enriched information. Unlike in the traditional process model, control can be applied also in the inputs, meaning that data and information inputs can be combined with different types of data and information in a control process called *mash-up.* The logic definition does not aim at automated processing of service information, instead of that the logic and the whole construction aim at defining information processing needs – and all of them cannot be performed solely by humans or computers. The input data and information, as well as the output information do not have to follow any data format, as information by definition does not require these to be set. Therefore, the incoming material can be in any format from mental models and experiences to well-defined charts and mixed reality models (physical-virtual models).

The process layer describes the actual processes that are included in the design artifact. The first version of the design artifact, in the context of this study, consists of five different processes. The processes are described using categorization of what is created (outcome), how it is created (process) and from what it is created (the main inputs). In the process layer, the outputs are further divided into four categories: design information, operational information, operational designs as a combination of design and operational information aimed at usage in operations, and designs as a combination of design information aimed at usage in design. All outcomes are created through filtering data from the operations and service realization, and the outcomes can be created on the basis of existing artifacts (organizing information through existing artifacts), or information can be created through constructing new artifacts which originate from existing artifacts. The difference between the data describing the service realization and service realization is in their nature: data may describe service realization using different variables or a different lens from what can be observed directly from the service realization or through participation in the service realization. In all process types, a strict principle has been to follow the guidelines set in the existing literature. The five process types are presented in table 9.

Table 9. Processes included in the design artifact

Reference	What is created – outcome	Through	From
Process 1 "Designs through reverse engineering"	Designs (combination of design information)	Constructing a component-based model based on design filters	Operational data and service realization
Process 2 "Shared design and operational artifacts"	Design information	Filtering data using architectural design	Operational data and service realization
Process 3 "Experiential data to design and operational information"	Operational information (for operations) and design information (for design)	Filtering data using architectural design	Experiential operational data and service realization
Process 4 "Operational designs"	Operational designs (combined design and operational information for operations)	Filtering operational data and combining it with design information using architectural design	Operational data and design information
Process 5 "Filtering reality through artifacts"	Operational information (for operations) and design information (for design)	Filtering data using architectural design	Operational data and service realization

4.3 Functionalities of the design artifact

Defining processes does not define the functionalities of the design artifact. The processes divide the customers on the basis of the outcomes into design and the operation domains. The functionalities set guidelines for how to create value through the usage of the design artifact in these domains and underlines the difference between the current situation explained in the literature and the improved situation in terms of value creation potential. In the design artifact, each process provides a single functionality as the main outcome for the relevant customer. The functionalities include 1) the ability to recover service designs in the existing service delivery systems, 2) ability to map difference and reveal local service variables between static designed delivery and dynamic service realization, 3) ability to transform experiences into design information and utilize them in the operations, 4) ability to create more systemic responses to variety through using operational designs, and 5) ability to analyze service activities as resource integration and resource production type interventions.

Functionality 1: Provides an answer to the question of how to form a design description in a service context or system, where the operations have emerged through work procedures and other drivers, but designs for service have never been created. The purpose of providing this functionality is to create an ability to form designs, but it is acceptable if service designs are not created or are not considered as important. The functionality utilizes process 1 for creating the design description and creates new contribution for service operations management and design literature by focusing on existing service systems.

Functionality 2: Provides an answer to the question of how to use the same service artifacts in static design descriptions and when managing dynamic service operations and realization. The functionality aims at converting design artifacts into the language of operations, and also connecting operations back to design through the artifacts. The main focus is on creating design information through utilizing process 2. The utilized design and service artifacts exist already in the service literature but their connectivity to operations is poor and mainly one-directional (design to operations).

Functionality 3: Provides an answer to the question of how to extract qualitative knowledge that is produced by service workers and embedded in the service operations. Especially in the service context where the autonomy of individual employees is high and where the employees work also as designers it can be proposed that all information made visible and accessible in the information systems does not cover all information used to design and managing operations. Functionality utilizes process 3 in the creation of both operational information for the operations domain and design information for the design domain. The idea is to utilize the same, mainly experiential and observation-based data related to the service operations and filter it through service artifacts. Instead of creating and supporting individual views, processed service information will harmonize experiences and represent them through artifacts, which is a new approach also in service research.

Functionality 4: Provides an answer to the question of how to form operational designs that combine design information and operational information for operative decision-making. This functionality, unlike the other functionalities, aims at managing variety and variability in the service context. The idea is to modify design information to fit operational decision making needs, instead of expressing it in the design format. This functionality introduces a new need and provides also a solution for it: increasing situational awareness during service operations. Situational awareness is a well-known concept in transportation and military-related decision-making research, but for some reason evidence in the service context is still relatively scarce. Therefore the contribution offered through this functionality provides new insights for service operations management research.

Functionality 5: Provides an answer to the question of how to express existing service activities through artifacts in a way that creates not only new information about the activity but also potentially new knowledge for service design and management. This functionality serves also as a platform for testing service artifacts and their capability to create new information. The functionality utilizes process 5, which is an extended version of process 3. The focus is on operational data, and the difference between experiential and mental model -related knowledge and operational data is acknowledged and their differences utilized. The main contribution for service research is created through transforming the service artifacts for practical usage and testing them in real environments. Instead of just abstracting reality as artifacts, it is proposed that the reality can also be filtered through artifacts.

4.4 Operationalizing the design artifact – the action plan

The design artifact consists of the layout, the logic and process layers, and functionalities. All components of the artifact are based on the existing service research and literature in various disciplines. The core idea in the artifact is to combine them in a new way and provide new contributions through focusing on service information. According to design science research methodology (Peffers et al., 2008), the next phase or activity will focus on testing or demonstrating the artifact in a real context. Peffers et al. (ibid.) state that demonstration means using the artifact to solve one or more instances of the problem. The methods vary between experimentation, simulation, case study, proof, or some other appropriate activity. Demonstration or testing only is not enough, “resources required for the demonstration include effective knowledge of how to use the artifact to solve the problem” (ibid., p. 55).

In this study the testing phase is named as operationalizing the design artifact. The phase consists of the following sub-phases: 1) presenting the complete design artifact, 2) forming sub-artifacts for the testing, 3) selecting the testing format (design science -based testing or case study -based demonstration), 4) completing the test, 5) evaluation of the sub-artifacts, and 6) evaluation of the complete design artifact. In this sub-section the focus is on sub-phases 1-3, sub-phases 4 and 5 are presented in the section Publications and sub-phase 6 in the section Evaluation of the artifact.

4.4.1 The complete design artifact

The conceptual construction of the design artifact is finished by presenting the layout, the logic and process layers and the functionalities in the same illustration. This version of the design artifact has been developed and evaluated through testing, and the updated version is presented in the Conclusions section of the dissertation. An additional part in the design artifact is controls, which were included in the logic layer but not defined or explained when the processes and functionalities were introduced. Controls consist of controlling not only the process and performance of the design artifact but also how the functionalities are utilized, promoting the options that explain how value can be created through usage and controlling the quality and contents of the inputs and outputs.

In the illustration which describes the design artifact, the controls are located below the functionalities – the idea is to control and adapt or adjust functionalities which have effects on how processing takes place and also what is processed. The controls are expected to be operated by the customers (who require, need and use the processed results) or by the provider (who provides information and potential for value-creation). These positions or roles refer to customers and providers of information, not to the service provider or end customers. However, when the role definitions are expressed through information, they are merely interfaces or options to participate in the information-related processes and functionalities. The complete design artifact with all the main components is illustrated in figure 19.

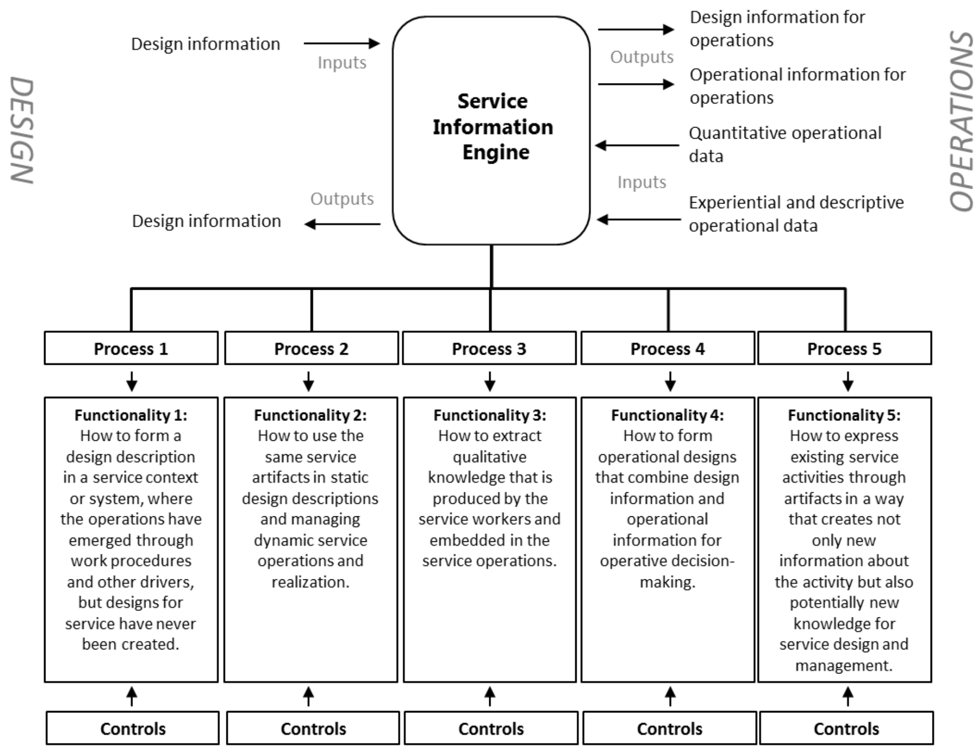

Figure 19. The design artifact – Service Information Engine (SIE)

4.4.2 Forming the sub-artifacts and selecting the test procedures

Each process and functionality requirement including the controls was transformed into sub-artifact constructions. The sub-artifacts follow the design artifact construction but as they are aimed also at independent implementation, the contents have additional functionalities. The sub-artifacts were tested and demonstrated independently but the contexts were partly shared. The independent testing in the empirical contexts should also reveal characteristics, constraints and information potential that may not be spotted if all processes are tested simultaneously.

The processes and functionalities 1, 2 and 4 were tested by using the demonstration approach where the sub-artifact framework was tested and analyzed through case studies. The constructions were tested through analyzing both qualitative and quantitative data and evaluating the results with representatives of the studied organizations. Processes and functionalities 3 and 5 were tested using the design science approach where the testing consisted of testing the artifact itself, not just analyzing data through the artifact and evaluating the results as in processes 1, 2 and 4. From the reliability perspective, the difference between the two approaches may not be significant, but from the information extraction and insight creation perspective differences exist and they are acknowledged. In all cases, the researcher's task was not to solve a real-life problem but to design and test the construction – therefore participatory techniques such as action research were not implemented.

5 REVIEWING SUB-ARTIFACT -RELATED RESULTS

This section focuses on reviewing the sub-artifact constructions and the main results related to each sub-artifact. Each sub-artifact has been explained and introduced in a single publication. The publications do not explain the design construction proposition as a background because it would not have been possible to explain all details in limited space and scope. Extracting the relevant findings, discussions and main conclusions from the design artifact perspective is the main task in the dissertation. Each publication has been exposed to revision requests by journal referees, and therefore the content of a single publication may not be fully coherent with the original design artifact, which will also be discussed in the evaluation section.

The sub-artifacts are connected to both the design artifact developed in this dissertation and also to three sub-questions derived from the main research question. The sub-questions were: 1) What conceptual service design and operations artifacts form the core concepts in the service delivery system, and how can the connections or shared properties in the artifacts be transformed into information?; 2) What kind of information connections exist between service design and operations based on conceptual and empirical knowledge, and how can these connections be utilized to reveal the dynamics of the relationship and new information needs?; and 3) What kind of information connections exist between service design and operations based on conceptual and empirical knowledge, and how can these connections be utilized to reveal the dynamics of the relationship and new information needs?

5.1 Positioning the publications to the research questions and structure of the dissertation

Providing an answer to sub-question one was done mainly in section three which focused on constructing the knowledge base for the design artifact. In addition to that, publications 2, 4 and 5 provide valuable insight into research question 1 by focusing on the potential of artifact-related information and creating a combination of shared properties provided by the artifacts. Sub-question two has been addressed in all the publications (1-5), providing both new type of information-based connections between service design and service operations, and providing examples, propositions and findings of new information needs that have not been previously addressed in the service literature or in the empirical service environment in the selected social care and healthcare contexts. Publications 3 and 5 aim at providing an answer for sub-question three by focusing on new resource creation and analyzing information processing as resource integration and production. Also publications 1, 2 and 4 create new information resources, but in these publications new resources are mainly new versions of design information, whereas for example in publication 3 experiential knowledge of employees create a totally new category of operational information. A complete answer to sub-question three is provided through the evaluation of the design artifact developed in this dissertation. As a summary, the relationships between the research questions, publications and relevant sections in the dissertation are illustrated in figure 20.

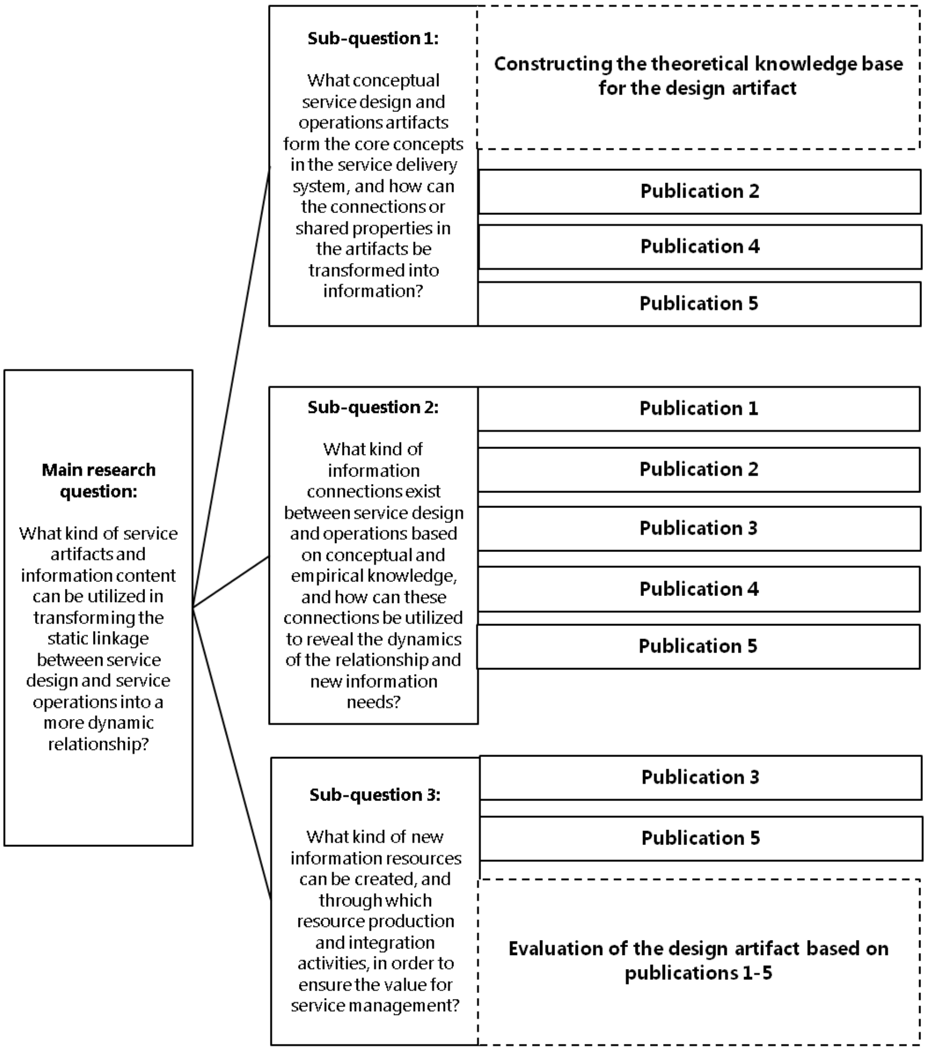

Figure 20. Positioning the publications in relation to the research questions, knowledge base construction and evaluation of the design artifact

In the evaluation phase, the focus is on the design artifact and therefore the evaluation provides a significant contribution to the other sub-questions as well. In the evaluation phase, the publications are not referred to; the evaluation utilizes only the inputs from the publications and the sub-artifacts that were designed and tested or demonstrated in the publications. The next sub-section focuses on summarizing the core content of publications 1-5 through the following structure: name of the publication, objectives of the publication, theoretical background and setting, contribution to the research, and the main findings related to the design artifact. Although the publications are independent studies, the connections between the contribution of the studies, if similar or contrasting, are explored in the Contribution and Main findings sections.

5.2 Summary of the publications

Publication 1: Recovering existing service design through reverse engineering approach

Objective of the publication

The main objective in this publication was to focus on service activities that do not explicitly follow any formal plan or design. The aim was to form an alternative path for creating ‘service designs’ in existing service systems. Instead of using the popular service blueprinting (Shostack, 1984) or flow-chart-mapping techniques when mapping assumes service activities, service managers should focus on questions like “what are the core elements of our service delivery system based on the service realization?” It was proposed that a realization-based service design or similar descriptions will provide new perspectives on service delivery, and also new service information needs in the form of identified gaps between service design and service delivery or operations. It was further proposed that if the focus is only directed towards renewing service designs based on experiences in the existing systems without a clear link to operations, the service organization may increase the legacy system effects caused by previous designs in the service system. The legacy system describes a phenomenon where service designers and managers are unaware of why certain solutions have been implemented or remain in the service system.

Theoretical background and setting

Most service design models focus on designing new service products or delivery systems. The service literature provides only a limited contribution to the use of service designs in existing service systems. Shimomura and Arai (2009) have identified severe gaps in the utilization of service design in existing systems. They state that gaps exist between customer analysis and service activity design, as well as between functional design and service activity design. Zomerdijk and Voss (2010) have proposed that formal service design may lower the risk of concept or design replication by competitors. De Jong and den Hertog (2010) have conceptualized service innovation 3.0, which requires formal service design methods also when technological developments are translated into service propositions. If these propositions are translated without acknowledging the operational characteristics, it is possible and likely that valuable information remains unidentified.

The theoretical base of the designed solution and method relies on the reverse engineering methodology developed in the manufacturing of computer systems. Reverse engineering is opposite to traditional forward engineering where the development or design process moves from high-level abstractions and logical designs to physical implementations of a system (Raja and Fernandes, 2008). Chikofsky and Cross (1990, p.15) define reverse engineering in the information technology contexts as "process of extracting design information, functional specifications and, eventually, requirements from the program code". The reverse engineering approach is applied when the implementation is known but the original design and/or requirements are unknown. In this publication the reverse engineering approach was applied by utilizing the service development model by Bitran and Pedrosa (1998) reversely and starting from identifying system components and flows that can be identified or observed from the implementation.

Contribution of the publication

The main purpose of the publication was to produce insights and information that was directly observable from the implementation or service delivery, although these observations and identification of process and service elements formed the input data of the model. The insights that were achieved during the implementation process were categorized according to their sources, design relevancy, and operational relevancy, and mapped according to their realization in each design area. These design areas were not exactly the same as the ones developed in the construction of the knowledge base, but the connection to the design artifact is clear. The main findings included:

Customer perspective (design area): the service providers demanded high quality of customer input parameters and used scripts in controlling customer behaviour (the scripts were coded in instructions, guidance and communication), the customer was a very standard unit in service delivery, and as irrational behaviour would cause ceasing of service delivery, technology-readiness and acceptance seemed to have significant role in the willingness to cooperate with the service providers.

Provider perspective (design area): the full potential related to the information input of customers was not realized, no evidence of service supply chain management existed, relevant 'service supply chain' information was not shared, and several local 'service designs' were discovered. They instructed service operations within small interconnected activity groups (a service system design did not exist, however), and local service designs governed the local service processes. Formal process definitions, measurements and managerial procedures did not exist. Technologies and technical systems were used to standardize and steer most of the service operations in the local systems.

System perspective (design area): critical flows were either pure information or information + material pairs, and typically these information flows were already standardized by using some kind of a technological solution. The independent service activities were connected to each other mainly through information, software and automated solutions, the formal logic of service and the main objectives of each actor were not recomposable, but some evidence related to informal objectives and optimization could be observed. Mapping all connections between all identified activities revealed overlapping control mechanisms as well as activities that were not controlled at all.

As a main contribution to the research it was concluded that 1) the results achieved in this study suggested that the design area in service systems should be expanded radically. Instead of using the design concepts only as pre-delivery tools, methodological development should be aimed at run-time design concepts and managerial tools to be utilised during the service delivery; 2) the results of the study indicated that service designers and managers could create interesting insights if existing operations were recomposed to service design representations, instead of decomposing designs into realisations; and 3) the findings indicated that information flows might have as significant a role in service systems as material flows in production systems: processes are defined by them. Information flows may reveal how the actual service processes are organized, managed and coordinated.

The main findings related to the design artifact

The main findings related to the design artifact provided several change requirements for the conceptual design artifact, but also some of the assumptions were supported by the empirical evidence. The following implications were extracted for the evaluation of the design artifact:

1) There is a need to create designs during operations. From the design artifact perspective this would mean that the designs should be updated or made livelier on the basis of the operational changes or dynamics in the operations.
2) Design information can be recovered by observing and identifying operational components and flows – this information is not comparable to the design information proposed in the service literature, however.
3) Design information created as an outcome of design activity such as instructions and scripts is coded twice – the first coding codes the idea to the format of an ideal service delivery model and service behavior, and the second coding transforms the message for the right address, either to the customer or the provider.
4) The customer can and in most cases does create design information.
5) Recovering the design is not only an option in a system which explicitly does not follow any design – there is also potential failure in the conceptualization of design since searching for process maps and charts and task definitions is not the only way to govern or steer service operations and delivery. Legacy system -related design and service management should be revealed instead.
6) Information processing forms a production system in the service context, even though it may not follow the logic of the service fully, it provided in the case context of this publication the only traceable connection throughout the service delivery system.

In the design artifact, it was assumed that design information can be manipulated and mixed with operational information. The findings of this publication supported the idea but also revealed that design information is a much more multifaceted concept than what the original design artifact acknowledged.

Publication 2: Identifying product and process configuration requirements in a decentralized service delivery system

Objective of the publication

The main objective of the publication was to identify the systemic requirements and characteristics set for product and process configurations in a decentralized service delivery system. It was argued that the current service design artifacts emphasize the role of systemic characteristics and possibly even aim at a service system design without clearly explaining what the systemic nature causes to the traditional artifacts. In simple systems or service contexts the behavior of artifacts is not as critical as in larger systems where different types of processes including material, information and customer are processed simultaneously. The aim was to analyse the two important artifacts in the service contex, namely service product and service process as configurations and to identify the dynamic nature that these artifacts are exposed to during usage. Instead of placing product and process artifacts in the middle of a service delivery system, they were positioned according to their role in the existing service literature.

Theoretical background and setting

Ng et al. (2011) have identified operational and usage information as a critical requirement for configuring a service delivery system (SDS) effectively, a feature that is missing in the existing models. Our aim was to continue extending the current knowledge about configurations in a SDS and to find out how the systemic characteristics actually affect the product and process configurations. Though these configurations affect real-life operations they are mostly information in the configuration phase. Tax and Stuart (1997) state that the main purpose of service delivery system design is to address the question of how the service defined in the service concept can be delivered to the customers. Ponsignon et al. (2011) state that the more customised the concept is and the more concepts there are, the more complex and greater are the requirements for employee skills discretion, and the less routinized tasks and automation can be utilized. The service concept design and related decisions are translated into lower level artifacts such as product, process and interaction configurations (Bullinger et al., 2003). The product model is a definition of the service contents and a structural plan of the service products, and it guides the service activity that realizes the service for the customer (ibid.). A service product and packages cannot be delivered without a channel, and therefore channel selections are often connected to service product design.

The process elements consist of tasks, processes and cross-functional-level coordination (Lillrank, 2010), and the processes can be divided into front-office and back-office activities, describing the process activities that are visible and non-visible to the customer in a closed environment (Glushko, 2010). The process design and related decisions do not only specify the order of activities, the flows between the process steps and transformations related to a single task, they also set an order and timeframe for the service delivery. Process designs can also be used to identify sequences where automation can be applied. Interaction is mostly configured as a part of the process, but the effects are mostly visible as a part of service realization. Interaction can be organized as touchpoints that can use multiple delivery channels simultaneously (Secomandi and Snelders, 2011). The first interaction aspect focuses on following a pre-defined task (responsiveness), the second aspect on the social content of the interaction and adjustments within it (personalisation), and the third aspect on how well the customer's request can be fulfilled (customisation). Lillrank (2010) offers four additional elements: the service provision point (SPP), access, which means the time and trouble for the customer to get to the SPP, service range, describing the number of different offerings in a single SPP, and speciality, referring to different grades of offering that address the same need.

Already the brief review of configurable elements shows that there is lots of information about design decisions available or at least potentially available. The most challenging characteristic between design decisions and realization is the fact that designs are used to guide the operations directly or through managerial interventions, whereas the realization defines the actual design of the service. This link is often missed if different artifacts and parameters are used in the design of service realization and when measuring the outcomes, quality and performance of service operations.

Contribution of the publication

Defining the products and related service processes do not form a real challenge for service organizations, as both theoretical and practical knowledge is well established. It can even be argued whether product or process models should be implemented if their benefits cannot be identified. When the focus is on open, dynamic and decentralized service delivery systems, things change radically. Multiple simultaneous processes including non-transparent service delivery with individual customers and their individual needs mean that service operations management requires new and more advanced ways to create and utilize information about the configurations. In these types of contexts, the traceability of service realization requires using information that is not included in abstract process or product configurations.

The only way to validate service delivery is to create and utilize information about the activity, and it also the only way to manage the service quality and efficiency of service delivery. Therefore also the service configurations are highly dependent on information. In the empirical system, it was observed that most of the problems and challenges in the case system were due to a loose connection between the designed product and process models and critical operational elements in the SDS, such as location information, activity and human status information, and coordination of internal and external logistics. In order to use information in an efficient way, there is a need to utilize structures. The findings of the study supported the idea of creating operative versions of product and process configuration models. The core of the operative configuration model should be static (standard) and the content dynamic. This would allow using the same platform throughout the SDS, but also enable local configurations based on dynamic operational information, as traceability would be guaranteed. Despite the significant role of information, the service designers and managers should acknowledge that the focus cannot be isolated only on a single event or a general process, the architecture of the service configurations should be acknowledged instead.

The main findings related to the design artifact

Design information has at least two additional dimensions – it guides the operations but the content is partly defined by the operations or service realization. This characteristic indicates that there is a link between design information inputted to the operational system and the operational data extracted from the operations. How well the extracted operational data supports analyzing the gap between inputted design information and information about realized design defines at least partly how much the designs can be improved. Another point related to the same aspect is changes in operations that are not measured in any way. Operational data might indicate something different than the actual operations would indicate if better measurements could be attached. This emphasizes the role of experiential data or information, which provides an easy way to improve designs as well as operations, but which can be difficult to automate.

The findings supported using the configuration artifact though they did not reveal how the configuration information is organized. For example status information is not present in any popular service artifact aimed at process design or product design. Configuration in the service context describes available decision-making options and decisions that have been made. As observed in the empirical context, these configuration options may or may not be based on designed products or processes, but the realized service versions can be analysed as product or process designs through these configurations. The idea of operative configuration models would require defining an additional interface between operations and the design information processor. The reason for this is that most of the design information actually implemented in the operations is very local, but configurations in a service system are linked together through time slots, locations, resources and other constraints. The most significant constraint seemed to be connected to the ability to interpret the information, whereas some employees did not need or acknowledge information if it was preprocessed.

The second publication could not prove whether the existing service artifacts were valuable or not. Their content seemed to be embedded in the operational configuration options – if these options cannot be controlled and there is high autonomy in the decision-making, there is no point in trying to utilize product or process models to support right options. Reversely, the realized configurations if recoverable may include valuable information about the realization.

Publication 3: Service designs and mindsets – extracting experiential knowledge from service realisation

Objective of the publication

In this publication the power of service design structures was both questioned and emphasized. In complex systems, where complexity is created and interpreted by humans, the old-fashioned two-dimensional management tools are no longer relevant. In order to achieve new insights, it has been proposed both directly and indirectly that services should be designed as they are experienced (Gross and Pullman, 2012; Ostrom et al., 2010; Zomerdjik and Voss, 2010, 2011). The main objective in this publication was to create a method that would capture both the employee experience and the perceived system view, in other words how human resources and more specifically service employees perceive the service context in which they work. It was proposed that this type of a method could support creating new type of knowledge which would enable creating improved and more adaptive resource configuration options. The focus was on the mindsets that are needed and utilized in the resource configuration and in providing value creation potential for customers. Through the method development, the employee experience was conceptualized, which was a similar artifact as customer experience, although the parameters were different. This publication aimed at providing a framework for capturing employee experience and extracting knowledge from it.

Theoretical background and setting

Service is a perspective on value-creation where the focus is on the customer and how to understand the interactive, processual, experiential and relational nature of service better. Though this a common statement in service research, it provides a too limited view on analyzing and improving services. In this publication the core idea was taken as the starting point, but instead of the customer, the main focus was on the employee. The literature provides a few examples of using the employee experience or a similar conceptualization in labour management (Warhurst and Nickson, 2007), in healthcare sector services (Harley et al., 2007) and also in supply chain development (Smith, 2012). These studies focus mainly on managing human resources and on behavioural aspects of working. Using the employee experience as a design or engineering concept has not been used as widely.

In contrast to the employee experience, customer experience, experience management and total customer experience are intensively studied areas in service research (Palmer, 2010). Sheth et al. (1999) conclude that the context plays a significant role in experiential service designs and service events, and a combination of three factors will help in shaping the consumer’s attitude to an event: 1) stimulus characteristics that are perceived differently according to the sensory characteristics and the information content, 2) the context where the stimulus is perceived, and 3) situational variables in which the information is received, including social, cultural and personal characteristics. Palmer (2010) further states that creating new experiences requires tools that are capable of eliciting a response from potential customers and capturing the emotional and situational context in which the experience will be encountered. Service research and the related literature emphasize the role of a customer by underlining for example that only an actor can create value for him/herself (Grönroos, 2011) and that service is most likely a valuable unit only in the actor's own reality. If the pre-set limitation related to focusing on the customer role is removed, the relevant question is: when the employee experiences service delivery, does he or she create value through successful activities and if value is not created, is there still valuable experience waiting to be extracted to information?

Contribution of the publication

The main contribution to the research was provided through the design artifact that captures the employee experience through the utilization of the Perceptual Cycle Model (PCM) (Plant and Stanton, 2012). In the PCM model the information processing steps in a decision-making situation is modeled using three categories of information: information about the present environment, schema of the environment, and perceptual exploration of potential actions. The artifact provides a unique contribution by supporting access to an employee's actions and by extracting experiential information that are not visible in the service process or in organizational charts. Based on the results we stated that all actors within a service delivery system form an experience that includes processing service- and resource configuration-related information.

The results also showed that the length of the experience is not limited and does not follow the service process definitions or charts, but is affected by the social context and interpretations in the present environment. Based on the results, it was further proposed that the way the employee thinks and interprets the environment should not be fully standardized, as that can hide very valuable service information and knowledge. As practical findings it was suggested that a better insight into the employee's own schema is connected to the performance of the service process. However, by focusing on the human aspects of service operations, it can be stated that as long as the computer and information systems remain pre-coded and include trust in the assumed behaviour, there will remain a need to integrate several different mechanistic views and also experiential views in order to extract and create right information for the service delivery system.

The main findings related to the design artifact

One of the most challenging tasks in capturing and extracting the experiential knowledge is translating it to accessible information without losing any valuable content. In the design artifact of this study, the employee experience was connected twice to the operational or environmental information. Operational information differs from the operational data in its content and timeframe. The content of operational information describes changes in the operations during a timeframe set by the employee who experiences certain events. This experiential information was transformed through a meta-model describing the service system through experiences and operational information into design information. This of course added new components to the design artifact.

The core idea in experience creation is that people do it constantly, which raises an important question: whose experiences are recorded and in what kind of situations. Though this question was not addressed in the original publication – it will define the quality of design information and also operational information when it is returned back to the operations. The findings also revealed that events or episodes that are experienced and connected together in our minds may follow a different logic or sequencing than the service or work system was used to or expected to follow. If this information is further processed into design information, it would potentially cause gaps between two different timeframes but also a need to synchronize different types of design information.

Is experiential information valuable for the design activity and how will it be used? Making justifications based on experiential information would require a reference model of experience to be designed. This link may have two significant indications: firstly, also design information in the design domain has different usage models, and secondly experiential information is not only very subjective but it is also dependent on the contextual or environment state parameters, s well as the quality of the experience reference model.

Finally, the publication contributed to the design artifact through revealing the previously not so well-known concept of employee experience. The approach also provided several questions or constraints for the information processing and the reformatting of the design artifact.

Publication 4: A modular response model for increasing awareness of systemic variety in service operations

Objective of the publication

The main objective of this publication was to create a modular concept for creating process level responses in a service system, and to make the response creation visible by identifying the components and potential challenges in the response creation. The study aimed at increasing systemic and information usage -focused insight into the field of service operations management, in addition to the existing approach focusing on engineering service processes through simulations and modeling. The model utilizes various types of design and operational information when supporting the decision-making situation where the response for the observed, sensed or identified variety (symptom) is created. It has been suggested in the service literature that managing variety requires new strategies, such as an ability to increase or amplify variety (Godsiff, 2010; Ng et al., 2011). From the systemic perspective this would mean that new states are identified and executed intentionally, and also transformed into understandable information. In this paper it was proposed that by finding a structure for response creation in the service context, service organizations would be able to construct new response variants by improving the existing responses with additional components.

Theoretical background and setting

Whereas the traditional process model consists of inputs, transformations and outputs, and is based on a highly reductionist and closed system view (Batista et al., 2008), it was proposed that a more systemic view would extend the reductionist model by creating state-awareness. Inputs have been acknowledged as disturbances that change the prevailing state of the system (Godsiff, 2010). As a systemic phenomenon, variety describes the possible states that a system may possess (Shinners, 1998). Variety has at least to significant meanings in the service operations management context: variety as design solutions and request characteristics. Variety describes a design option balancing between the degree of customization and the volume of production, which can be described by using a volume-variety matrix (Slack et al., 2007). Variety also sets processing demands at an individual stage of the process (input variety) or as the time taken to perform the activities, also known as processing variety (Slack et al., 2007). The input variety or request characteristics are often referred to as variability.

In the service context, variety is most often connected to the loosely manageable participatory role of a customer. Frei (2006) introduces five variability types that are tightly connected to the customer: arrival variability, request variability, capability variability, effort variability, and subjective preference variability. Focusing on the customer may hide other types of sources of variety and also the logic of how the responses are created. Frei (ibid.) proposes two managerial strategies for each category to deal with the variety: accommodating the realization based on it, or reducing the variety. What are often bypassed are the internal or organizational sources of variety. For example Schemenner (2004) states that the more central and independent the role of an individual employee is, the higher the service process variation. Ponsignon et al. (2011) even state that a typical response to variety is tightly connected to transforming the requirements of the service concept for the operational system instead of the requirements set by the external input. Some of the sources of variety and potential logics embedded in response creation can be observed or identified only in dynamic or runtime service operations. For example the dynamic nature of service highlights the ability to connect episodes and transfer the correct information and materials from episode to episode (Frandsen, 2012).

The main challenge in the design of a more systemic approach is adding more and more state parameters in order to understand more about the systemic nature. Godsiff (2010) argues that eventually this will lead into the situation where the analysis begins to suffer from the curse of dimensionality. Therefore it was proposed in this publication that by using the architectural view on service operations and by creating modular information structures based on this architectural view, it would be possible to deliver dynamic information by using the architecture of variety in the service context. In order to maintain the validity of the framework, the focus was on process-level responses to variety where the systemic view has to be formed as quickly as possible at the event context.

Contribution of the publication

The contribution the research covers three areas and the sub-artifact itself. The three knowledge areas are: 1) managing variety through responses at the operational level, 2) improving process performance and responsiveness through modular responses, and 3) identifying distractions and process errors by utilizing the modular response approach. Firstly, the results indicated that a lot more attention should be paid to the processing of formal and informal information during operations where processing can be partly or fully automated or manual and human-centered. It seems that both computer systems and humans try to filter the most relevant information and neglect information that seems to be irrelevant, cannot be accessed or is unknown. A formula where information is added or deleted based on situational and personal preferences is followed. However, it be should noticed that the logic of information systems does necessary follow the logic of service delivery or vice versa.

Secondly, in practice the modules in the design artifact did not contain formal designs or an operational model; they seemed to contain only mental models. Also the situational information modules contained mainly filtered information based on a personal mental model. The mental model should here be understood as human-centric visions and ideas of how to realize a service activity, in contrast to formal and common plans. Thirdly, the sub-artifact increased the traceability of operations and therefore the most promising way of utilizing the modular response structure would be to use it in identifying process distractions and errors. It could also be used to trace information elements that are considered important but are currently missing or not used. As a summary, the developed artifact provided new insights with the idea of making the processing of operational information visible through a modular response structure. Even though a service organization would not need or utilize designs in its normal routine activities, the modular response tool could be useful in analysing how the response is structured at the moment.

The main findings related to the design artifact

The main findings supported the experience structure utilized in publication 3. Here the term mental model was used to describe the decision-making model and processing of related information. Compared to the employee experience, a mental model is a design describing how things should be performed, whereas experience refers to the result after processing. Based on the results and findings, it could not be stated how these elements are connected and whether they should even be conceptualized using similar structures as in the design artifact. However, as stated in the publication 1, actors do have their own designs and therefore humans can be considered as both consumers and producers of design information.

The visualizations of operational information for decision-making by using static operational and situational operational information have basically two implications: there is design information embedded into the operations in the form of designs or visualizations. If they are inputs in the same format as the outputs of designing activity, they are clearly design inputs (not just information). If not and if they are supplemented by dynamic information as suggested, then the visualizations must be categorized as a new type of information.

The content of this publication also added new evaluation criteria for information. The results indicated that there are interpretations of what relevant information in a specific situation is and what information can be neglected because of its irrelevancy. For the design artifact and the whole service information concept, this meant that the relevancy status of core information has to be adjustable. Providing status information added also a new category to the design artifact.

Publication 5: Managing resource integration and production through usage of advanced service information

Objective of the publication

The main objective of the publication was to create a design artifact in the form of a structure and process of usage for analysing resource integration and resource production in a service system. Kleinaltenkamp et al. (2012) state that there is much to learn about the practices of integrating resources and how to design and configure the integration process, and as an example they state that for example technology may have a potential role as a more active resource than the traditional way of seeing it. It is a well-known fact that service exists if an activity involves at least two entities, one applying competence and another integrating the applied competences with other resources (value-creation) and determining benefit (Maglio et al., 2009). At a more practical level, the relevancy of resource integration and resource production has not been widely studied, and creating new knowledge has high potential.

The focus in the study was on providing information for the design activity and for operations management. This information would describe the activities as they are realized in the service context, but the information would be structured and presented based on the value creation concepts integration and production, in order to form a service-oriented connection between practical activities and abstract value creation models. In the creation of the model, the design science approach was utilized, and in order to link the developed design artifact with practice, technology was selected as the key resource unit. The artifact development was expected to provide new insights into resource integration and production for the disciplines of service design and service operations management research.

Theoretical background and setting

Akaka and Vargo (2013) consider technology as a collection of practices and processes, as well as symbols that are drawn upon to serve a human purpose. They propose that especially in service ecosystems, conceptualization of technology as an operant (compentence and skills) resource provides a more encompassing view of the way in which technologies are intergrated as resources, value is co-created, and service is innovated. The traditional view of technology separates development from use by considering development work as value creating and usage as value destroying activity. Integration of resources is referred to as a key activity in value creation. In the service dominant logic domain where value creation is a central term, resources are divided into two groups: operand (require action taken upon them to be valuable) and operant (are capable of acting on the other resources to contribute value creation) (Vargo and Lusch, 2004). Following this categorization, the main resource types in the service system consist of resources with rights, resources as property, physical entities and socially constructed resources. Spohrer and Maglio (2010) add a new resource type by emphasizing the role of symbols as an important mechanism in a service system. Individual actors are often required to manipulate and re-interpret symbols in developing new meanings and new way of thinking.

Akaka and Vargo (2013) utilize the structuration approach when they state that when actors in a service system interact or enact practices they continually produce new social structures as well as systems. In other words, they modify existing and create new resources for the system they are in. In the case of technology, Orlikowski (1992) states that humans recognize interaction with technology as having two iterative modes: the design mode and the use mode. It is both a medium and an end result. Arthur (2009) adds that technology includes also the practices and processes by which new forms of value and solutions can be created. While Akaka and Vargo (2013) redefine the role of technology at the ecosystem level as a combination of technology, practices, processes and institutions, the more practical level remains untouched – could resource integration and production (Grönroos and Voima, 2013) provide valuable knowledge for linking design activities and use at the less abstract level?

Contribution of the publication

The key resource technology, the design artifact and related usage process developed in the publication were evaluated through four evaluation criteria: 1) revealing the original purpose and functionalities of technology, 2) identifying the difference between resource integration and resource production, 3) revealing the interface between service and technology – the role of technology in the service delivery system, and 4) new information/insight which the analysis of technology as a service system produces. The first category revealed the original purpose in terms of activities which consisted of *changes, makes, tests, analyses, stores and creates.*” and these functionalities were used in the work system processes. The artifact can be used to reveal information flows, but without technical system descriptions these flows represent only relevant or the most commonly used information in the work system. In the second evaluation category the artifact aimed at separating incoming resource elements from outgoing produced elements. The incoming elements consist of inputs that are actually inputted into the technical system and inputs that are used or should be used but are never inputted into the technological system. The inputs in the first subgroup can be identified through using technical system descriptions, as the system cannot receive and handle inputs that are in the wrong format. The second subcategory includes inputs such as procedures, skills, rules and norms which are well identifiable in cases where the work process can be traced and less identifiable where traceability is poor. Additionally, resource integration may involve e.g. information that is used but not changed. Resource production covers directly traceable outputs, indirect outputs (for example learning) and information that is collected and used by the technical system (log information).

The third category focused on identifying the role of technology as a part of the service system. Technological solutions are typically either event-dependent or connectable to several activities. The event-focused analysis of technology showed that though resource integration and production can be partly identified and the service function of technology revealed, the role in the service supply chain is much more difficult to identify. The testing of the design artifact revealed that the supply chain perspective is important, as adding or removing technological components requires also service supply chain and logic knowledge. The fourth category focused on the information perspective where the new information and knowledge extracted through the artifact were compared with knowledge that already existed. The results suggested that information and knowledge creation should be analysed at least at three different levels: 1) to explain and extract how technology resources are used in the service delivery, 2) to link the technology resource with the work system event and information which describes how the integration and production is operated, and 3) to combine these elements to the service supply chain description or service logic in order to describe how the service is actually delivered and what kind of resource connection exists in the current system.

The main findings related to research questions and the design artifact

The main findings contributed to the design artifact of the dissertation through two channels: firstly, also this study revealed a significant number of new design information categories including the purpose of resources, integration and production processes, the role of resources in the service system (being not necessarily the same as the purpose of resources), demonstrative cases of how resources can be used, work system and integration or production connectivity information and service supply chain status information. All these can be categorized under the heading design information. Instead of describing the explicit and existing design information they are merely options and potential that a service system may have. Whether it is feasible to extract all these information types and what it requires to manage them could not be evaluated as a part of this dissertation – their potential value in the sense of information is discussed in the next section.

Secondly, a contribution for the design artifact was created through the combination of resource integration and resource production as a form of a sub-artifact. The artifact in its current version offers altogether 19 information types – the contribution was created mostly through the logic of using the sub-artifact as well as its architecture. So far the core of the design artifact, the service information engine, had remained as black-box. Several information categories from and to design and operations were revealed but the information manipulation process had been bypassed. The findings of this publication supported the idea that information processing should be in general considered as resource integration and resource production with their own properties. In addition to the fact that the construction will help in identifying components of integration and production, it also can be used to separate automated processing and human-processed information.

In contrast to existing service design and operational artifacts, the sub-artifact construction considers information as dynamic but partly controllable and traceable resources which can be used not only to manage operations or design activity but also to produce new types of information resources and also to remove or recover valuable information elements. Through the integration and production construction, the findings made in the publication 1 about information forming the core logic of a service delivery system can be explained. Information is and can be stored in an intangible format if an information processing model like the design artifact in this dissertation can be created. However, information stored in an information database is different from one that is stored in the mental models of a service employee or a customer. This indicates that the service information engine cannot be only about information processing functionalities but service information inventory management has to exist as well.

6 EVALUATION OF THE DESIGN ARTIFACT

The main purpose of the evaluation phase in design science research methodology is to analyse how well the artifact supports a solution to a problem (Peffers et al., 2008). In an ideal situation this activity focuses on comparing the objectives of a solution to actual observed results from the use of the artifact in testing or demonstration. In practice the evaluation phase is not a pre-formatted process; it offers multiple opportunities for the evaluation of the design artifact instead (Peffers et al. (2008), including e.g. quantitative performance measures such as budgets or items produced, the results of satisfaction surveys, client feedback or simulations, response time, or availability. In this dissertation the evaluation of the design artifact focuses on theoretical reflection of the refined solution, as suggested in the design science approach by Holmström et al. (2009).

The theoretical reflection aims at creating an extensive theoretical view related to the potential of service information and knowledge by evaluating the design artifact as a whole, through the results achieved in the sub-artifact studies. This section consists of five evaluation phases: 1) evaluating the sub-artifact findings from the design artifact perspective, 2) the role of the design artifact in managing the connection between static and dynamic elements, 3) evaluation of the process and functionalities included in the design artifact, 4) improving the connectivity between the service designs, design activity, operations management and service realization, and 5) new information and new knowledge that can be created through the artifact. These elements are compared with existing knowledge in service research and other relevant disciplines and with the feedback and evaluation processes of the service employees in the test environments.

The evaluation phase does not aim at providing true or false values. Due to the qualitative and abstract nature of the solution, such propositions or conclusions would not be relevant. Instead of that the evaluation phase provides new insights and understanding about service information, managing, creating and processing service information for the service research community, and also for service managers and employees. The evaluation phase is structured as a process which begins from the findings made in the five independent studies and ends in an illustration of the improved design artifact based on the evaluation phase findings.

6.1 Evaluating the sub-artifact findings from the design artifact perspective

The findings from the five publications indicate that there is a need to rethink the design concept in the service context. A plan or a description about how the concept should be implemented as suggested in the service literature seem to provide only limited understanding about the multifaceted nature of design in services. The summary of the findings focuses on six key aspects that reveal the views and observations extracted through the testing and demonstration of the design artifact.

- The first aspect is related to the design formats and characteristics: design is information, a result, visualization, and an expertise domain. Based on the findings, design and design information can be produced throughout the service delivery system and coded multiple times in order to convert the content for the right audience. Even if there is a department or domain focusing on service designs and development, designs are created throughout the service delivery system. The contents of service designs are partly defined by the realization, but operations may use their own designs internally, which may not visible for the rest of the organization.

- The second aspect focuses on missing the service: where is it? When the scope is narrowed to the information perspective, service becomes less evident and less visible. Grönroos and Voima (2013) state that service is merely a perspective on value creation. The testing of the artifacts and findings in this study support this argument and they also support the idea of using information to change the mindsets of human resources. It was assumed in the original design artifact that service-related changes play a central role in information processing. This argument is supported in the findings but the pre-set roles of the provider and the customer are not.

- The third aspect is related to the central role of information supply chains in service delivery systems which do not necessarily follow the logic of service or work processes. A service system can also be viewed as an information processing system but unlike a real world system, the information processing system can be extended through artificial constructions. These constructions form hierarchies and layers which are used to provide different types of information for the service system. The supply chain is an important perspective when trying to understand how and why certain information is created and how it can be processed further. However, this information processing view should not be mixed with the more technical view focusing on information technology systems.

- The fourth aspect emphasizes the scope and delivery channel of the information resources. If the focus is on provider-customer-interactions as suggested in the service literature, the assumption is that all relevant information is delivered through this channel. The findings implicate that a significant amount of service information does not describe the interaction between the provider and the customer but the internal actions of the provider employees instead.

- The fifth aspect raises an important question of information usage in service systems. As the previous aspects described, service information cannot be isolated from the reality and personal mindsets around the context where the information is used. Design and operations both take place in a flow of information and activities formed by interacting systems. Neither designs nor operations can be created out of nowhere. The findings support the contextual assumptions of the design artifact – the design context and the operational context – but these categories form only headings. The design context can be shared, but more likely it is local and similar ways as in the operations' local contexts are more likely to exist than those in shared contexts. From the information perspective, especially based on publications 3 and 4, the information content has to be adapted based on the local contexts while maintaining the shared context and content beyond this.

- The sixth aspect is about the roles in the service context: information-driven artifacts can be used to change the existing roles in service system. Sampson and Spring (2012) propose eight roles for a customer in a service supply chain, which all can be accessed through service information and related artifacts. In a similar way, an employee may have multiple roles and these contents can be used to describe the current state of a service system in a way that the employee recognizes, perceives and understands it.

6.2 Managing the connection between static artifacts and dynamic reality

The sub-artifacts aimed at capturing the dynamic characteristics of service delivery, and also the proposed link between static designs and dynamic operations or realization. The design artifact construction provided a static approach for design and operations based on the assumption that focusing on information and the architectural level would produce a static view. The underlying problem was that static design descriptions are not applicable in the dynamic reality. These assumptions were proven to be too simplistic and the defined scope was too narrow. First of all, designs as such are neither static nor dynamic if they are considered as information. When design descriptions are visualized, they may seem static or dynamic. Visualized designs are representations of the original design information dependent on the delivery channel and visualization technique. In publication 3, visualizations were presented as a combination of static and dynamic information during the test phase. The evaluators perceived the dynamic nature of illustrations even though the visualizations were static – the visualizations created a sense of dynamism for the user because there were elements that behaved or were visualized as they behave in real life.

The accuracy of information and access to valid information seemed to be enough to create a sense of dynamic information. If this insight were translated into design-operations relationships, it would indicate that designs can be made more dynamic when they seem to adjust according to operations or other relevant changes. In operations, the more frequently the needed operational data or information is updated, the more dynamic nature of operations is sensed. The sub-artifact construction in publication 4 represented a situation where both information types were present. In a normal situation in the test environments, the employees had their mental design models which were used when the incoming observations and information were filtered and evaluated. The perceived cycle model (PCM) in publications 3 and 4 included a proposition that when a human person processes information about the present dynamic context and compares it with relevant alternatives, the context has to be made to a standstill, otherwise decisions cannot be made. The more complex the situation, the more time has to be consumed to understand the situation.

When these findings and reasoning are contrasted with the existing literature, it becomes evident that most service artifacts are not suitable for usage in managing or designing service operations, as their ability to be flexible and change based on dynamic information content is not explained. These characteristics should also be acknowledged in the redesign of the design artifact. The main inputs from this evaluation criterion are illustrated in figure 21.

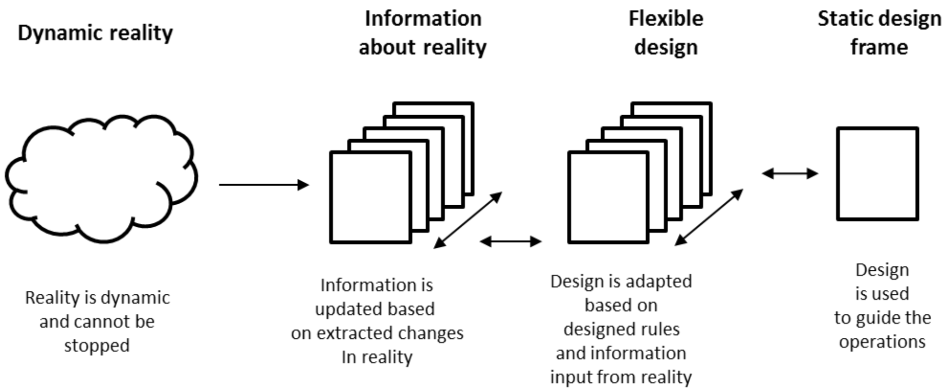

Figure 21. Managing the connection between static artifacts and dynamic reality through information

6.3 Evaluation of the design artifact processes and functionalities

The design artifact consisted of five processes, each of which provided a single functionality. The first processes focused on transforming operational data, including observations from the service realization to designs consisting of undefined categories of design information. The functionality was aimed at service contexts where the original designs were outdated or they were never created. Based on the findings, this information describes the design as a result of implementation without objectives or clear concept definition, and therefore the information cannot be used to measure service quality or performance. The recovered design information was also local and the process nature and the operational logic could be retrieved only by tracing the information supply chain. Although the functionality and process work, for whom is this information relevant and how can it be used? It is proposed here that the information content as a form of design information provides information frames and context where changes can be extracted. The local designs form frames for flexible designs that can be adapted on the basis of the information content. In both propositions it is accepted that reality cannot be fully captured, in other words there are activities and information that cannot be recovered easily, and also that flexible design frames do not implicate what the core design behind these frames is .

The second process focused on transforming operational data and service realization into design information through filtering the source data using architectural design artifacts. The underlying logic behind the related functionality focused on comparing input design information with output design information based on the service realization using the same artifacts. The findings did not support using the existing theoretical service artifacts but did not clearly prove them invaluable either. The findings supported using operative configuration artifacts or models that are not as abstract as most of the existing process or product artifacts. Here abstractness has a slightly different meaning, however. Abstractness refers to context independency and therefore the operational configuration artifacts are more context-aware, but still the evaluators in the test environment considered them as abstract.

The third process was very different from the rest of the processes. It focused on transforming and filtering experiential operational data and service realization data to operational information for operations and design information for design. The related functionality aimed at providing a tool for extracting experiential knowledge which is produced by the service employees and embedded in the operations. Some of the existing artifacts acknowledge this kind of information source, but it is mainly considered as a distraction. In the dissertation it was assumed that not only is experiential knowledge valuable, there also exists an employee-dependent mental model about the whole service or work system. Through the experiment and testing of this sub-artifact it was found out that experiences do not follow the same time frames as service designs or even the realized service events. Even though the sub-artifact is only a wire-frame model, it created two valuable lessons: humans create and are sources of design information, but experiential information is highly subjective and context-dependent. However, using it as data for additional processing may provide potential for creating experiential design information.

The fourth process focused on combining design information with operational information in order to form more relevant information for decision-making and extending the decision-making horizon from a single event to a wider system perspective. The functionality provided through this process consisted of operational designs provided as a form of designs for operational usage, instead of just providing operational information in the form instructions and descriptions. Based on the findings, this process provides two important new aspects: 1) whatever the design information provided for the operations is, it is compared with the situation through mental reasoning or as in publication 4, through pre-formatted but dynamic situational information (in other words filtered), and 2) design information can be improved by providing status information related to the decision-making context as supportive information.

The fifth process and the related functionality provided a solution for converting operational data and service realization data to operational information for operations and design information for design activities. The main purpose was to express the existing service operations in a format that would create new knowledge about operations for operations and for design. The sub-artifact represents a filtering frame which describes a conceptual process with actual parameters. This process forms the activity component for the main design artifact of this dissertation. By focusing on resource integration and resource production, information processing activities can be abstracted in an understandable way while maintaining the ability to provide very detailed information. If Grönroos and Voima (2013) are followed, producing new resources is the same as creating value creation potential for the user or the customer, and integrating resources is same as creating value. Translated to information processing language in a service system, it is only valuable to produce information resources that can be integrated with other relevant information resources in order to create value.

6.4 Improving the connectivity between service design and service operations

In Merriam-Webster (2013) connectivity is described as “the quality, state, or capability of being connective or to be connected.” The problem behind the design artifact focused on improving the connectivity between service design including designing activities and results, and service operations including service realization. The connectivity was proposed to be poor, mainly one-directional, and the difference in the level of abstractness was too big. Evaluation of the sub-artifacts provided evidence about what could be done in order to improve the connectivity, but a comprehensive view was still missing, and more importantly, the link to service as a concept was not explained clearly.

The revised and final version of the design artifact consists of 17 processes, 14 types of information and 7 frames. The construction does not only solve connectivity challenges between service design and service operations, it is based on information processing without the limitations of existing information technology systems. Information processing is about integrating resources and producing new ones. At the architectural level the purpose is not to explain how it is done, instead the relationship and main functions are explained. The main construction in the design artifact is the reality where the service delivery takes place, but not as a work system as was proposed in the introduction part. Instead of that reality is a dynamic, potentially complex and incomprehensive unit which can be understood through extracting information about it and inputting information into it. In the design artifact, reality is not a service system or any other construction.

The processes are constructed around frames which include an experiential information frame, an operational information frame, a situational information frame, a value creation frame, a flexible design frame for creating design information for operations, a flexible design frame for creating design information for design, and finally a core design frame. The frames are used to filter relevant information from incoming data. For all frames, the incoming inputs are data and the outgoing outputs are information. How this information is visualized for the users is not solved in the architectural description, but examples can be found in the publications.

Information processes (left side in figure 20) that do not communicate with designs (solution frames) represent bidirectional processes, whereas the processes that communicate with designs (right side in figure 20) form two different loops: 1) adapting designs based on operational data and returning design information for operations, and 2) design information for making changes to the core design and returning core design changes as inputs for flexible designs. The logic of the artifact is also bidirectional, providing design information for operations based on the core design, and extracting operational data from the reality and processing it for design purposes. The whole construction is illustrated in figure 20.

The processes and information types (the processes are presented by numbers in figure 22)

Process 1: Experiential data from operations (Information type 1)
Process 2: Operational data from operations (Information type 2)
Process 3: Situational data from operations (Information type 3)
Process 4: Experiential design information for operations (Information type 4)
Process 5: Operational design information for operations (Information type 5)
Process 6: Situational design information for operations (Information type 6)
Process 7: Experiential operational information for the value creation frame (Information type 7)
Process 8: Operational information for the value creation frame (Information type 8)
Process 9: Situational operational information for the value creation frame (Information type 9)
Processes 10-12) Update information for the frames (same as information types 7-9)
Process 13: Operational information for analysing designs (Information type 10)
Process 14: Operational information for adapting designs (Information type 10)
Process 15: Design information for operations (Information type 11)
Process 16: Change input information for the core design (Information type 12)
Process 17: Change input information based on changes made in the core design (Information type 13)
Status information (Information type 14)

The frames (figure 22):

Frame 1 Experiential frame
Frame 2 Operational frame
Frame 3 Situational frame
Frame 4 Value creation frame
Frame 5 Design analysis frame
Frame 6 Design adaption frame
Frame 7 Core design frame

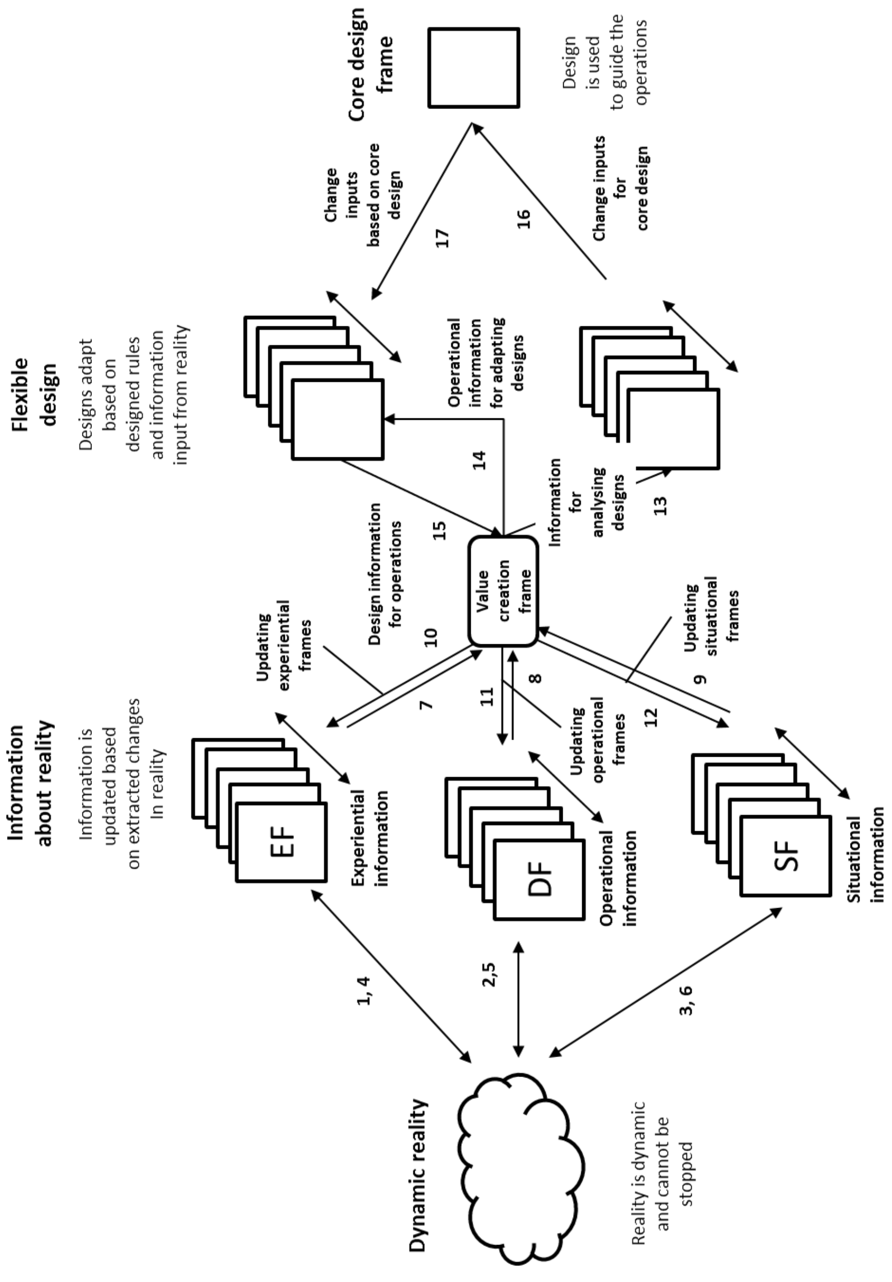

Figure 22. The revised design artifact based on the findings and evaluation of connections between static and dynamic components, processes and functionalities, and connectivity between service design and service operations

6.5 Creating new information and new knowledge through the design artifact

The final sub-section in the evaluation phase focuses on evaluation of the novelty of the design artifact and especially the solutions that can be formed through using it. In other words, the main quality criterion for the design artifact is the ability to provide new knowledge for relevant scientific domains (Hevner and Chatterjee, 2010) while maintaining the ability to solve practical problems. New information and knowledge, as well as their novelty and quality are evaluated through the following eight arguments:

- **Design artifacts are only filtering frames** – connectivity to operations is solved through information and ability to integrate design as information. It is a common assumption in the service literature that designs in various formats represent higher knowledge than the actors participating in the service delivery or responsible for service realization are able to create. In this study, designs are considered as frames for filtering information. In practice data, information, ideas, insights and experiences are integrated, and as a result new resources are produced in the form of an artifact. However, if the designs are viewed from the information perspective, the design represents reformatted, filtered and processed information. Design as such does not change anything; it has to be integrated with something else in order to be valuable.

- **Ability to extract relevant information from operations will eventually define the quality of the design frames.** Even though in most service design models, the design information is not extracted or recovered in the operations, it is proposed that the only way to validate design information is to compare the designed service as information and executed service as design information. Executing service activities will create design information that describes the executed designs. Though this data or information is usually not processed as designs, it is a way to create new knowledge which supports the analysis of the service better.

- **Operative designs (artifact) require flexibility and they can be adapted based on relevant information inputs.** Kimbell's (2011) idea of separating service engineering and designing for services will here be supplemented by an approach which shares both characteristics. Service does not have to be considered as problem solving, and still problem solving may take place through the processing of service information. The configuration of service delivery is about analyzing the situational information and comparing it with operational information, design information and experiential information. This is what Kimbell's (2011) exploration of potential solutions means, if it is described in the language of service engineers. Neither designs nor operations should be considered as pre-defined static units, but flexibility and adaptations should be created through effective information processing and usage instead.

- **Service information resources and transformations form a system that requires both designing and operations management.** There are two realities in the service literature: one which is more abstract and less exposed to the environment around the organization, focusing on designing solutions, and the other which is more concrete and context-specific, focusing on delivering or providing solutions. It is a novel idea that a service expert, whether in the role of a service researcher or a manager, would be interested in designing and managing other types of operations than the core service. Shostack's (1984) and Glushko's (2010) division into front-office and back-office activities does not fulfill the information design and management needs in a service context, since the information domain is a layer which covers both offices. In this study it is argued that the information management field in the service context should not be left for information managers or experts, but instead of that service experts should design and manage service information processing and usage.

- **Information processing can be viewed as resource production and resource integration** – and therefore the information processing system is a service system. Through viewing information processing as resource production and resource integration, two new insights can be created: firstly information processing fulfills the service system definition by Spohrer et al. (2007) who define it as a dynamic value co-creation configuration of resources, including people, organizations, shared information (language, laws, measures, methods), and technology, all connected internally and externally to other service systems by value propositions. Secondly, processing service information is connected to preceding resource integrations by value propositions. The service system view provides new roles for service system design and management, but also requires moving from closed systems towards more open ones. The main difference between traditional services and information processing is that it might be difficult to reuse traditional services with exactly the same conditions, but information can be used and reused without changing it.

- **Designs in service operations do not necessarily include designs about the service delivery or designs for the service.** In the design artifact, it was not assumed that service would be observable in reality or that operations would strictly follow the service descriptions and designs. The test and demonstration phase implicated that what is emphasized as a service in the empirical context seems to have relatively little to do with elements that are used when service is executed. Based on these observations, it can be proposed that the service mindset may exist at the design level but is not communicated into practice, or the service mindset exists in reality as a part of delivery but it does not exist at the design level or it cannot be extracted from the service delivery. However, the most challenging combination was observed in the empirical contexts of this study. Service mindsets existed both in the design and in the operations, but they were not connected, in other words both are needed but they do not necessarily communicate with each other. Through using the design artifact developed in this study, the connection can be created, and if necessary also the difference between the two mindsets can be maintained, which is new kind of thinking in the service context.

- **Design and operational information require both status of information and status information to be relevant, convincing and enable integration.** The design artifact introduces several new types of information that can be categorized into design information and operational information. However, producing new information is not valuable if the status of information cannot be stated clearly. If outdated or context-specific information is integrated without the status of information, the produced resources may not be valid. In this study, the status of information refers to the content which specifies how and where information can be integrated and with what other resources. However, it is not same as the status information which is used to import conditions and rules from the static designs to more dynamic artifacts in the reality where service is delivered. The status information answers partially the request by Ng et al. (2011) who criticizes the reductionism in service research. The proposition is that static aggregations can be modified through a more dynamic content.

- **In practice, artifacts are used in the same reality where the service is realized but in different contexts.** The final argument and proposition for new knowledge is created through the difference of the reality where service is realized and the contexts where service is realized. Based on philosophical arguments, it was stated that there is only one reality which can be described through different perspectives and actors. The design artifact supports separating the reality from the context which may have actor-dependent or service delivery-dependent components. Designs should be created for one reality, but designs can be modified and adapted to fit many contexts. Reversely, this means that when information is extracted from the service realization, the context should be known in order to succeed in the information filtering for design adaptions and the design context.

The new information and knowledge elements proposed in this sub-section form a bridge between design and operations in the service context through information, but also show how service research tends to simplify design and managerial tasks in the service delivery system. By focusing on the information perspective, characteristics that have not been previously noticed as relevant elements can be emphasized. The theoretical contribution and managerial implications are discussed in detail in the following section.

7 CONCLUSIONS

Lemon (2013) states that service research at its heart has always reached across disciplines. Whereas Andersson et al. (2013) state that integrative service research must acknowledge the macro environment around service and consumer entities, in this study the opposite direction was taken. The microenvironment inside a service delivery system offers also a potential base for creating new knowledge and contribution for the emerging scientific fields in service engineering, service operations management and service design. In service research, the hierarchy of perspectives or layers covers today all the way from service ecologies (highest abstraction, Spohrer et al. 2011) to service events and tasks (Lillrank et al., 2011). Another dimension starts from technical descriptions of service delivery (Sakao et al., 2010) and ends at abstract value creation processes (Edvarsson et al. 2011). Additional dimensions could be acknowledged and as a result a multidimensional illustration of a service could be created. The microenvironment in this research setting refers to elements that actually link the more or less abstract models in theory and in practice into an efficient service delivery system, but which are not necessarily observable, or the logic of their behavior is not comprehensively understood.

For this kind of setting, this study provided a design artifact aiming at improving service management by linking design and designing to operations and service realization through information. Offering a new solution or service should raise the relevant questions: why should there be a link, and if there is a link, what does it mean? These are the questions that were formatted in this study into the main research question and three sub-questions. The main research question was: *What kind of service artifacts and information content can be utilized in transforming the static linkage between service design and service operations into a more dynamic relationship?* The underlying assumption was based on Simon's (2001) argument of artifacts where he proposes that artifacts are used in the interface of inner and outer worlds. The microenvironment of service artifacts was entered through the information perspective, which focused the study on the content of the artifacts and how they could be utilized more efficiently.

Finally, after an intensive study, conclusions can be made. The previous section focused on evaluating the main findings in the form of an evaluation process. This section has a different purpose: the contribution is explained in detail in three areas: scientific contribution, methodological contribution in the service context and managerial implications. Due to the abstract nature of this dissertation, there are several limitations that have to be discussed in detail, also from the reliability and validity perspectives. Finally, this sub-section raises four topics that should be researched in the future, in order to make the service research contributions more reliable and to reveal elements that have been so far unidentified.

7.1 Answering the research questions

Answering research questions and related discussions provide a path leading to the main conclusions of this dissertation which are summarized as three arguments at the end of this sub-section.

1) What conceptual service design and operations artifacts form the core concepts in the service delivery system, and how can the connections or shared properties in the artifacts be transformed into information?

The answer **to the first sub-question** was provided through the construction of the knowledge base as well as through independent theoretical background sections in five publications. The original intention was not to repeat or review existing artifacts, but rather to get beyond these artifacts and identify the content within them. In section 3, Construing the knowledge base, it was concluded that there are nine different changes which dominate the service literature: 1) combining resources to the form of a work system for meaning activity, 2) transforming resources (physically, virtually, logistically….), 3) interactions, direct or surrogate (Sampson, 2012), are required in order to have service, 4) creating experiences through interaction, 5) changing the state of the service object (problem, human….), 6) changing the reality of an actor who creates value through using the service, 7) changing the reality of an actor who provides potential for value-creation, 8) changing the social context and the environment, and 9) creating value or perceiving value. Though these activities or processes were interpreted as changes, from the design and management perspective they form the core artifacts focusing on constraints and rules as a form of control, frames that both guide the activity and create shared understanding of the activity, and also artifacts or artificial reality that describe the activities using formats that do not describe reality but visualize or express something else (physical movement of persons is described as a flight journey).

On the basis of the theoretical artifacts it can also be concluded that while design is usually separated from the activities focusing on delivery or realization, both represent designs which can be transformed into information. The service literature offers relatively little help in understanding and managing operations in the run-time environment. A potential reason for this might be obtained from scientific requirements: the run-time environment contains so many context-specific elements that traditional methods of generalization cannot be applied and the validity objectives may not be achieved. Artifacts provide also other types of contents that are not directly observable but which can be identified at the architectural level and as information: a direct and an indirect link to actions, and solution space. By creating artifacts scientists and managers aim at direct control or description of activities or by limiting or describing the boundaries of activities. For example Zomerdijk and Voss (2010) propose many approaches for managing experience-centric services by using indirect artifacts. Solution space refers to the horizon of the artifact effects. In most artifacts, it is assumed that the artifacts alone or in some rare cases in combination with other artifacts are able to provide a complete solution. As an alternative or opposite model, Kimbell (2011) describes a design orientation where it is accepted that constructing a complete solution is not even possible because all aspects of reality cannot be captured. As a summarizing conclusion to sub-question one, it can be stated that while scientific design and operations artifacts provide a basis for service management and development, without understanding the embedded characteristics in the form of information, they should not be applied.

2) What kind of information connections exist between service design and operations based on conceptual and empirical knowledge, and how can these connections be utilized to reveal the dynamics of the relationship and new information needs?

In the case of **sub-question two,** the original goal was to focus on service information that is expected to exist based on theoretical artifacts in service design and service operations, or which could be identified in empirical case contexts. It was also proposed that this information, conceptual or existing, could provide new information and knowledge if it were viewed at the architectural level. The conclusion was that information between service design and service operations can be extracted from both knowledge bases, but the content of information is quite different. Most theoretical abstractions and artifacts are already at the architectural level but the view is not information-based and the relationships between the elements are not usually described. The architectural view in this study referred to changing the view or the main perspective, not the level of abstractness. In empirical contexts, moving to the architectural level transforms information to less context-dependent, while it is still possible to maintain the contextual parameters as descriptors or characteristics of elements. In the empirical context, the main challenge was the lack of service elements - there are designs and operations but service is not extractable. As a combination, the theoretical information-based view and empirical architectural view were close to the same level, especially when the empirical view was also described from the information-centric perspective.

The combination opened a view into a dynamic world that has not been widely explored in earlier service studies. It should be emphasized that information itself is not as new as the perspective or lens that is used to view it. Traditionally this would be an area for information system scientists or software engineers in the empirical context, but then the content would not be the same as it is for the service researcher or service manager. Through development and revision of the design artifact, 17 processes, 7 frames and 13 types of information were found when the theoretical artifacts and empirical information were combined at the architectural level. Of course, this is not the complete solution; lots of processes, frames and information are still available. Based on the design artifact and the whole process explained and introduced in this dissertation, a relevant question would be: why have this information and information processing activities not been identified in service research? An answer could be that information is both a too trivial and complex concept as it exists everywhere but using it requires and forms a complex system around it, which is not the same as technology based information systems. At the meta-level or architectural level, information processing is not dependent on the solutions used in practice, and based on the findings this is the layer where service information should be managed.

3) What kind of new information resources can be created and through which resource production and integration activities, in order to ensure the value for service management?

The third sub-question was based on a proposition that service information could be managed as resource integration and resource production, and therefore also as a service system. Though the question may sound as it already includes the answer, the actual answer is much more complex and multifaceted. Sometime service systems are referred to as systems of systems (Mars et al., 2012) or as ecosystems. The service dominant logic approach (Vargo and Lusch, 2008), as well as some other contributions in the service science (Maglio and Spohrer, 2013) consider service systems as interactions rather than role setting between providers and customers. If service is a perspective on value creation (Grönroos and Voima, 2013), a service system is a configuration or a dynamic organization of resources for value creation (Spohrer et al. 2007), and a service system is a system of systems (Tien, 2009), then also resources form systems and resources are systems. The main challenge in this kind of reasoning is the complexity around the dynamic nature. Fundamentally if a system is a dynamic artifact it means that it cannot be stopped. In order to understand the behavior of the systemic elements or the systemic nature of resources, dynamism has to been analysed through structural snapshots. Again, if value creation is about integrating resources, and new resources are created or emerge through integration as a form of production (Grönroos and Voima, 2013), then it can be proposed that the integration of resources and production of resources are abstractions of their dynamic counterparts which exist in the reality. If they are valid for individuals (humans) in value creation which is independent or cooperative usage of resources, why should they not be valid also for lower abstraction layers, after all they are already used at the higher abstraction layers, such as ecosystems. A practical example: if integrating resources create valuable service then also how the resource components are constructed should follow the same value creation logic.

As a conclusion, this is a basic information process logic in information technology systems, but in the sub-artifacts it was also tested that non-technological information processing can be captured through resource integration and resource production as well. By applying the service system approach to all information processing where both resource activities are present, new knowledge can be created. The approach combination can be used to reveal what formal and informal information is used in service design and service operations, and also when identifying the gaps or reveal the spots where information is used but cannot be traced or monitored. This is the most significant value element for service management.

As the main conclusion of this dissertation, the answer to the main research can be summarized through the following arguments:

1) Service information is a resource type that requires both design management and operations management in order to guarantee effective usage which forms a pre-condition for making the relationship between design and operations more dynamic.

2) Service information will be placed in a new role if service information processing in a service system is acknowledged as a system itself which provides information resources for several usage scenarios, services, being still non-technical or non-software-oriented service

3) The core of the service system is formed through changes as processes. All service artifacts embed frames, processes and information types that can be managed through resource integration and resource production as any non-information service system.

7.2 Contribution to the literature

In the research design section, this study was positioned in the interdisciplinary field of service research as a combination of service operations management, service engineering, design science research, and service science. The contribution to the literature is introduced through the same domains, excluding design science research which is introduced in the sub-section of the methodological contribution. Despite the strong information focus, information system science was excluded in order to maintain the dominant perspective of service information.

Service operations management (SOM) focuses on production processes where the customer can input an object or the customer can be the object (Sampson, 2012). The SOM domain is interested in improving the quality and performance of service operations (Slack et al., 2007). Originally service operations management was not very interested in value creation even though the researchers had also ideas from the service marketing discipline (Voss et al., 2008). Information has a strong role as a resource but how it is managed or used in the service context has not been the most attractive topic in SOM research. This study contributes to service operations management research by two major inputs: 1) service operations management is management through information, even if no automation or technology is involved, and 2) service operations management has much to offer for service information management, especially if service information is managed by maintaining the service and work system focus.

The first input requires conceptual processing and explanation before the message is clear. Using and creating information is integration and producing information resources even if it is not conscious. Integration and producing are work that can be automated in some cases. According to Grönroos and Voima (2013), these frames should not be used together when value creation is analysed, but here it is proposed that when service operations are managed through information, they should be used together. Information as any resource can be produced without having a customer, which causes a situation that value creation potential exists but not the actor who would create value. Integration and production require managerial interventions, otherwise value creation may not succeed or resource inventories are created. The second input focuses on these interventions and the different logics that are embedded in service systems. Service follows a certain logic, information processing a certain logic, experience creation a certain logic, design a certain logic, and so on. Close to the shop floor operations, these logics are embedded into activities or changes. At the higher abstraction level, the connections between different logics can be explored and acknowledged in the form of architecture, as was demonstrated through the design artifact in which the connections and processing were viewed as information.

The service engineering (SE) domain originates from the engineering tradition and includes at least two different sub-domains: service engineering focusing on services in industrial systems (Cavalieri and Pezzotta, 2012) and service engineering focusing on the technical view of services (Bullinger et al. 2003). It is grounded on the argument that services are usually under-designed and inefficiently developed. This study contributes to the field of service engineering by providing a design artifact that has been tested in a non-industrial context (a social and healthcare system) and where the focus of the design artifact is in both design and operations. However, even this view is challenged by Vargo and Akaka (2009, p. 32): "as traditionally practiced, management and engineering tend to be focused primarily internally toward design specifications, operational processes and efficiencies in the creation of output, rather than toward the broader value co-creation space." In this study, the value creation space is acknowledged more extensively than in traditional engineering studies, when value creation is seen through resource integration and production functionalities. The main argument is that there is practically no way to improve value creation or co-creation if it cannot be connected to real activities. Therefore this study contributes to the service engineering literature by stating that service information resource has both tangible and intangible nature, and therefore it can be conceptualized and described in a flexible way as a link between abstract value creation and concrete operations.

Service science (SS) is an emergent field in service-focused research disciplines that relies on four main principles: service systems as basic constructions for service science, value propositions as a basic relationship of service, access to resource as a basic operation of service systems, and physical symbol systems as a basic substrate for service system computation (Maglio and Spohrer, 2013). Service science aims at breaking some constraints that often prohibit the creation of knowledge. Maglio and Spohrer (ibid.) for example state that value co-creation emerges from the interaction of many parts, and it can be formalized, analysed, and designed despite its complexity. A service system can configure four types of resources dynamically: people, technologies, organizations, and information. While value propositions and access to resource are important principles, the fourth principle is the most relevant in this study: "Service system entities compute and coordinate actions with others through symbolic processes of valuing and symbolic processes of communicating" (Maglio and Spohrer, 2013, p. 4). Valuing refers to reasoning about value and communicating is (often) an effective symbolic process (ibid.).

This study focused on valuing the content of information and ways of delivering it to potential customers or use situations. While service science highlights the role of service systems, most studies fail to analyse what this service system is and how it can be managed. Based on this study and the design artifact construction, a potential reason for this can be proposed and new ways of entering the service system suggested. First of all, the processes and functionalities in the design artifact are based on symbolic processes. When valuing is combined with the design artifact, it can be stated that valuing as reasoning takes also place in the local contexts, and extracting the symbolic processes as information requires understanding the local context. By extracting the experiential information and transforming it to information may also reveal the valuing logic, and valuing may be connected, controlled or managed through the approach that was proposed in publication 4 to manage systemic variety. On the basis of these arguments it can be proposed that valuing is information processing and communication is producing new information resources or actions based on the integrated information resources.

7.3 Methodological contribution

This dissertation did not originally aim at contributing to methodologies, but through the usage of the design science research methodology with the case study component in the five independent studies, some contribution could also be made to the methodological field. Though the design science research provides a decent basis for conducting successful studies, it has so far been relatively little used in the service research context. Service research is rich in models, artifacts describing elements, processes, and functionalities related to the service context. However, it could be criticized that the paths or development processes used to create these models or artifacts are less clearly documented. Based on the experience achieved through this study, design science research provides clear steps and procedures to document the research, even if the main methodological selection were not design science.

The second methodological contribution is related to extending the scope of Design Science Research Methodology (DSRM) and the whole design science concept. The first extension is related to the utilization of DSRM outside the information system context. As the content of this dissertation shows, moving to new contexts and research settings can be done if the design logic can be transformed into the new environment. The second extension is related to the core assumption in design science research methodology: the design artifact itself does not contain human elements, and humans are connected to the artifact through its usage. However, in this dissertation the artifact itself was not aimed at usage as such. Instead of that the processes, frames and information types can be used through any interface if the processes and functionalities can be created. The documented procedure shows how the design artifact may represent different types of information and serve as a reference construction, but the testable tools which originate from the design artifact may have different interfaces. The third extension is formed through combining the case study methodology to design science in order to increase the reliability and validity of the results. The additional components of case study methodology were utilized in order to get a more extensive view on the test environments than would have been possible through evaluation intervention. By selecting a single methodology as mostly suggested in the literature may not have provided an acceptable ground for analyzing and evaluating the results. Through these extensions and utilization it can be argued that both DSRM as a method and service systems as contexts require also new methodological approaches to be developed in order to ensure access to high quality and multi-perspective knowledge.

7.4 Managerial implications

The managerial implications in this study are addressed to social and healthcare service organizations, but also to service contexts which share the properties with these systems. The original goal in this study was not to develop services but to use service contexts as test and demonstration platforms in the improvement of connections between service design and service operations. Throughout the development of the design artifact, observations were made also from the managerial perspective and the main findings and conclusions can be translated into service managers' language as well. The managerial implications are explained through three topics which address the managerial challenges and development themes mentioned in the introduction section: 1) improving information awareness (value of service information and extracting service characteristics that are not directly observable), 2) improving design and operations management awareness (operationalizing designs and innovations), and 3) developing new expertise (learning from service operations).

Information awareness in service organizations seems to focus on information systems and software properties and interfaces. Though this is the most obvious link to information in practice, throughout the design artifact development it was observed that the amount of information outside the information system is high. Part of it can be explained through relatively low skills and competence related to information technology usage, though after being present in the service context for at least 20 years, this should no longer be an acceptable explanation. Informal or non-archived information can be visually observable but also created, used and stored in human-based reasoning. As tested in publication 3, these mental models form, if not a shared service system but at least a partly shared symbolic system. Connecting it to automated measurements and information technology systems does not usually exist and management of these information systems does not exist. In the test and demonstration environments, the technology-based system was experienced as a supportive solution to the actual work system, where the informal information dominated. Service managers and designers should pay special attention to this and acknowledge that this may partly explain the high failure rate in information system implementations.

The second managerial implication focuses on improving the design and operation -awareness. In the social and healthcare contexts there were at least three levels of designers who had a possibility to influence the service realization. The first level is the strategic or tactic service design where general guidelines for the service organization and the realization are designed. The second level is the unit or expertise domain -based design, where expertise-related ambitions, traditions and objectives either update the existing designs or create totally new ones. The third level is the service realization where the individual service employees and teams form their own designs locally before or during the service realization. These design layers have their own idea of what the operations are and what the service realization requires, so in practice there are three different operations. In reality the operations and realized service may not follow any of these designs (a fourth level). As a managerial implication, service managers should understand that this fourth type of operation - how service is actually realized - forms valuable information that can be used to validate designs on various design layers, but also to recover a design that visualizes how operations are executed. The main proposition for service managers is to create, manage, and use design and operational information to coordinate and create a shared view of service.

The third theme in the managerial implications is creating new expertise. Whereas a researcher may design and describe valuable information in the service context through artifacts and visualizations, in practice these skills do not exist, expertise focuses on the substance domains instead. Service thinking with design and operation flavors must be constructed as supplements for existing expertise in order to create the ability to learn from operations. Though this may sound difficult and time-consuming, the test and demonstration phases and the related publications showed that if new knowledge and skills are presented in a format that is both understandable and connectable to the service context, then most of the employees are willing to learn new things. The main point in this argument is that the time used to improve an individual's situation directly is considered worth spending, but if the efforts do not have a direct link to the employee’s role or tasks, then it may not lead to a successful outcome. Improving information, design and operations -related skills do not require hiring new managers, in contrast, if the manager is the only employee acknowledging the proposed connection there will hardly be any progress. The skills and competences must be integrated and decomposed at the level of daily activities, change is made through operations.

7.5 Limitations and considerations related to validity and reliability

Every scientific study contains limitations of which some are addressed and explained, some remain embedded and hidden. In this study, the author acknowledges that both the subject and the field are in a phase of early exploration, and it is too early to aim to create new theories or improve existing ones. Service research that intends to go beyond well-known concepts and enter the systemic nature of service, has to accept the perspective where the early exploration creates potential paths for new knowledge but has to be exposed to tests in order to find out whether the path to new knowledge areas is worthwhile to travel. None of these explanations remove the necessity of discussing the limitations of the study, including also validity and reliability considerations.

The main limitations are related to 1) the service perspective as non-theory, 2) the interpretative nature of information, 3) the subjective role of the author in the development of the design artifact, and 4) the performance of the design artifact. The first limitation is related to service as a research context and the lack of background theory. This study did not exploit the hard management theories such as transaction cost theory, resource-based view theory or social science theories, even though some elements and characteristics from them are identifiable in the artifacts. The reason for this selection was that the value of service information cannot be explained through these hard theories; instead the focus must be closer to practice while still maintaining the scientific view. The second limitation is related to the interpretative nature of information, which refers to phenomena where information, though having originally only one meaning, can be interpreted in many ways and there are no true or false values. This is actually also the explanation: the world around us enables interpretations, and instead of considering it as a limitation, it provides a value interpretation of the world, and using different lenses may create new types of knowledge. Service, in general, is a context where observations seem to have only one value as part of the reality but when they are transformed into information or viewed through abstractions the value might change, or as was proved in this study, the value may also vanish. This supports the philosophical foundations of modern constructivism which was selected as the guiding philosophy related to the questions of how the world is constructed and what can be extracted or understood about it.

The third limitation introduces the challenging role of a researcher in a study where a descriptive and objective approach is mixed with an objective to form solutions. In the philosophy of science (Couvalis, 1997) it is sometimes argued that there is no such thing as objective research. In this research context, if the researchers remain passive by taking the objective role, no progress will happen. Someone, in this dissertation the author, has to take a risk and go forward. By accepting the risk, new insights and valuable knowledge may be created or the whole attempt may equally be worthless. The design construction in this dissertation describes the risk: an attempt to create new insights and knowledge. Is this more subjective rather than objective view an acceptable and reliable base for scientific research? The detailed documentation in this dissertation aimed at introducing and explaining each step that was taken during the study. If someone disagrees or is unsatisfied with the results, the selected path, the research design, the research process and the documentation offer an opportunity to extend or narrow the knowledge base, find and alternative path and through testing and demonstration show that the arguments presented in this dissertation are wrong. This is how the early exploration will eventually enter more mature phases through different phases.

The fourth limitation is related to the performance of the design artifact. Measuring and comparing conceptual and abstract construction of artificial elements without realization as a whole solution is not possible in the reality. However, through tests and demonstration in five independent studies, it can be stated that the sub-artifacts improved the performance of the case systems. The explanation is quite simple: throughout the development of the design artifact, data and information in different forms were utilized which already existed either in the scientific literature or in the empirical context. The performance-related producing of them was already performed or was part of the current activities. In this study and in the sub-artifacts, new ways to integrate this information were tested and new information resources were produced by integration. Therefore only relevant measurement is time - whether the integration of existing resources (and extracting them) in a new way consumes more time than the current situation, and therefore the performance will decrease, or the new information resources are more valuable than the additional costs from the extraction and integration activities and the performance is increased. The final argument related to performance is a proposition based on the empirical evidence: unidentified but existing and relevant information about a service system is in the long term more hazardous to performance than investments in the extraction of this information will cost in the short term.

7.6 Suggestions for further research

This dissertation provided important and new insights as well as knowledge for both the theoretical and empirical fields. Due to the novelty of the approach and the early exploration type of the study, several interesting paths remain unexplored in the same research area. One of the most challenging ideas is related to information creation and how it raises new topics also for scientific research. In this study, it was accepted that information can be created, modified or even manipulated on the basis of the aims related to the effects of information usage. It was also proposed that a service system, even as a static and limited construction embeds information which is just waiting to be extracted but also information that cannot be extracted with the existing methods. This is, however, a slightly narrow view, as it may create a sense of control related to information, which may lead to false assumptions. Information is created now and will be created in the future using such tools and techniques that cannot be understood today. This is why the design artifact in this study requires constant updates - new technological solutions will enable new frames, processes and information types. These do not replace the existing elements immediately, but instead of that they have to be connected to the existing elements. Though producing new technological solutions and information types are not a task of a service researcher, how to use them or integrate them to provide valuable service information is.

In order to ensure that service information, architectural platform and testing of SIE as well as redevelopment of the design methodology for the service context will take place and inspire new service researchers, the following research agenda is introduced:

> **1) Service Information Model:** This study showed that by using or creating the right tools and perspectives, service information can be

revealed and utilized in new ways. This study did not provide a single or comprehensive definition to what service information is, and therefore it is a field that requires much more exploration and research interventions. It is relatively easy to propose that so far, including this study, only a small part of the role of information in the service context is understood and that new knowledge through new studies will eventually change how the service system is viewed, designed and managed.

2) Further development of Service Architecture for connecting conceptual ideas to practical needs: This study provided a level of analysis (architecture) which makes balancing between conceptual developments and empirical service delivery more effective and dynamic. The architectural level model should be further developed towards a service platform which is able to handle and process different types of service conceptualizations and as well empirical phenomena.

3) Evaluation of the design artifact SIE (Service Information Engine): As a connecting element between previous arguments, the design artifact SIE should be evaluated as a whole. This type of evaluation would not only test and validate the design artifact as a whole but it would connect the arguments introduced and explained in this dissertation back to mainstream research in the service context and eventually lead to more comprehensive theoretical developments and theory creation.

4) Further development of design methodology in the service context: Service contexts lack the design methodology as a scientific and rigorous research method. Design as a term and designing as activity are often used, but their content and activities do not have a common meaning from the methodological viewpoint. In order to create and provide new design-related results there is need to rely on existing methods such as DSRM while modifying it to meet the traditions and expectations in the service research context.

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PART II: PUBLICATIONS

PUBLICATION 1

Karppinen, H., Huiskonen, J. and Seppänen, K. 2013. Recovering existing service design through reverse engineering approach, *International Journal of Business Excellence*, Vol. 6, No. 2, pp. 214-230

Recovering existing service design through reverse engineering approach

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Abstract: The paper introduces a procedure for recovering the service design in existing service systems, based on reverse engineering methodology. The complete procedure for planning a reverse engineering procedure, implementing it and analysing the results is presented. The main objective in the methodological approach is to map the service based on real implementation. The methodology and the reverse engineering tool approach are based on a review of forward engineering methods in services, and designing services and reverse engineering implementations in computer and information systems. The implementation of the framework is demonstrated in an empirical service system consisting of human, material and information elements. The main findings of the study concern analysing the existing service system, how the existing service system includes various types of service designs, and how higher level abstractions of the service system reveal new insights into the system.

Keywords: reverse engineering; service design; service component; service design framework; service design recovery; existing service design; service business.

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1 Introduction

Gadrey et al. (1995) define service as a solution to a problem. To produce a service means organising a solution by combining human, technological and organisational capabilities and competencies. Although materials and physical products may be included in the problem solving, a product is not a solution. Another definition, offered by Hill (1977, p.318) describes a service as a "change in condition or state of economic entity (or thing) caused by another". Both definitions include (although not mentioned or underlined) a precondition of planning and designing. A solution cannot be created if it is not planned – change may happen but the direction may not be right without planning. Instead of being a separate activity Zehrer (2009, p.344) conclude that "service design must be undertaken in a holistic manner that is embedded in the organisational culture of the service provider".

Herbert Simon (1969) popularised the design thinking philosophy, and it has eventually reached also the service world. Despite the intensive interest in service designs, service delivery systems and service system designs, many challenges still exist. Recent contributions in the service design field have not come far from the definition by Gummeson (1994, p.85), "Service design covers the hands-on activities to describe in detail a service, the service system and the service delivery process... [However] inadequate service design will cause continuous problems with service delivery". What has changed during the years is the role of the ultimate customer: from a passive target to an active co-creator. It has also changed the focus in service designs towards enabling co-creation (Maglio et al., 2008) and providing unique service experiences (Patricio et al., 2008).

The service literature provides only a limited contribution to the use of service designs in existing service systems. Shimomura and Arai (2009) have identified severe gaps in the service design utilisation in existing systems. They state that gaps exist between customer analysis and service activity design, as well as between functional design and service activity design. Zomerdijk and Voss (2009) have proposed that formal service design may lower the risk of concept or design replication by competitors. De Jong and den Hertog (2010) have conceptualised the service innovation 3.0, which requires formal service design methods also when technological developments are translated into service propositions. Despite the recent development trends in service design methodologies, we argue that the service literature totally excludes service systems that are operated without a formal design.

The main focus of this study is on service activities that do not explicitly follow any formal plan or design. The objective is to form an alternative path for creating 'service designs' in existing service systems. We claim that instead of using the popular service blueprinting (Shostack, 1984) or flow-chart-mapping techniques when mapping assumed service activities, service managers should focus on questions like "what are the core elements of our service delivery system based on the service realization?" By using this type of an approach, organisations would not increase the influence of the legacy system (Müller et al., 1994), they would stop it instead by creating a map or description of the current system design. The legacy system describes phenomena where system designers and managers are not certain why some parts of a system exist or why certain parts of the system are operated as they are.

1.1 Research purpose and research questions

Our aim is to provide a method to answer the question: What would the design look like, if the current services had been designed systematically? Our proposition is that recovering and revealing the 'hidden' design elements, the service improvements can be justified more easily than just trying to change the service processes. In order to recover the design, we construct a framework that follows the core idea of reverse engineering, revealing hidden constructions. In industrial systems, as well as in software and computer systems, a design must exist in order to construct or code the final product. We argue that in the service world, a formal service design is not a prerequisite for operating a service system. That is why design recovery may be a significant tool for the service system itself but not very useful for the competitors, meaning that reverse engineering could have a positive reputation in the service context.

The research questions are based on the main objectives of this study:

RQ1 How to implement the reverse engineering approach in the service environment in order to recover the service design?

RQ2 What kind of design can be recovered through reverse engineering and what kind of information does it reveal?

The study consists of six main sections: introduction, literature review of service design and reverse engineering, research design, findings, discussion and conclusions.

2 Literature review

The literature review consists of three sub-sections: the first sub-section focuses on the definitions for service design and designing service, the second sub-section concerns engineering-oriented development methods for services in the existing literature, and the third sub-section the forward and reverse engineering approaches in industrial, computer and information technology contexts. This section provides insight into what is the service design to be recovered, how and what type of engineering or technical methods are typically utilised in the service context, and how the reverse engineering approach is applied in other contexts.

2.1 Service design and designing service

Service design and designing activity are often connected to new service development (NSD) or service engineering (SE), although both fields miss the commonly used terminology. The following examples demonstrate the variation in definitions: Holmlid and Evenson (2008, p.341) suggest that "service design is concerned with systematically applying design methodology and principles to the design of services", Evenson and Dubberly (2010, p.404) propose that 'service is the design' and Kingman-Brundage and Shostack (1991) define that service design covers design, implementation and service production.

The increasing interest in service design covers also other research areas than marketing, operations management or engineering. Mager (2007, p.354) represents the design school and defines the task of service designers as follows: "to visualize, formulate, and choreograph solutions to problems that do not necessarily exist today; they observe and interpret requirements and behavioral patterns and transform them into possible future services. This process applies explorative, generative, and evaluative design approaches, and the restructuring of existing services is as much a challenge in service design as the development of innovative new services". Kimbell (2011, p.42) defines designing for services as "one specific way of approaching service design, combining an exploratory, constructivist approach to design, proposing and creating new kinds of value relation within a socio-material configuration involving diverse actors including people, technologies and artifacts". Oliveira and Von Hippel (2011, p.807) have criticised the traditional and mainly internal service design procedures by stating that "Service developers employed by the producer firm are tasked with creating and testing new services intended to be responsive to the needs identified. Service users are clearly not viewed as potential service creators in these processes".

Most recent approaches highlight the role of a customer or a service user. Heinonen et al. (2010, p.545) found a practical implication that "there is the need to design a service based on the new in-depth knowledge of customers. Rather than trying to persuade customers that the offering is valuable to them, companies need to try to embed service in customers' existing and future contexts, activities, and experiences". Maglio et al. (2008, p.400) propose that design activity should be tightly connected to value-creation in services: "Each service system engages in three main activities that make up a service interaction: (1) proposing a value-cocreation interaction to another service system (proposal), (2) agreeing to a proposal (agreement), and (3) realizing the proposal (realization)." However, according to Sakao et al. (2010, p.289) there is a significant problem related to the existing methods, cocreation in the service design field and more realistic service designs: "Quite a few methods or tools support the environmentally conscious design of product-service systems". Sakao et al. make similar notification about computer-aided service design tools, they do not exist either.

2.2 Engineering-oriented service development methods in the literature

SE has received increased attention during the last decade, mainly as an alternative to service marketing-based approaches in service research, e.g., NSD. According to Bullinger et al. (2003), SE can be defined as a technical discipline concerned with the systematic development and design of services using suitable models, methods and tools. Sakao et al. (2010, p.270) clarify the main difference between industrial engineering and SE through the design activity: "Traditionally engineering design has aimed to improve only functions. In services, not only the functions of artifacts but also the contents must be matched to the specifications given by receivers".

Fähnrich et al. (1999) states that although methods can be transferred from product engineering to the service environment, the amount of so called soft factors in contrast to technical factors and customer-contacts are the key determinants for what and how methods can be transferred. The typical development path follows the industrial forward engineering approach, which means starting from concept/idea generation and going on to more intensive and detailed plans of service. Kapitsaki et al. (2009, p.1296) have criticised the existing SE methods as follows: "A general observation is that the service engineering community still lacks a set of universally accepted basic design and development principles that can lead to a uniform approach towards efficient context-aware service development".

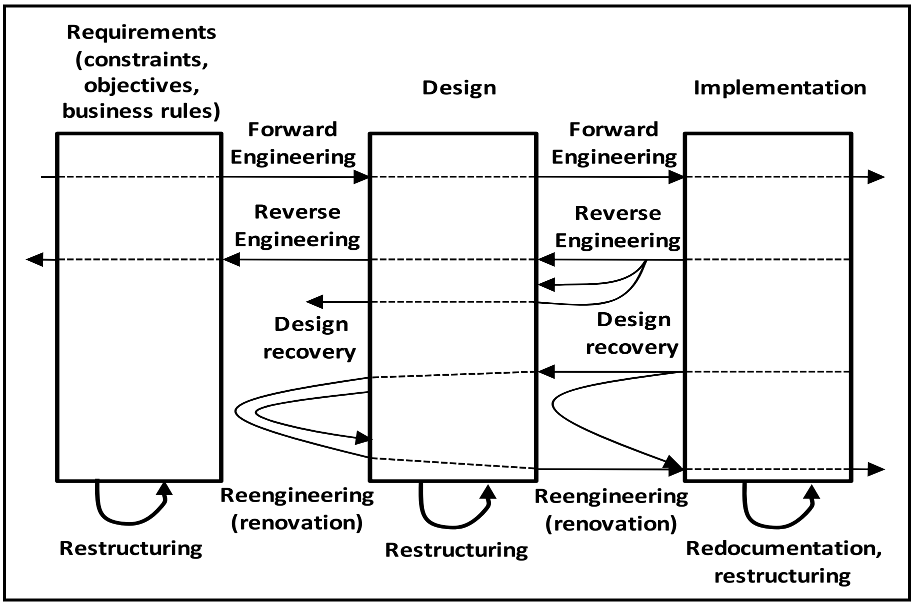
Similar to engineering methods, also other product-oriented methods focusing on quality and performance have been applied in the service context. Methods like QFD (Tan and Pawitra, 2001), Kano (Kano et al., 1984), Servqual (Parasuraman, et al., 1988), SHER (Pramod and Banwet, 2011) or recent innovations in performance tools (Turhan and Vayvay, 2011; Ukko et al., 2011) support connecting 'what happens' to 'how the operating system works'. The connection is mainly based on customer requirements, customer complaints, performance, and quality factors that provide a connection to the end customer. Service transaction analysis (STA) (Johnston, 1999) and critical incident technique (CIT) (Stauss and Weinlich, 1997) could also be classified as belonging to this group, but again, the purpose of these techniques is not to describe the existing service system as a design. The service blueprint method (Shostack, 1984) describes service design based on the path that a customer follows in the services but it has been mainly used as forward engineering method.

Limited evidence of recovering a design or a similar description from existing service operations exists in the literature, but mainly in contexts were the service includes information technology or a physical product. For example the form-based business process recovery (Kim and Kim, 1998) and reverse engineering of business processes exposed as web applications (Di Francescomarino et al., 2009) support at least partly the idea of recovering the design. Kaufman and Woodhead (2006) suggest functional analysis as a tool for identifying product-related functions, components and services. Ibusuki and Kaminski (2007) introduce the value engineering method in the automotive context, where also the service aspect is evaluated. Although the above methods begin mainly by asking the question 'what happens now', their main purpose is not to discover manageable objects and their interconnections (to recover the design).

2.3 Forward and reverse engineering approaches in other contexts

Definitions for forward engineering and reverse engineering exist at least in the industrial engineering and information technology literature. Raja and Fernandes (2008, p.2) defines forward engineering in the industrial context as “the traditional process of moving from high-level abstractions and logical designs to the physical implementation of a system”. The forward engineering approach is applied when the requirements for the system and the final product are known and a solution can be designed. Chikofsky and Cross (1990, p.15) define reverse engineering in information technology contexts as “process of extracting design information, functional specifications and, eventually, requirements from the program code”. The reverse engineering approach is applied when the implementation is known but the original design and/or requirements are unknown. The main differences between forward and reverse engineering, according to information technology literature, are presented in Figure 1.

Figure 1 Relationships between the terms forward engineering and reverse engineering



Source: Chikofsky and Cross (1990, p.14)

According to Choi and Scacchi (1990, p.66) reverse engineering in general requires “a design description from an implementation description” and abstraction of four critical properties of a system: structural (resource exchange between modules and subsystems through interfaces), functional (semantics of the exchanged resources with pre- and post-conditions), dynamic (procedural algorithms), and behavioural (behaviour of system objects). In the computer and software environment, Quilici (1995) connects forward engineering and reverse engineering by stating that the purpose of reversed engineering is to produce abstractions from an existing legacy code, and these specifications can be used in forward engineering of a new version of the system. Reverse engineering has not lost its significance, even though the original methods were developed in the early 1990s. Chung et al. (2009, p.180) have connected reverse engineering methodology to service-oriented architectures (SOA) as well: "Service-oriented reverse engineering starts with understanding physical and static properties of a given legacy system. A developer is interested in the deployed legacy system at the deployment phase". Software deployment covers all of the activities that make a software system available for use.

The purpose and typical techniques for reverse engineering, as well as the objectives for design recovery in computer and information systems are presented in Table 1.

Table 1 Reverse engineering concepts and their use in computer and information systems

Source	*Concept*	*Definition and functions in ICT environment*
Müller et al. (1994, p.219)	Purpose: extraction of system abstraction and identifying software structure/components	"The main purpose is to understand and abstract. Refers to a collection of artefacts software engineers use to form mental models in designing, documenting, implementing or analysing software systems"
Henrard et al. (1998, p.70)	Purpose: recovering or reconstructing functional and technical specifications	"… recovering or reconstructing its functional and technical specifications. The recovery of these specifications is generally intended to re-document, convert, restructure, maintain or extend legacy applications."
Harris et al. (1996, p.186)	Purpose: recovery of a higher level 'design'	"The recovery of higher level 'design' information and the ability to create dynamic, task – adaptable software documentation is crucial for supporting a number of program – understanding activities."
Chikofsky and Cross (1990, p.15)	Special focus: design recovery	"… domain knowledge, external information and deduction or fuzzy reasoning are added to the observations of the subject system to identify meaningful higher level abstractions beyond those obtained directly by examining the system itself"
		"Purpose to answer to the following questions: what does a program do; how it does it, why it does it. The design recovery process involves using an existing code, existing design documentation, personal experience, general knowledge of the problem, and application domains."

The methods introduced in the computer and information system literature are quite general and do not provide more than general steps for conducting a reverse engineering process. Therefore, in constructing a 'reverse engineering' technique for the service environment, we focus on reformation of a forward engineering method designed for the service context. However, issues that can be adapted from computer and information systems are the function of constructing subsystems, constructing subsystem interfaces, and flow graphs that describe the subsystem interactions and resource-activity connections. Our purpose is to enhance both human understanding of the system and knowledge about architecture, design tradeoffs, constraints and system application.

3 Research design

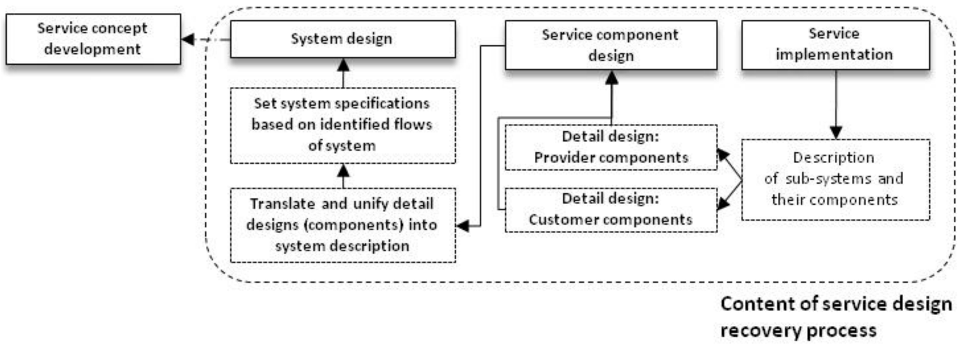
The research design section consists of three subsections: forming the research framework, describing the test environment, and describing the data collection methods.

The purpose of this section is to set requirements for a scientific contribution in the rather abstract field of research.

3.1 Framework for service design recovery

The reverse engineering approach for service design recovery is based on the process introduced by Bitran and Pedrosa (1998). Although their original process is planned for traditional 'forward engineering' utilisation, our approach has been constructed on the basis of its reverse implementation. When Bitran and Pedrosa start from such high level abstractions as 'strategic assessment' and 'concept development', we start from detailed-level 'implementation' and 'component design'. In our reverse version, the first step is to create descriptions of the sub-system components on the basis of implementation. The reverse engineering approach for service design recovery is illustrated in Figure 2.

Figure 2 Service design recovery process



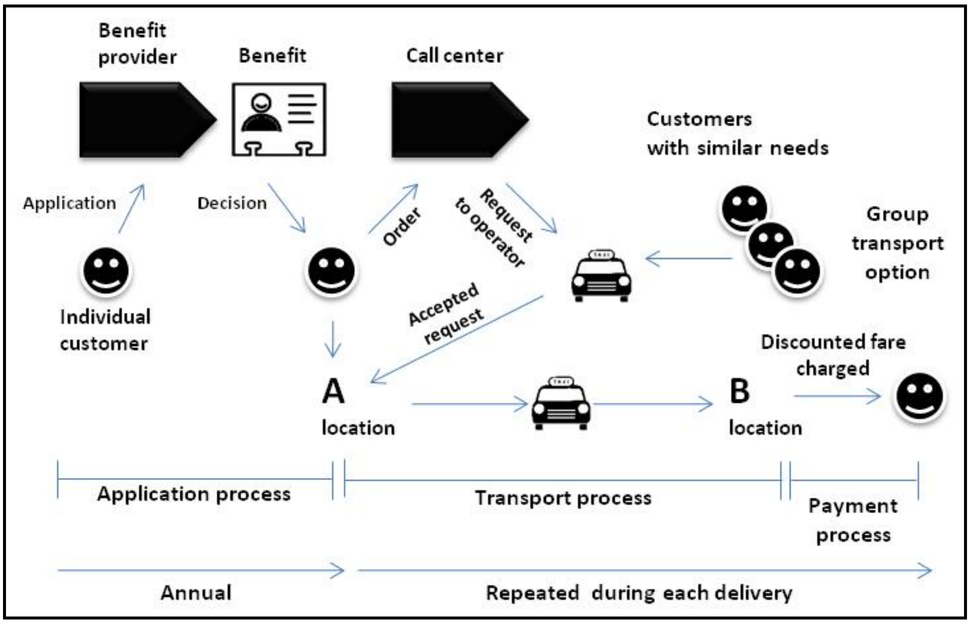
As the reverse process starts from implementation and component identification, it is necessary to define the concept of 'service component'. Service component is a common term in service-oriented computing/architecture literature (Erl, 2008), but not in the mainstream service literature. Bitran and Pedrosa (1998) describe service components only on a general level as people (including customers, front-line employees, support employees), infrastructure (including external organisation, technology, internal organisation), and service offerings (including a mix of tangibles and a mix of intangibles). The categorisation of service components is expanded and improved in the approach of Karni and Kaner (2007). Their model includes nine main classes (customers, goals, inputs, outputs, processes, human enablers, physical enablers, informatics enablers and the environment). The main classes are similar to the component classes of Bitran and Pedrosa, but the Karni and Kaner model includes a much deeper decomposition of classes into service attributes for component identification.

We propose that the service component designs represent constructions related to both sub-problems (customer and internal customers) and sub-solutions (provider) of service design. According to the system definition by Müller et al. (1994, p.3), a complete system design should also present the dependencies between the system components. In order to complete the service design, the design recovery process must include a flow and connectivity identification step, where the material, technology, human, and information – related flows and connections are systematically tracked. Each flow represents a potential problem or solution – related connection. If the customers and providers, as well as the processes as transformation activities (inputs to outputs) and flows can be traced, it is possible to recover the service design.

3.2 Test environment

The service environment in this study is a human transportation system for special group passengers. A special group can apply for a benefit which entitles a discounted fare for a taxi journey. The difference between the regular fare and the discounted fare is compensated by benefit authorities as a subvention. The taxi system is governed by law and national conventions, and the subvention is paid by the municipality. As a whole, the system includes four major actors: the public sector organisation granting the licences, the business organisation for taxi transportation, the business organisation for creating technical solutions for the transportation operators, and the business organisation whose responsibility is to manage the invoicing processes. The amount of the discount [€] and the criteria for getting a licence are set by the law. The general arrangement of the test environment is illustrated in Figure 3.

Figure 3 Pre-abstraction of the test environment (see online version for colours)



The significance of formal design was recognised when the service providers faced recently a radical increase in demand and costs, which revealed that the service was not managed or operated as a system. For example, organising group transportation for customers with similar needs was not successful because of unknown needs and unshared information flows related to the needs. Operational failures related to customers, such as no-show of taxies or long waiting times could not be recognised by the authority. Although the problems were recognised, the system structure, connections and the question of “who should operate and control what” remained unclear.

3.3 Data collection

During the research process, altogether 11 thematic interviews (duration 1–1.5 hours) were organised, including people from the service providers, service authorities and service system designers. In addition, a service monitoring activity was organised where the researcher followed independently through a full customer process. Both quantitative and qualitative data were acquired from each part of the system, including documentation of earlier versions of the service system, performance data, technology descriptions, as well as various instruction and application guides. Despite the large amount of documentation, the service documentation was considered very scattered and partly invalid (outdated). Formal designs or plans of the service system did not exist for the current system version.

4 Findings

Each stage of the reverse engineering procedure provided interesting insights that were not existing knowledge in the testing environment or available straight from existing descriptions. We argue that a three-stage implementation was a prerequisite for a successful reverse engineering process in the case context. Realistic understanding about service operations could only be achieved by participating and observing existing processes separately from different perspectives, whether they were simple customer processes or complex provider processes.

The insights that were achieved during the implementation process were categorised according to their sources, design relevancy, and operational relevancy, and mapped according to their realisation in each design area. We summarise the most relevant findings from reverse engineering and design recovery perspectives in the following list:

4.1 Customer perspective (design area)

- the service providers demanded high quality of customer input parameters
- the service providers used scripts in controlling customer behaviour (the scripts are coded in instructions, guidance and communication)
- the customer is a very standard unit in service delivery, irrational behaviour would cause ceasing of service delivery
- technology-readiness and acceptance seemed to have significant role in the willingness to cooperate with service providers.

4.2 Provider perspective (design area)

- The full potential related to the information input of customers was not realised.
- No evidence of service supply chain management existed, and relevant ‘service supply chain’ information was not shared.

- Several local ‘service designs’ were discovered. They instructed service operations within small interconnected activity groups (service system design did not exist, however)
- Local service designs governed local service processes. Formal process definitions, measurements and managerial procedures did not exist.
- Existing problems were well known in each local system, but how to solve them and how to organise the system based on new solutions were not.
- Technologies and technical systems standardised and steered most of the service operations in the local systems.

4.3 System perspective (design area)

- critical flows were either pure information or information + material pairs, and typically these information flows were already standardised using some kind of a technological solution
- the independent service activities were connected to each other mainly through information, software and automated solutions
- the formal logic of service and the main objectives of each actor were not recomposable, but some evidence related to informal objectives and optimisation could be observed
- mapping all connections between all identified activities revealed overlapping control mechanisms as well as activities that were not controlled at all.

5 Discussion

The main objective of this study was the practical need of recovering a service design. Although the need is very much practise-oriented, the question itself “how to recover a service design?” is also interesting from the scientific perspective. Service design, as well as most service research and service science terminology are very abstract and provide only limited tools for either service managers or service researchers, and therefore practical needs and scientific interest meet in this issue.

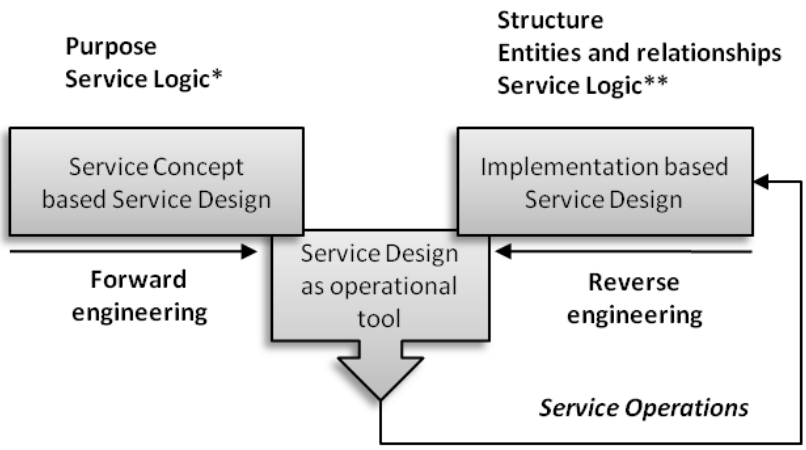
The purpose of the first research question was to form a clear task for the researchers: Is it possible to recover a service design and how to do it? Instead of following strictly the procedures introduced in computer or information system literature, the researchers ended up in implementing a forward SE principle reversely. The basic requirement for reverse engineering was fulfilled, as the unified abstraction revealed why the service system was not managed as a whole. The information flows that included control information did not connect the activities, operational information was not shared between the actors nor used in an optimal way, and the system included actor-independent planning activities that influenced the whole system. These insights were not available directly from the system, only through higher level abstraction.

Answering the second research question required a detailed analysis of information that the recovered design provided. The recovered design represents a system design (how to integrate the components) including information about the component designs (content and type). If the service concept is considered as a basic element of service design, then the recovered design is not a complete service design, as the information about the goals of the system and all operating principles were not recovered.

On the basis of the recovered design, the researchers observed that the local service designs seemed to govern the service operations locally. The system consisted of small groups of interlinked activities, though the groups were only loosely interlinked to other groups. It revealed also that these small groups, sub-systems, followed some form of designs that guided and controlled the operations. For example a design for customer contacts could be found in written instructions, controlling transportation operations was designed through bids and agreements, and payment operations through smartcard and telecommunication solutions. The local designs did not follow the functional or actor limits, in contrast they focused on certain problem-solving situations. The service literature often assumes that the service concept and the service system are created first, and technical and working system (production) configured afterwards. In this case, these two subsystems seemed to dominate and created conflicting logics with each other and with the service logic/service purpose.

When translated to the terminology used by Bitran and Pedrosa (1998), component knowledge existed but it was scattered, and architectural knowledge existed only within the subsystems. One way of validating this observation was the finding that only two to three information flows existed in the service system that involved more than one-to-one connections. These flows were agreements between the providing actors and transaction information for payment activities. For example control or quality management flows that would cover the entire system could not be identified. In the recovered design, the activities remained as black boxes with certain tasks and input/output flows. On the basis of the data and abstractions, it is impossible to say how the activities were actually executed. However, if the activity was completed in a way that the preset output flows of any type could be provided, then the activity was not interesting from the selected perspective.

Figure 4 The extended role of service design as an operational tool in existing service systems



Notes: *Goals and operating principles
**Interconnections between service entities

The main shortage of the reverse engineering technique developed in this study was the incomplete information about the organisational goals and operating principles. In the test environment, where the service design was completely missing, we formed a sketch of new service design for the system. It consisted of three separate but interconnected parts:

1 service concept-based design

2 implementation-based design

3 operational design to be formed based on the concept and implementation designs (Figure 4).

According to our proposition, the service design could have a significant role in managing service operations beyond the traditional and limited role as a development tool. The service system requires a real-time service design for managerial purposes. As an operational tool, service design should provide situational information about service operations based on existing service entities, relationships, and logic, and about the service concept which defines the purpose and operating principles. In the test environment the researchers constructed an operational 'paper and pen' tool for service managers. According to the feedback, it provided more information than the existing reporting systems and process charts did.

6 Conclusions

The theoretical contribution of this study covers three significant implications and it is aimed at challenging and expanding the current insights in the service design methodology research. The results achieved in this study suggest that the design area in service systems should be expanded radically. Instead of using the design concepts only as pre-delivery tools, methodological development should be aimed at run-time design concepts and managerial tools to be utilised during the service delivery. The continuous and rapid development of information systems and solutions will soon support real-time design tools that have all elements available: pre-delivery, run time/during delivery and post-delivery (analysis).

The second implication focuses on the decomposing trend in the service design methodologies, which suggests decomposing systems and services into smaller and smaller units, e.g., service modularity (Pekkarinen and Ulkuniemi, 2008; Voss and Hsuan, 2009). The results of this study indicate that service designers and managers could create interesting insights if existing operations are recomposed to the service design representations, instead of decomposing designs into realisations. The case environment is a good example of a service system that suffered from both managerial and operational decomposing. The final implication for theoretical and methodological development in the service design research is related to information integration. The findings indicate that information flows might have as significant a role in service systems as the manufacturing or production systems have in the industrial systems: processes are defined by them. Information flows may reveal how the actual service processes are organised, managed and coordinated.

Unlike in industrial environments, the reverse engineering approach could provide mainly positive functionalities for the service system. It is hardly a useful tool for those trying to copy a single service product or concept. We propose that the reverse engineering approach in services provides new insights for service managers. The main implications are listed below:

- If there is no possibility to recover the full design, managers should focus on recovering local designs that govern a unique part of the service system and find out dominating factors behind local designs
- Mapping the service activities and service system should be a constant and routine activity. Automated updates of the design should be supported by information systems
- Introducing so called fact-based process and activity mining software in any service organisation should not replace the qualitative understanding demonstrated in this study. Our suggestion is that automated process mining solutions and their logics should be constantly compared with real operations.
- Baldwin (2010) has suggested that architectural knowledge and architectural innovation actually define the success of an organisation. The ability to recover a service design based on service implementation should be considered as a part of architectural knowledge in practise.

A major limitation of the study is the limited amount of empirical evidence; the framework seems to raise interesting insights into how to benefit from different types of system mapping, but it has been tested only in a single service system. Therefore the contribution of this study can only support some previously discussed ideas and encourage for more intensive research. The case system consisted of private and public sector actors. The demonstrated reverse engineering technique requires quite extensive data for validation. It may be difficult or impossible to achieve extensive access to data sources in pure private sector service systems (outside an organisation). Similar difficulties may exist in the tracking and observation of customer activities.

The relationship between service design and service architecture requires further research. So far, the relationship between service design and service architecture has not received enough attention. The concept of service architecture or architectural knowledge, although mentioned several times in non-information technology-oriented service literature (e.g., Bitran and Pedrosa, 1998; Voss and Hsuan, 2009; Baldwin, 2010) is still a research area dominated by information system researchers. The question rises whether new insights could be created about the service architectures if the service systems including several service products/concepts were also reverse engineered?

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Identifying product and process configuration requirements in a decentralised service delivery system

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Abstract: Designing new service solutions and improving the performance of existing ones have always played a central role in service management. In order to maintain the capability to create innovative solutions, a necessary step is to extend the closed management models towards understanding the systemic nature of services and how systemic characteristics affect service operations management. The main purpose of the study is to identify system characteristics in a service delivery system and to find out how they affect the product and process configurations on the operational level. The main contribution of the study is providing new insight into product and process configurations and how these static artefacts require dynamic information in order to work properly. The results are based on an empirical case study in a decentralised healthcare service delivery system. The practical and future research implications aim at adding systems thinking into service system research and service operations management.

Keywords: service product; service process; product configurations; process configurations; decentralised production; healthcare service system.

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1 Introduction

When a customer participates in a service delivery process, an intentional or emergent configuration is created. Multiple customers with simultaneous delivery processes form a service system, which is defined as “a configuration of people, technologies, organizations and shared information, able to create and deliver value to providers, users and other interested entities, through service” [Maglio and Spohrer, (2008), p.18]. Configurations are constantly challenged by the natural characteristics of systems: “dynamic and potentially self-adjusting and thus simultaneously functioning and reconfiguring themselves” [Vargo and Lusch, (2011), p.185]. Translating these characteristics into operations management language requires the utilisation of static structures and dynamic flows and relationships in order to be effective (Badinelli et al., 2012). One way to do this is to follow lessons learned in the supply chain context: instead of overreacting when facing increasing amounts of operational data, the dynamic behaviour of the system is made visible for the relevant actors (Shu and Barton, 2012).

An agile business model is a solution for fast reactions and better adaptation of collaborative networks (Loss and Crave, 2011) at the strategic level, but what does flexibility require from the service operations? In the manufacturing system, flexible operations require designing dedicated or flexible multi-stage processes based on the demand, available capacity and costs (Eynan and Dong, 2012). In services, the approaches tend to focus “on the characteristics of individual ‘service processes’ without considering the interrelated nature of the multiple channels of service delivery” [Ponsignon et al., (2007), p.8]. It is relatively unknown how flexible the basic artefacts service product and service process is and how they behave in a system. Lillrank et al. (2011) point out that service can be a process or not. It requires identifiable handovers between process steps and repetitive sequences in order to exist; therefore a process is not a suitable unit of design and analysis in all cases (ibid.).

We argue that the link from system-level models to practical and actual operational configurations is too weak, and the basic models require an urgent update. Ng et al. (2011b, p.24) suggest that the system characteristics should be understood first on the abstract level because only then "future service design could be systemic, structured and deliberate to ensure sustainable service excellence". We state that without understanding the operational reality, it is not possible to capture the relevant systemic characteristics, and there is a potential danger of adding too many parameters. Lusch and Vargo (2012, p.195) underline that "complex systems emerge from the micro activities of resource-integrating and resource-creating actors".

The operational perspective requires new insights, especially in service contexts where combinations of 'customer-processing', 'material-processing' and 'information-processing' activities are realised simultaneously. Ng et al. (2011a) have identified operational and usage information as a critical requirement for configuring a service delivery system (SDS) effectively, a feature that is missing in the existing models. Our aim is to continue extending the current knowledge about configurations in a SDS and to find out how the systemic characteristics actually affect the product and process configurations. The main contribution of the study is focusing on the operational level instead of discussing the relevancy of systemic models at the abstract level. In order to do so, the main research question has been defined as follows:

- *What requirements do systemic characteristics set for product and process configurations in a decentralised SDS?*

As a starting point, a conceptual framework has been created, based on existing theoretical knowledge of service product, process and delivery system configurations. The framework has been further utilised in a case study in a healthcare service system. The empirical phase provides insights into the relevant configuration elements and how they can be managed efficiently. Though this study has a strong empirical focus, the main contribution is advancing research in the field of service operations management.

The rest of the study is organised as follows: the next section concerns the research design. The third section forms the theoretical background for the conceptual model, and the fourth section presents the case study. The fifth section focuses on discussing the implications and the last section on conclusions, limitations and further research interests.

2 Research design

The research design consists of a conceptual part covering references that focus on artefacts and concepts in the fields of service operations management, service science and service engineering. The main purpose has been to review existing knowledge related to known configuration options in a SDS. Based on the review, the authors have formed a conceptual framework on the architectural level, which has been utilised in the case study.

Extending operational knowledge requires access to an empirical system that is complex enough. The systemic characteristics in a complex system include a high number of events and processes, and if possible also emergent properties. The healthcare context was selected on the basis of known characteristics existing in a healthcare service system (Tien and Goldschmidt-Clermont, 2009). A healthcare service system is an integration or combination of three components – people (service demanders and suppliers), processes (procedural processes and algorithmic processes) and products (physical and virtual).

2.1 Research methodology

The case study methodology was selected due to the requirements set in the research question. Halinen and Törnroos (2005, p.1286) suggest case study strategy when there is a need for "an intensive study of one or a small number of business networks, where multiple sources of evidence are used to develop a holistic description of the network and where the network refers to a set of companies (and potentially other organizations) connected to each other for the purpose of doing business". Case study research has been recognised as being particularly good for seeking answers to *how* and *why* questions (Yin, 2003), also in operations management (Voss et al., 2002). In this case *how* refers to how configuration is done and how the systemic characteristics are acknowledged in the SDS. The *why* question is also relevant when the researchers try find out why certain characteristics are more relevant than others.

Voss et al. (2002) underlines that in a case study, the question can be formatted also before the conceptual framework is created, as has been done in this study. It gives a focus for the theoretical setting but also for entering the case organisation. In this study the existing configuration knowledge was utilised in defining how the configuration elements should be modified to achieve a more systemic perspective. In order to avoid some known limitations related to a single case study, such as poor basis for scientific generalisation (Yin, 2003) and potential misjudging of single events (Voss et al., 2002), special attention was paid to data collection from multiple sources and data analysis, and also to how the results were interpreted and discussed.

2.2 Research process and data collection

The research process included four phases:

1. constructing the conceptual framework
2. collecting the data
3. analysis of the data
4. making interpretations according to the research question by using multiple interactive methods.

In this subsection, each phase is introduced and their relevancy for this study explained.

The first phase covered constructing the conceptual framework, selection of the empirical case, and defining the needs of data collection. The data collection needs were divided into two groups:

1. collecting information about the daily routines, operational procedures and working system as they were currently implemented
2. collecting data such as service plans, service agreements, information system designs etc. that described the service system structure and also the dynamic actions indirectly.

The first illustration was based on only what the actors said, observed and reported to the researchers.

The second phase included the data collection. Altogether five researchers participated in this. The interview part in the data collection included 15 thematic individual interviews (nurses, doctors and service managers) and eight thematic group interviews with two to five members (service managers and nurses). The interviews were conducted between February and December 2010, and altogether 40 persons participated in them. The interviewees were selected on the basis of their geographical location, the team they worked with, and the competence/role that they had in the operations. All interviews followed a thematic structure with eight themes (see Appendix), and the duration of the interviews varied between 30 minutes and nearly two hours. All interviews were audio recorded, and transcriptions were created for the analysis phase. The data included six development and analysis reports and also detailed information system descriptions. The quantitative data included the number of visits, service offerings, the amount of resources in different areas, and the number of customers. Customer data were excluded due to privacy reasons.

The third phase consisted of data analysis where three researchers analysed the interview transcriptions and compared them with qualitative and indirect data, such as the system descriptions and designs. In order to avoid misunderstandings, some additional interviews were repeated as phone interviews during spring 2011. The members of the case organisation had also access to the transcriptions. The fourth phase was closely linked with the third phase. It included interpreting the results of analysis and organising interactive workshops with members of the case organisation. The participants from the case organisation evaluated the results using an internet-based ThinkThank – innovation tool, and selected the development case processes in an interactive workshop in May 2011. The development work and the implementation processes were excluded from this study.

3 Theoretical background

From the customer’s perspective, a service provider offers a potential or configuration of inputs for the customer’s own service and value-creation process (Gummerus, 2010). Only the customer can create value for him/herself based on his/her personal expectations and reality (Grönroos, 2011). Ponsignon et al. (2011) state that there is both a need for and lack of studies focusing on the design of SDSs. Obviously, the existing studies and models are further challenged by the customer-focused arguments presented above. The service operations management and service engineering fields have traditionally focused on less dynamic aspects (Sampson, 2010) in service delivery. According to Sampson (ibid.), adding dynamic elements would require identifying variation in production inputs, adjusting the service production process based on the input type, and a capability to provide the promised outcome as process output (functionality or change). This would enable operational flexibility (Ngamsirijit, 2012; Alolayyan et al., 2012) and better performance in a service system (Murat and Nepal, 2010). In order to operationalise Sampson’s idea, this section focuses on three theoretical aspects: identifying configurable elements in a SDS, what characteristics specify the SDSs in the healthcare context, and creating a framework of analysis for SDS configurations with local or systemic characteristics.

3.1 Configurable components in a SDS

The design of a SDS addresses the question of *how* the service concept is delivered to the target customers (Tax and Stuart, 1997). Service concepts can be typically divided into two groups: customised services and standardised services. Customised services are characterised by numerous configurable parameters and require a close relationship with the customers, whereas standardised service concepts consist of limited configurable parameters, and they are usually based on transaction-focused customer relationships (Ponsignon et al., 2011). The more customised the concept is and the more concepts there are, the more complex and greater are the requirements for employee skills discretion, and the less routinised tasks and automation can be utilised (ibid.). As in demand-driven supply chains (Verdouw et al., 2011), also in services the employees must be able to take part in multiple service delivery configurations concurrently and to switch rapidly to new or adjusted configurations. Though most configuration models are manual, also technologies and automation can be utilised in them (Liao, 2011).

The service literature offers three main categories for delivery system configurations: product, process and interaction configurations (Bullinger et al., 2003). The product model is a definition of the service contents and a structural plan of the service products, and it guides the service activity that realises the service for the customer (ibid.). A service product requires a channel for delivery, where channel refers to the means of communication that are used during the realisation, and the channels can be categorised on the basis of the interaction type (Sousa and Voss, 2006). The service package describes the degree of customisation at the product level, and its scope varies from unique (full customisation) to selective (considerable customisation), restricted (limited customisation), and generic (little or no customisation) (de Blok et al., 2010). A service bundle describes a combination of a number of different services sold in one package, which can be used in a chronological order or simultaneously (Dixon and Verma, 2013).

The process elements consist of tasks, processes and cross-functional-level coordination (Lillrank, 2010). On the task level, the pre-task set-up, the task, and post-task checks are the key elements, and together they form a total tact-time (ibid.). The process level connects independent tasks, and the elements of analysis include inputs, handovers between independent tasks, and inventories that may exist between the process steps (Lillrank et al., 2011). The processes can be divided into front-office and back-office activities, describing the process activities that are visible and non-visible to the customer in the closed environment (Glushko, 2010).

The way interaction is accomplished can be configured on the interpersonal level (Mittal and Lassar, 1996) and organised as touchpoints that can use multiple delivery channels simultaneously (Secomandi and Snelders, 2011). The first interaction aspect focuses on following a pre-defined task (responsiveness), the second aspect on the social content of the interaction and adjustments within it (personalisation), and the third aspect on how well the customer's request can be fulfilled (customisation). Also time-location constraints and the distribution process affect the service realisation (Lillrank, 2010). Lillrank offers four additional elements: the service provision point (SPP), access, which means the time and trouble for the customer to get to the SPP, service range, describing the number of different offerings in a single SPP, and speciality, referring to different grades of offering that address the same need.

3.2 Service configuration characteristics in healthcare

Healthcare systems differ from each other in different countries, but the general content is the same: they typically offer both cure and care (de Blok et al., 2010; Brailsford and Vissers, 2010). The cure operations consist of medical treatment, repairs and recoveries, and care operations are nursing, maintaining a particular health status and preventing deterioration (de Blok et al., 2010). Healthcare as a context sets special requirements for people-centric operations management (Brailsford and Vissers, 2010). Medical professionals have typically strong autonomy in the care delivery processes, but their interest is very local: a doctor's interest is in clinical processes, a nurse's in the nursing processes, but no one is in charge of the customer process as a whole (ibid.). In addition to roles, the professionals usually understand the seriousness of service situations much more comprehensively than the customers (de Blok et al., 2010).

The product configurations in healthcare systems have emphasised the role of modularity in the designing of care and cure products, but also as a model for professional work (Nakano, 2011). De Blok et al. (2009) have studied modular product structures, service packaging and bundling in the context of home care. In addition to theoretical product structures and components, they found that in healthcare the role of human behaviour during the delivery is significant, and it may change the intended service product.

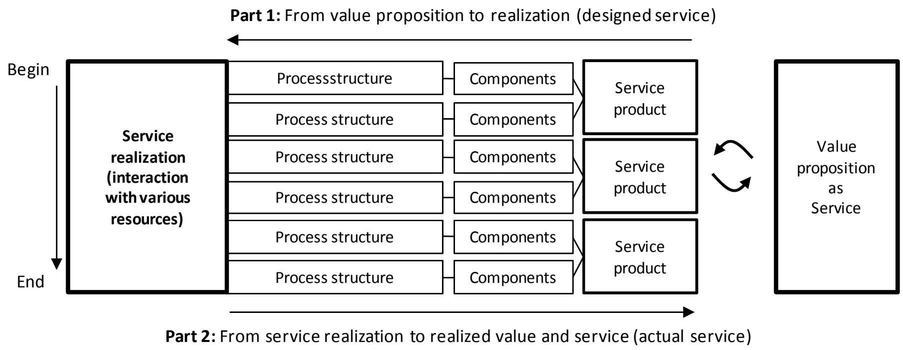
De Mast et al. (2011, p.1104) have identified three types of process improvement and configuration opportunities in a healthcare system: "1) a system of metrics for quantifying capacities, utilizations and overall resource efficiency. The system must be flexible enough to use a variety of process structures if needed; 2) an organizational model which breaks the healthcare processes down to macro and micro processes including resources and tasks; and 3) an axiological model which connects the business objectives of hospitals to process flow metrics". Lillrank et al. (2011) argue that when healthcare operations have strong predictability, the process concept with inputs, processing and outputs can be suitable and useful, but when predictability decreases, the focus has to be shifted towards sub-processes and components.

3.3 A framework of analysis for SDS configurations

The framework of analysis was constructed on the architectural level in order to identify the expected connections between product and process configurations. The key process in the SDS starts from transforming the service concept into a value proposition for the customer, and simultaneously to SDS design parameters. The customer buys a service product with single or multiple components that can be sold as sub-services, functionalities, or customised contents. Each of these functionalities has to be created through processing. In those cases that production is required, it may include inputs from the provider and the customer (or any other actor as well), pre-defined sequencing of activities, and handovers between process events and end-to-end logic or rules.

The second part of the framework focuses on a realisation-oriented view of the SDS. As de Blok et al. (2010) and Lillrank (2010) have identified, an actual service product is created only if it is realised. Also the decision-making in service operations is based on comparing the perceived context and activities with the designed activities and objectives (Veldman and Alblas, 2012). We propose that by transforming the design-oriented view into a realisation-oriented SDS view, it is possible to see what process elements or activity elements were utilised in the realisation and what kind of product and value-potential was created for the customer. The framework of analysis with the design and realisation views for a SDS configuration is illustrated in Figure 1.

Figure 1 The architecture of a SDS as configurations



4 The case study

This section describes the analysis of product and process configurations, the related challenges and potential solutions in a healthcare SDS. The main purpose of the section is to offer empirical evidence about transforming product and process configurations to meet the systemic service delivery requirements. The section consists of five sub-sections: description of the case organisation, description of the SDS, problems and challenges with the SDS, recommendations based on the test procedure, and finally the lessons learned.

4.1 The case organisation

The case organisation provides both cure and care in a geographical area with approximately 135,000 inhabitants. Due to long distances and sparsely populated areas, the service provider has to offer a wide range of services to be delivered in the customer's home instead of in a hospital or healthcare centre. The objective of the organisation is to support independent living at home as long as possible, as this has been calculated to be cheaper than if a person stays permanently in a hospital environment. In this case study, the focus is on healthcare operations at home or close to home. Though these customers may use regular health centre services and occasionally also hospital services, the main focus is in the outpatient and home care SDS.

The selected SDS provides services for two major segments. Segment A covers customers who are willing to and capable of living independently at home with the support of care delivered at home. The customers in Segment A live in both densely and sparsely populated areas, and the distance from the home care service hub to a service delivery point varies from a few hundred metres up to 50 km. Here the term hub refers to a central point where the delivery of services, product configurations and resources are coordinated and prepared. Segment B covers customers who are not yet customers of home care services but who live in an area where the distance to the healthcare centre is long. Even a simple service may cause significant costs in time and money for the service operator and the customer.

4.2 The SDS

The SDS consists of areal home care hubs that provide care for specific geographical areas in Segment A, and of a mobile healthcare unit that provides services for Segment B. Each home care hub consists of 1–4 teams with operational sub-areas. Each team has both practical nurses and specialised nurses as employees. The mobile healthcare has similar arrangements, but the number of employees is much smaller, and the geographical area where service is provided changes daily according to pre-defined schedules and routes. In the mobile unit the customer can pre-book a visiting time or enter without booking.

The total number of customers in Segment A is approximately 4,500, and services are delivered through 500,000 annual visits. The length of each visit varies between 5 to 30 minutes on average, and in normal situations a single employee takes care of the whole visit. The frequency of visits in the case of a single customer varies from once a month to several times a day. The services in Segment B cover only about 350 annual visits, though the calculated capacity is 2,200 visits. The case organisation is the main care service provider in Segment A, but the customers can buy additional services from any other provider. In Segment B the only alternative option is to visit a health centre. The general structure of the SDS is illustrated in Figure 2.

Figure 2 The case system described as a SDS

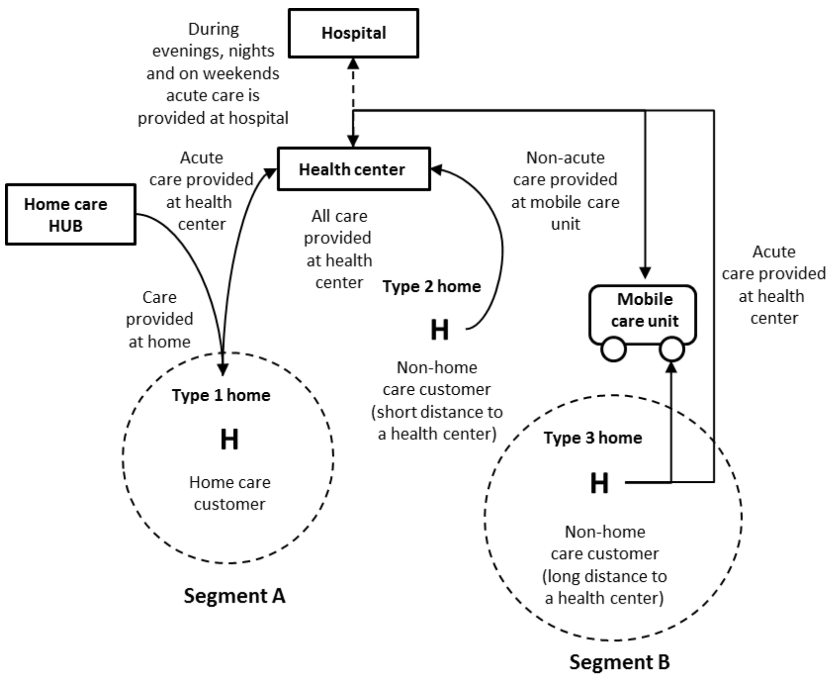


Table 1 Successful practices in the product and process configurations

Practice as described by an employee	*Potential implication from the service configuration perspective*	*Category*
"It is easy to include the customer's problems and needs in the care plan when it is created"	The care plan is quite a static unit and it is not used/cannot be used to guide dynamic operations	Product configuration
"Many acute care cases could be treated already at home without a need to visit the hospital"	Access to service could be improved by creating more flexible access channels	Product and process configuration
"Operations are based on tacit knowledge, no need for specific procedures", "We would need an operations manager who would coordinate our utilization, but not care"	Identifying the input parameters used in operational decision-making is difficult due to the independent roles of the employees	Process configuration
"Our service offering is designed only for 65+ customers", "Communication technology and connections define where we can provide our services"	Both the service offering and the technology may cause operative constraints that are not fully understood	Product configuration
"The Resident Assessment Instrument provides a good tool when a customer's capabilities are evaluated"	Implementing existing measurements and assessment tools require training and specific skills	Process configuration

Table 2 Problems and challenges in the product and process configurations

Challenge or problem described by an employee	*Implication*	*Category*
"The patient's status and location can change even before a plan for it is created"	Acknowledging the effects of operational decisions on the rest of the system, including also the customer, is challenging	Process configuration
"Only 5% of visits are irregular or temporary visits" – "The demand is unknown and unsure"	The service operations are not as responsive as they could be and adapting operations is difficult due to the real or expected nature of demand	Product and process configuration
"Home care nurses spend most of their time in a car"; "We need to know where the patient is now"	Logistics and the information related to logistical processes is important for both the providers and the customers	Process configuration
"What do we do with a booking system, when people can come and go also without any booking"; "We have tested video phone systems and where is the value-added?"	Technological solutions do not necessarily follow the same logic that is used in the service delivery. The importance of operational information should be acknowledged	Process configuration
"Measurement is too static and general", "It is difficult to manage anything", "There are too many local procedures and habits, all units should follow the same logic"	Measuring performance , quality and costs is difficult due to varying needs and ad-hoc configurations	Process configuration

4.3 Problems and challenges with the SDS

The increasing number of customers requiring care delivery outside a hospital creates significant challenges and gives a reason for developing new service delivery alternatives. The traditional way of providing equal services for a certain type of customers is to standardise the product and the delivery process. This is easy to do on paper, but in practice the service delivery requires reconfiguration during the realisation. In this study, the researchers identified and also questioned the successful configuration practices, as well as the challenges and problems in the case system. Based on the interviews and the evaluation procedure, the most popular issues in both categories are presented in Table 1 and Table 2. Both tables include implications that were studied in detail from the product and process configurations perspective.

4.4 Recommendations – focus on systemic configurations

Product configurations or agreements have a central role in defining operational boundaries. The frequency of visits and actions that have to be performed during a regular visit forms the requirements for the rest of the configurations. The order backlog of active and realised products should be made visible for the whole system. Also temporary visits should be transformed into operational requirements in order to see whether they can be realised or not. The daily visits are organised into stacks of activities but without a connection to the rest of the configurations. Most of the operational time is used in logistical processes, not in care delivery. The order backlog should be further connected into the logistical configurations which cover the route, hubs, schedules and other logistical functionalities. The logistical conditions change daily, and therefore the employee as an operator need lots of information from the operational network for his/her decision-making. Today most of the decisions are made by the service employees, and all their decisions cannot be traced afterwards.

The service access could be improved through new service access alternatives. At the moment the access configurations are static and less visible for the whole service system, and thus observing potential conflicts and overlaps in the service offerings is not possible. The access configurations are important also for the customer, as the customer may change his/her behaviour on the basis of added knowledge about the service delivery alternatives. The access configurations are closely linked to the realisation configurations. The employees in the case system did not find pre-designed and detailed process definitions useful or even important, instead they considered it more important to know ‘what I should know about the customer and the situation before realisation?’ and ‘what is expected of me?’

4.5 Lessons learned

The case study revealed an urgent and significant need for developing the information structures and processes. When the managers required a control system like air traffic control, they actually required valid information about field activities which could not be observed directly. Their biggest concern was that the nurses delivered also other services than were arranged with the customer. In addition, knowing the daily status of a customer would have explained why the time consumed in the service delivery varied so much.

The case organisation used the service process intentionally to describe the service delivery for the customer. Improving the service processes meant that more right things would be done instead of irrelevant actions, such as cleaning or warming food for the customer. However, the real benefits of the process model were not clear. Though the operational culture was based on independent decision-making, it did not fully explain why alternatives for the unsuccessful process model were not created. It was well known that personal and emergent factors affected the configurations, and still these parameters were not included in the managerial or information models.

The most critical issue was related to information management. In the current situation, information management was dependent on the properties of software and communication technology. There seemed to be a lot of information that was not recorded in any system because information input was not possible. The managerial needs, operational needs (network of nurses) and service needs (customer) required different versions of the same information. In the current mode these information streams were standardised into one version. Providing all groups with necessary information could decrease the perceived complexity.

5 Discussion and implications

This section focuses on discussing the relevancy of the results achieved in the case study and comparing the achieved evidence with existing theoretical knowledge. The section consists of two subsections: operational information as a key resource and how it can be utilised when architectural knowledge related to the SDS configurations is created.

5.1 The role of systemic operational information in the SDS

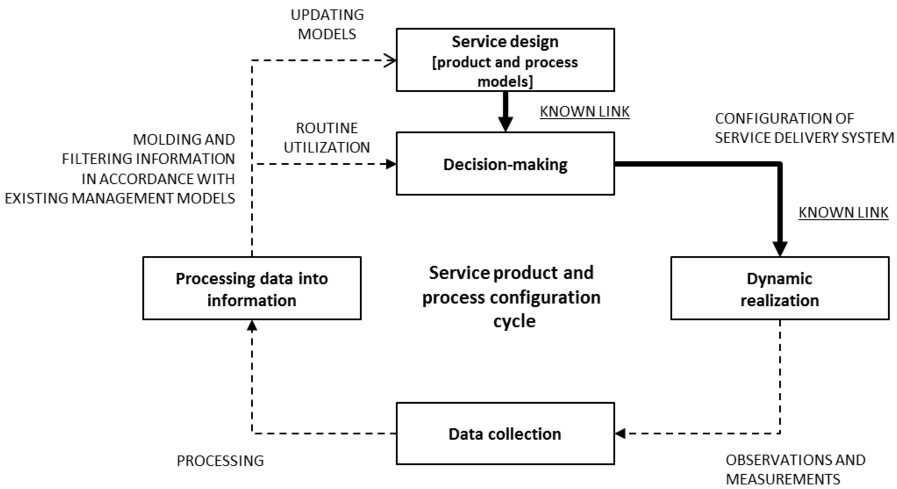
The current knowledge about the operationalisation of product and process models focuses on transforming the service concept into a SDS, and further on realisation (Ponsignon et al., 2011). According to our findings, defining the care products and the service processes based on them do not form a real challenge for the service organisations, as both theoretical and practical knowledge is well established. When the focus is changed towards open, dynamic and decentralised SDSs, things change radically (Lillrank et al., 2011). Multiple simultaneous processes including non-transparent service delivery with individual customers and their individual needs mean that the service operations management requires new and more advanced ways to create and utilise information about the configurations.

Operational information is known to play an important role as a part of efficient service operations (Ng et al., 2011b), but the literature does not contain detailed analysis of operational information in the service context. We argue that information is one of the most valuable elements in service operations management. For example the product and process definitions, as well as most activities are only beneficial when translated into information. To give an example: if it is not possible to observe the service realisation in real time, the only way to validate the service delivery is to create and utilise information about the activity. Therefore also the service configurations are highly dependent on information. Most of the problems and challenges in the case system were due to a loose connection between the designed product and process models and critical operational elements in the SDS, such as location information, activity and human status information, and coordination of internal and external logistics. All these elements are needed when operations management aims at accurate traceability of the service operations.

5.2 Architectural knowledge related to SDS configurations

Where there is information there is a need for structures. The findings of the study support the idea of creating operative versions of product and process configuration models. The core of the operative configuration model should be static (standard) and the content dynamic. This would allow using the same platform throughout the SDS, but also enable local configurations based on dynamic operational information, as traceability would be guaranteed. This approach also acknowledges the different roles and levels of decision-making, information creation and utilisation during the service delivery. An individual service employee utilises both local (self-observed) and systemic information, and a team which consists of several individuals will use also team-created information in addition to the previous information types. Finally, on the system level, the information types and usage form a very complex system themselves, where forming a comprehensive view is very difficult. Despite the significant role of information, the focus cannot be isolated only on a single event or a general process, the architecture of the service configurations should be acknowledged instead.

Figure 3 Architectural model of service product and process configurations



Baldwin (2010) defines architectural knowledge as knowledge about the components of a complex system and how they are related, including how the system performs, how the components are interlinked and how the system behaves, both in a planned and an unplanned way. The architectural knowledge related to service systems has so far focused mainly on product architectures (Voss and Hsuan, 2009). Based on the findings of the present study and the existing literature we propose that architectural knowledge should be developed also for service operations management, and especially for service configurations. It should be formed as a combination of design information (concept, product and process), dynamic service realisation including both information and actions, and a service configuration cycle (configuration process architecture). The proposed architecture is illustrated in Figure 3.

6 Conclusions

The main objective of this paper was to study the systemic requirements set for service product and process configurations in a decentralised healthcare SDS where the service delivery is done through multiple touchpoints, and which consists of independent and human-centric delivery units. As the main contribution of this study, we state that when the service system is open without observable boundaries and strict structural guidelines, there is an additional need to take an operations-focused perspective on service management in order to capture the potential and challenges of the service delivery fully. Only by understanding the reality of the service operations, the relevant systemic characteristics can be identified and their meaning clarified in practice. Most of the applicable systemic configuration characteristics in the SDS are information created simultaneously in various parts of the system as a result of system activities. Therefore, the operative versions of product configuration and process configuration options with right type of information have significant roles.

We propose that though emphasising the role of the customer is relevant, it is not enough for creating profitable service operations. The case system example showed that much of the system potential was still unidentifiable, mainly because tools connecting the design artefacts to the delivery artefacts were missing. If a service concept or service order cannot be connected to actual resources, they may have very little relevance in practice. In order to understand what system properties are available, the managers need to know what parameters are monitored and how that information can be used in management and design activities.

This study has also limitations that need to be addressed. The first limitation is related to the concept of configuration. It was assumed that systemic decisions are traceable and they can be presented as configuration structures. The researchers acknowledge that there may still be several other unrevealed configurations that will change the understanding of systemic configurations. The second limitation is related to the selection of methodology. A single case study, though implemented in a large service system, reveals only what is done in one system, and the reasons behind the solutions can be multifaceted. One system is still enough to reveal actual challenges and to compare them with existing theoretical views. The third main limitation is related to the context of healthcare services. They are a specific system type with their own cultural and nation-specific characteristics, and therefore some configuration ideas may not be valid in all service environments. However, where there is a service, there will be process and product configurations available for the service managers.

Two future research areas concerning architectural-level models and service configurations can be identified. The first area focuses on extracting relevant design and managerial information about service configuration points. In this study the potential configuration points were identified, but their relevancy could not be evaluated from the information access perspective. The second area focuses on developing methods for transferring configuration-related information from design to practice. The existing studies seem to keep some distance to information and computer system solutions. In practice, the managerial solutions rely heavily on information systems, and the abstract models can only be realised through IT solutions.

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Appendix

Structure of thematic interviews

Theme 0 employee's background and competence

Theme 1 typical and non-typical working day and customer needs

Theme 2 acute care needs in home care – case management

Theme 3 customer-related information management during a care process

Theme 4 customer logistics in home care (regular care, acute care, ad hoc care)

Theme 5 updating customer's service portfolio based on changing needs

Theme 6 preventive care and operational solutions, including the mobile care unit

Theme 7 existing services and development needs in services that support independent living at home.

In the interviews with the mobile care unit employees, the questions were modified to focus on the potential of mobile care and the perceived operational challenges.

PUBLICATION 3

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Service designs and mindsets – extracting experiential knowledge from service realisation

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Abstract: Effective service operations management leans heavily on information systems and humans. In practice, operational decisions require time-consuming information mining, and time is money. If an employee can interpret the environment and operational information without shared rules, the risk of making costly wrong assumptions and decisions is high. We propose that creating better understanding of how an employee experiences an operational event can reveal information that is not currently available. This study focuses on conceptualising the employee experience by designing a method for extracting experiential knowledge from the employee's perspective and using this knowledge during resource configuration. The designed artefact has been field-tested and evaluated in a healthcare system according to design science principles. The results provide an innovative contribution to service operations management when trying to release time for right and productive activities. By utilising the experiential knowledge, service managers will be able to decrease the complexity in service systems.

Keywords: service mindset; employee experience; perceived service; service engineering; service operations management; service design; service realisation; design science.

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1 Introduction

A modern service system is needed to provide easy, speedy access to seamlessly nested and networked, local and remote technological and human capabilities that have capacity to scale up or down with demand (Hsu and Spohrer, 2009). Working in a modern service system requires new types of skills and knowledge, but also understanding of the value-creation logic. “Each employee is complex and unique, and service activities that require an on-going transformation of the knowledge and expertise state of an employee (professor keeping up with advances in the field, doctors keeping up with latest techniques, business consultants keeping up with the latest technology advances) each start with a unique ‘as is’ state of the world” (ibid., p.274). Capabilities to work in situational and dynamic system do not emerge instantly, they have to be designed, implemented and reengineered systematically.

Unlike other service design-focused studies, we both question and emphasise the power of service design structures. In complex systems, where complexity is created and interpreted by humans, the old-fashioned two-dimensional management tools are no longer relevant. According to Ng et al. (2011), complex engineering service systems involve simultaneous transformations that are constructed around materials, technology, information and people. These simultaneous transformations must be managed to create value-creation potential for the customer, who creates value according to his/her own objectives (Grönroos, 2011). The prerequisite for value creation is successful integration of the production system (Sampson, 2012) and the value-creation logic (Vargo and Lusch, 2008; Payne et al., 2008).

Although service research usually takes either the provider’s or the customer’s position, the perspective is meant to be objective. Even if the focus is on experiential characteristics, the service delivery is described as the researcher observes it. In order to achieve new insights, it has been suggested that services should be designed as they are experienced (Gross and Pullman, 2012; Ostrom et al., 2010; Zomerdjik and Voss, 2009). These approaches support the so-called ‘human side of service engineering’ (Freund and Spohrer, 2012), where system requirements are studied from the human perspective.

Our focus is on the mindsets that are needed and utilised in the resource configuration and in providing value creation potential for customers. We conceptualise the employee experience, which is a similar artefact as customer experience, although the parameters are slightly different. We propose that with a method that captures both employee experience and the perceived system view, new type of knowledge can be created, which enables better resource configuration options. It also supports the employees in creating user-based innovations in services (Hasu et al., 2011). Hasu et al. (ibid., p.252) state that "Previously neither employees nor users were considered as capable of participating in innovation". We also propose that this type of approach visualises the differences between the expected service and the information structure guiding the realisation, and the execution perceived by the employee. The following research question was set in order to test these propositions:

- How to extract service system knowledge from employee experience in a service delivery system?

As its contribution, this study provides a framework for capturing employee experience and for extracting knowledge from it. With this new insight, managers can manage resource interactions efficiently in service organisations where the employees have strong autonomy or independent tasks. Efficiency in this context means that the provided approach will decrease the time used for searching different types of operational information significantly, and it also supports human-based interpretations more accurately. The contribution of this study is also introducing human-friendly technological solutions into service operations management, and offering practical guidelines for the actual creating of such solutions.

The rest of the study is organised as follows: the second section introduces the research design, and the third section covers the relevant theoretical background and existing knowledge of the topic. Theoretical understanding is used to formalise the design artefact. The fourth section focuses on the objectives and on constructing the design artefact. The testing of the design artefact and evaluation are presented in Section 5. The sixth section contains the discussion and conclusion part, where the contribution, managerial suggestions, limitations and further research objectives are explained.

2 Research design

Service research focuses on issues that include virtual and real artefacts. One of the biggest challenges is related to knowledge creation that is valuable only for researchers. There is clearly a need to go beyond service definitions and to understand better what the relevant characteristics are that drive service delivery as a form of activity (Alter, 2008). The artefacts need to have counterparts and relevance also in the real world. In order to create such research and knowledge, the objectives and methods are in a critical role (Nunamaker et al., 1991). That is why we have decided to explain in detail what we have done in each phase and how it is connected to the other phases, as well as to the original research question and objectives.

This study follows the design science research methodology, which is considered to be suitable when service is studied from the system and engineering perspective. Design science originates from design theory and design thinking, but it has been used also in management studies (van Aken, 2004). In order to create a new design artefact and to test it properly, we have selected the research process presented by Peffers et al. (2008). They have conceptualised the design science research methodology as a DSRM process. The process includes six main steps which are all utilised in this study. Peffers et al. (ibid.) state that although the process is presented in a chronological order, it allows also iteration steps to be taken.

DSRM process steps and their content

1 *problem identification and motivation* – presented mainly in the introduction and conceptual sections
2 *defining the objectives for a solution* – in the setting the objectives-section
3 *design and development of the artefact* – in the constructing the artefact-section
4 *demonstration* – in the testing and evaluation sections
5 *evaluation* – in the testing and evaluation sections
6 *communication* – in the conclusion section.

The problem, motivation and objectives of this study are closely tied to theoretical developments and models, not to solving a single problem in practice. This separates the selected and partly adapted research methodology from engineering methods that aim merely at a practical solution and relevancy. We propose that also theoretical model development can benefit from a process like DSRM, although the testing and evaluation produce practical implications.

3 Theoretical background

Edvardsson et al. (2005) conclude that service should only be used as a perspective on value-creation. The focus in the service perspective is the customer and how to better understand the interactive, processual, experiential, and relational nature of service. We have also taken this conclusion as the starting point, but instead of the customer, the main focus is now on the employee. Our interest is in finding out how well the employee perspective is acknowledged in the existing approaches that try to frame service and whether value creation and the context have a significant and different role from the perspective of the employee.

3.1 Employee experience in current literature

The current service literature does not provide a common definition for employee experience. In practice, the term has been used by the McDonalds company, which has productised it internally as a tool in engaging employees. Some examples of using a similar approach can also be found in the scientific literature, e.g., in labour management (Warhurst and Nickson, 2007), in healthcare sector services (Harley et al., 2007) and also in supply chain development (Smith, 2012; Heilmann et al., 2011). The studies focus on managing human resources and on behavioural aspects of working. Using the employee experience as a design or engineering concept is not as widely used.

In contrast to employee experience, customer experience, experience management and total customer experience are intensively studied areas in service research (Palmer, 2010). According to Sheth et al. (1999), the context plays a significant role in experiential service events, and a combination of three factors will help in shaping the consumer's attitude to an event:

1 stimulus characteristics that are perceived differently according to the sensory characteristics and the information content

2 the context where the stimulus is perceived

3 situational variables in which the information is received, including social, cultural and personal characteristics.

Gross and Pullmann (2012) suggest that creating relational and physical contexts will help in achieving the desired customer outcomes. They also argue that while the experiential context has been studied quite intensively, the employee perspective has been neglected. Zomerdjik and Voss (2009) propose a series of cues; sensory design, engaging customers, creating dramatic structure, setting fellow customers and linking the backstage more closely to the frontstage as service design tools in experience-centric service. Palmer (2010) states that creating new experiences requires tools that are capable of eliciting a response from potential customers and capturing the emotional and situational context in which the experience will be encountered. Human elements are relevant also in electronic negotiation (Sundarraj, 2011) and decision-making systems (Knoppen and Saenz, 2009). The role of the context seems to be very significant when the experience within a service is emphasised.

3.2 Framing service and the role of the employee

The service literature covers varying definitions of what service is or is not. From the experience perspective, service is a system of virtual schemas and real resources (Edvardsson and Tronvoll, 2011). A schema is a transposable procedure applied in the enactment of social life. A service system has schemas of its own, but they are influenced by the schemas of the social system. Virtual schemas include values (standards, moral principles), norms (acceptable behaviour) and rules (regulations governing a conduct or procedure, such as languages) (ibid.). Real resources comprise *human resources*, *physical resources*, *technological resources* and *informational resources*.

Maglio et al. (2009) define service as a dynamic configuration of resources, including people, organisations, shared information (language, laws, measures, methods) and technology, all connected internally and externally to other service systems by value propositions. The aim is to create value (ibid.) or value-creation potential for the customer (Grönroos, 2011). The main drivers for value-creation are defined through change in the state of the reality of some other entity, or the reality of the system itself (Barile and Polese, 2010; Hill, 1977; Gadrey et al., 1995). In addition to dynamic configurations, also humans play dynamic roles (Edvardsson and Tronvoll, 2011). Vargo and Akaka (2009) add that at least two service systems must attend the resource integration in order to create value.

The experience or the value-creation perspective is not the only way to frame the employee experience. Levitt (1972) and recently Sampson (2010, 2012) have proposed that service can be seen as a production system. Sampson has named his approach as the unified service theory (UST), where he aims to combine the traditional industrial orientation with value-creation aspects. The main unit in production-centric studies is the service process through which value is created, and the interest is in how the service is produced (Lillrank, 2010). This approach also separates process outputs, the customer's service experience and the service outcome as different units (Johnston and Clark, 2008). The main difference compared to value-creation studies is the production idea: service is produced (logic) while value is created (for the user or the customer). In a similar way, a service system can also been seen as a work system (Alter, 2008). A work system is a system where human participants or machines perform work using information, technology and other resources to produce products and service for internal or external customers. Information systems and supply chains are special cases of work systems (ibid.). In both approaches the employee is a part of the production system.

When products and services are combined within the same system, it can be framed as a product-service system (Mont, 2002) or as a complex engineering service (CES) system. CES systems consist of different types of transformations that are needed in value creation (Ng et al., 2011). The main difference to earlier service system perspectives is the coexistence of materials, information and people as objects of transformations. These transformations do not necessarily happen in a chronological order or even a logical order, they happen simultaneously, making the system much more complex (ibid.). In information system studies, service orientation means "composing applications by discovering and invoking network-available services to accomplish some task" [Papazoglou et al., (2007), p.38]. The key objective is to create value through processes, reuse, information and coordination (Bardhan et al., 2010). Thinking helps also in breaking process silos through modular services that can be produced independently or out-tasked to external actors (ibid.). A composing application is a similar term as resource configuration in the value-creation approach. Despite the simultaneous processes, these approaches suggest that a service can also be decomposed into components. Therefore an employee can also be seen as a service component.

All previous approaches emphasise the structures and structural or logical elements of service. Vargo et al. (2008) state that the previous approaches tend to use old-fashioned and goods-dominant logic-oriented *value-in-exchange*. They suggest that *exchange* should be replaced in a more service-dominant logic way with *value-in-use*. According to them, value-in-exchange puts producers and consumers to different roles, whereas value-in-use treats them equally (ibid.). In other words, value cannot be produced – it is co-created through the integration of resources and application of competences. Value-in-use has since been replaced by value-in-context. The context is a unique set of actors and the unique reciprocal links between them. The context also frames the service and the potentiality of resources from the unique perspective of each actor (Chandler and Vargo, 2011). Edvardsson et al. (2011) have extended the term value-in-context to value-in-social-context. They define value as a social construction which is shaped by social forces and reproduced in social structures. Value can also be asymmetric for the actors involved (ibid.). Grönroos (2011), on the other hand, states that only an actor can create value for him/herself. According to Grönroos' (ibid.) definition, a service is significant and most likely valuable only in the actor's own reality. In this case both the customer and the employee can be actors.

4 The design artefact

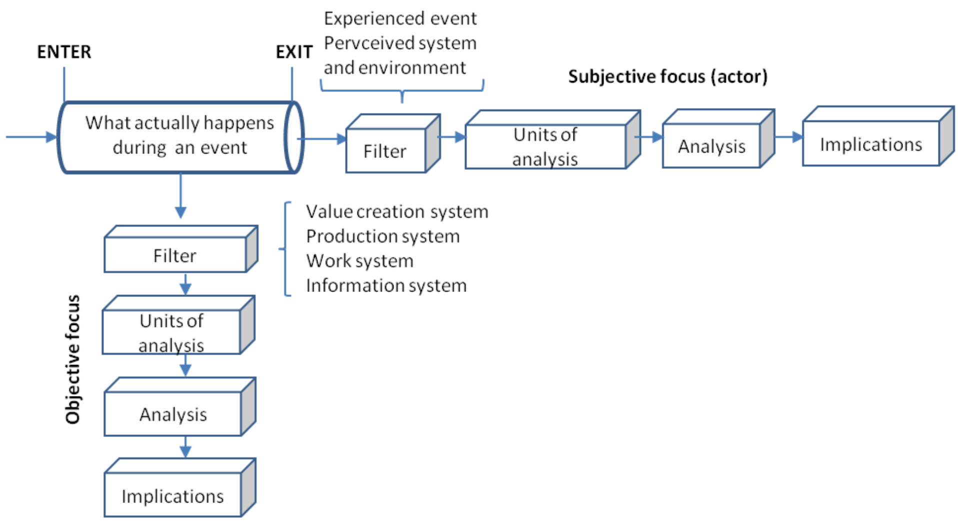
From the theoretical perspective, the employee's role is to be an active resource and to provide work as a process input. The most theoretical definitions and units of analysis are utilised on the design or even more on the abstract level. Though value-creation and managing complex systems are important issues, the operations or service manager's main concern is to manage and understand human resources in a run-time service environment. We propose that the event or task -level is a good starting point when constructing new insights, as it is a basic unit in a service process. Although it has been criticised that the event-based view of the world does not support capturing dynamic relationship and complexity (Stermann, 2001), we wish to underline that in a service process all decisions are made in situational contexts and during individual events. Therefore, our aim is to frame the employee experience in detail and find new ways of supporting decision-making and situational understanding during service events. It also helps in understanding how an employee interprets events in a service environment.

4.1 Employee experience

The first challenge is in framing the employee experience. What are relevant events and what constitutes a relevant episode? As described in the first subsection, service can be framed from several perspectives. However, we propose that the length or duration of an event is not necessarily the same when we analyse an activity from the information system or the work system perspective. These are only service schemas, as Edvardsson et al. (2011) describe. The experienced context and activity can be very different.

To create additional insight, we have created a frame for capturing the employee experience (Figure 1). The employee experience can be externally analysed from different perspectives (vertical direction), but the actual content of the event is defined by the employee who experiences it (horizontal direction), not by the unit that used to analyse it. The employee experiences the event as a difference in the states between the entering point and the exit point, and it is surrounded by the social context.

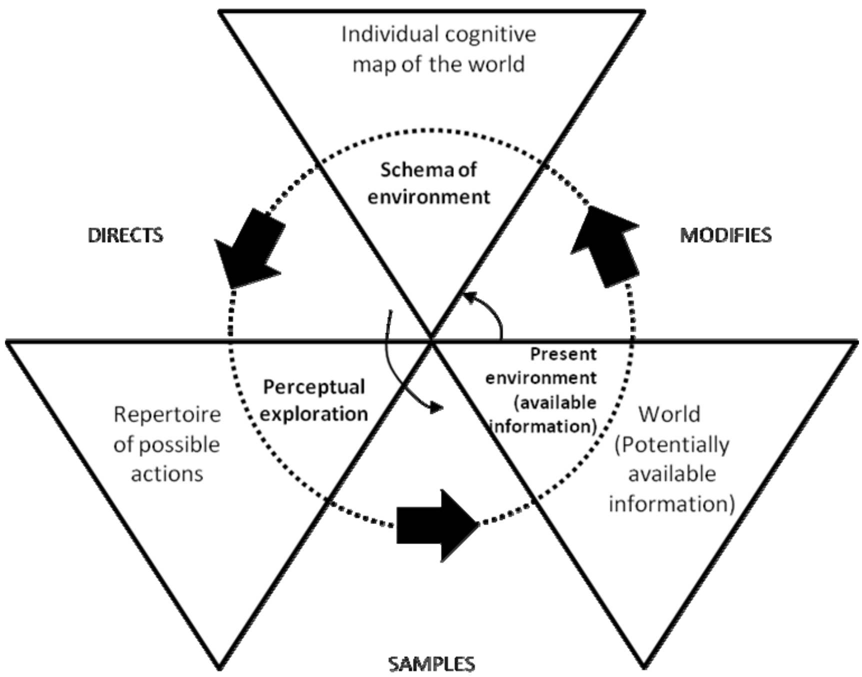
Figure 1 An employee experience event – the difference between objective and experiential models (see online version for colours)



If the employee experience is visualised using for example the service blueprint technique (Bitner et al., 2008), the experienced event cannot be captured in full. We do not know how the employee unifies different events and what the actual experienced episode is for the employee. According to Sheth et al. (1999), the experienced event includes some kind of a stimulus with sensory characteristics and information content. The stimulus is perceived in a context which is influenced by situational variables. We propose that the perceived event is what creates a sense of a dynamic event. If the perceived stimulus changes due to the context and situational factors, the employee's experience can vary a lot.

In order to frame the experienced event, we have utilised a concept called the perceptual cycle model (PCM) (Plant and Stanton, 2012). PCM is used to capture the reciprocal and cyclical nature of interaction between a person and the environment. It describes how people change a situation by their actions, but also how the evolving situation may change someone's behaviour. Even though PCM extends the service context beyond traditional engineering limits, our aim is to use it as an engineering tool. The PCM is illustrated in Figure 2.

Figure 2 The PCM



Source: By Plant and Stanton (2012)

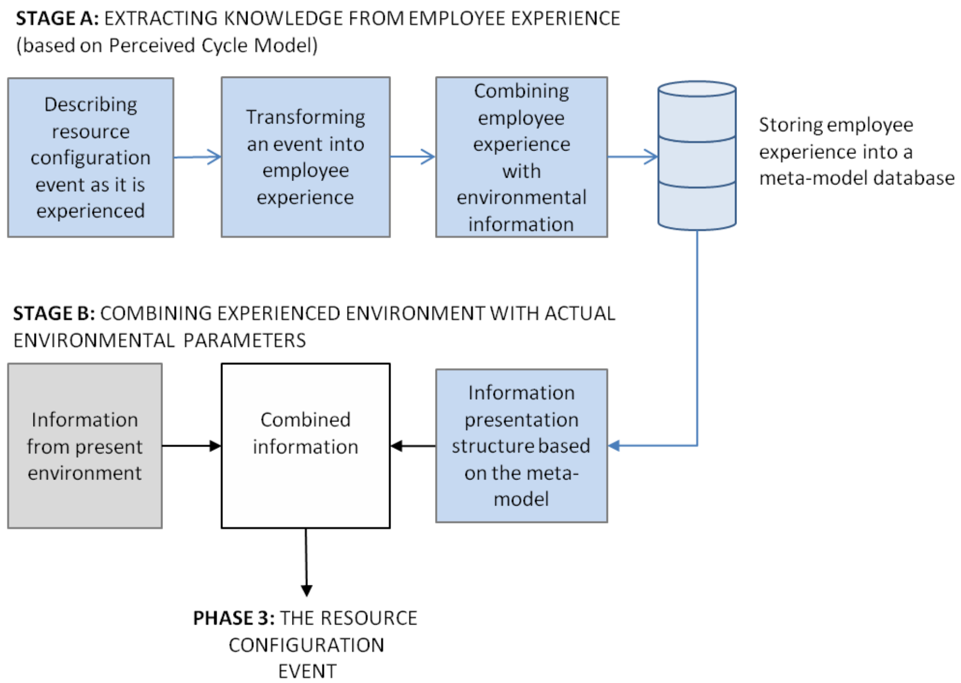
We propose that the employee's experience event and PCM together form a base for a mechanism that can be used when the employee experience is captured. Through this mechanism it should be possible to change situations by steering the activities and to modify situations by creating a new type of behaviour if necessary.

4.2 Content of the design artefact

The core of the design artefact is the PCM, which is used to capture the sequences of employee experience. During a cycle the employee interprets, observes and senses the present environment. This information is used to modify the schema of the environment. The schema represents a residual structure that guides the activity in the system (Plant and Stanton, 2012). It should be understood that the interpretation of the present environment and the schema of the environment are subjective elements. The modified schema will direct perceptual exploration, meaning actions that are considered to be relevant and required in a given situation (ibid.).

In value-creation models, the key element of a service delivery system is the phase where resources are configured to create value. If the resource configuration is a result of perceptual exploration, the resources are configured on the basis of a schema of the environment and information about the present environment. In order to direct the resource configuration on the employee level, the service system management should facilitate the employee experience through present environment information and connect it to subjective perceptual exploration habits. The PCM steps and their connection to resource configuration are presented in Figure 3 (the design artefact).

Figure 3 The design artefact (see online version for colours)



Stage A concerns transforming the actual service events and the employee's perceptions into employee experiences. When the experience described by an employee is combined with the information of the system state at the same moment, it can be stored on a database for further utilisation. The stored event includes information about the perceived event and the event through measurable parameters. When several experiences are stored, a meta-model can be created that describes the service system as it is perceived by many employees. In stage B, the employee's own 'way of thinking' is combined with information about the present environment in a real-time configuration situation. The combined information is presented to the employee, who should now have information in the right format presented in an understandable way.

5 Empirical test and evaluation of the design artefact

In order to test the design artefact, a field test was organised. The case system was selected on the basis of criteria defined in complex engineering systems (Ng et al., 2011) and complex service systems (Tien and Goldschmidt-Clermont, 2009). The case organisation was a specialised healthcare organisation with three different subunits. The service was organised around acute care that was provided 24 hours and seven days a week in an area of about 100,000 inhabitants. The acute care unit bought support services from laboratory and radiology units that served also non-acute care units within the same area. The following characteristics were considered as qualifying criteria during the context selection:

- multiple customers with varying priorities – a unified view of the customer did not exist
- hierarchical units with relatively autonomous activities and professionalism-oriented management
- the service information included contextual and non-contextual issues
- the service events took place according to customer requirements (mainly patients)
- acute service delivery as well as non-acute product production (service-product-information transformations).

The researchers formed two separate focus groups that participated in the test. Focus group one included employees of the acute unit and units that bought non-acute services or products from the subunits. The second focus group included employees of the laboratory and radiology units, which delivered service and products to customers. Additionally, a third group was formed before the last phase of the testing procedure, consisting of a mixture of employees in focus groups one and two.

5.1 Test procedure

The testing was organised in four different phases by four different researchers and case organisation members in order to maintain the validity of research. The phases and their main content are described below:

5.1.1 Phase 1 – identifying resource configuration situations

The first phase included altogether 34 thematic interviews, where the themes presented in the Appendix were discussed. The focus was to find out normal routines and daily working situations that might cause challenging or problematic situations for the employees. Before the interview the employees were asked to sketch a stakeholder network where a subjective perspective on the employee's role and the relevant stakeholders was drawn. The duration of each interview varied between 1 hour and 1.5 hours. All interviews were recorded.

5.1.2 Phase 2 – transforming situations into use-case descriptions

Based on the recorded interviews, subjective situations were identified. The situations were categorised by three different characteristics:

1 IS a resource configuration situation

2 IS NOT a resource configuration situation

3 IS PARTLY a resource configuration situation.

The last category included situations that were indirectly connected to a resource configuration event. The identified situations in categories 1 and 3 were further transformed to use-case situations on the basis of the model of Regnell et al. (1996).

5.1.3 Phase 3 – visualising use-cases to describe the employee experience

The use-case descriptions were visualised for the employees as decision-making situations or as problematic situations. The original employee-experienced situations were transformed on the basis of the design artefact into personalised visualisations. Various interfaces were used to present the visualisations, such as a tablet-computer, a mobile phone, television and desktop computers. The situation and the visualisation tool were explained to the employee and then the employee was asked 'what would you do in a situation like this?'

5.1.4 Phase 4 – testing use-case scenarios with focus group members

The use-case scenarios were tested with 13 persons in individual tests with four to eight use-case situations. Altogether 84 situations were tested in cooperation with the case organisation members. The participants were selected on the basis of their position in the organisation, the opinions presented in phase 1, and the employee's own willingness to participate. The use-case visualisations were presented on a tablet-computer and if needed, printed paper versions. Twelve persons approved recording of the test situations.

After the four main phases, the design constructions and the test process were evaluated. The evaluation consisted of two parts: reflection of the participating researchers and analysis of feedback, and reflection of non-participating researchers and analysis. After the two independent evaluation phases, the researchers summarised the results of the analysis and organised a workshop were the results were critically discussed and reflected upon. After the researcher-focused phase, the results were evaluated by the case organisation members.

5.2 Evaluating the results

The methodological requirement for the evaluation phase was answering the question 'Does the artefact support a solution to the problem?' (Peffers et al., 2008). According to Peffers et al. (ibid.), this involves comparing the objectives of a solution to actual observed results of use of the artefact in the demonstration or testing phase (ibid.). It requires also the right type of knowledge of metrics that can be used in the analysis of the success of the artefact.

The results are discussed below through the following evaluative questions:

- Does employee experience exist and is it connected to the configuration of resources?
- Can it be accessed through information creation and visualisations?
- Do the *PCM* steps reflect the way the employees operate?
- Can the personal schema of the environment be imported into the information system and does it offer additional information for the service organisation?

Already in phase 1, the employees succeeded in explaining what they considered as problematic issues in their work. They were also able to tell why the situation was problematic and even what possible elements were causing it. However, the image of the activities was not a process but more like a database of positive and negative episodes or experiences. According to the employees, the work system focused on proceeding from task to task: "Once you complete a task, you start another one". Resource configurations existed at least in three categories:

1 human-human configurations

2 human-information configurations

3 human-technology configurations.

However, none of the interviewees could see interaction as a resource configuration; it was rather seen as an interface and a solution that were actually used. There seemed to be also emergent configurations where the interpretations of individuals guided the configuration, instead of formal instructions.

Especially in the human-information relationships, the state of the system and activities were experienced as a challenging issue. The state was not expressed clearly, and information was mostly late or did not exist at all. Of course, state information always exists, but it was not coded properly for utilisation. Information creation and visualisation therefore offer an access point to the employee's experience. However, this happens only if the employee is obligated to use the information and leave 'a footprint' of using it. Otherwise the information created, modified and shared within the social context seems to be more relevant. Even if some information or instruction is clearly expressed in the information system, a rumour or an unofficial work procedure may be considered more relevant. Work cannot be isolated into the information system, and therefore it is exposed also to disinformation. The power of example is strong, and most of the working procedures are originated in experimental work procedures.

The relevancy of the PCM was tested in several ways. In the first phase, the stakeholder network map and the interview represented the personal schema of the environment. In the last phase, the responses to the use-case visualisations were used as environmental information for the users that was originally created by the users. The quality of the personal schema varied according to work experience, task stability and communication needs, the size of the work team, and the working culture. It cannot be said that the dominating schema was totally personal, as in both support service units the dominating individuals actually formed the prevailing schema. People were careful of performing actions against this schema. It seems that using information to influence one's personal schema is possible, but only if the interface, device and the type of representation are acceptable. The most influential visualisations were short text messages provided through a mobile phone or television and visualisations where the visualised object was described exactly as it existed in the real world. Graphs or abstract visualisation were considered irrelevant or difficult to understand.

The last evaluation criterion included the assumption that it would be possible to transform personal schemas into information systems. The researchers proposed that a human being's capability to observe activities create insights that could be useful if they were shared with the rest of the system. The proposition was manually tested using the testing procedure described in the previous section. The results showed that the main difficulties arose from event-centric knowledge. The employees created insights during every single event. It can be impossible and invaluable to transfer all of them to common and shared information. Therefore a so called meta-system (or architecture) was created to join the independent situations together and to conclude what was relevant knowledge and what was not. The meta-system reflected quite well the organisational positions, the power settings and the operative logic. The meta-model was sketched simply by asking questions like 'if this is the problem, what creates the problem and who is affected?'

The design artefact provides a promising start for capturing the employee experience. It shows that the content and length of an experienced service event is different from the ones used in information systems, process maps and task descriptions. It also provides evidence about applying an experimental tool to achieve better understanding of why humans act as they do within the service context. The human side of service engineering can also extend the focus towards understanding and affecting human behaviour. As long as the computer and information systems remain pre-coded and include trust for assumed behaviour, there will be integrative tasks for engineers and service engineer researchers.

6 Discussion and conclusions

The results of this study contribute to the service operations management and engineering literature by conceptualising the employee experience as a new source of service knowledge. To formalise the main contribution, a design artefact was created and tested. The artefact provides a unique contribution by supporting access to an employee's actions and by extracting experiential information that are not visible in the service process or in organisational charts. The idea was derived from existing concepts of value-creation in services and experience management models that have previously focused on customer experience. Based on the results we state that all actors within a service delivery system form an experience that includes processing service- and resource configuration-related information. The results also show that the length of the experience is not limited and does not follow the service process definitions or charts, but is affected by the social context and interpretations in the present environment. As the main conclusion we state that the way the employee thinks and interprets the environment should not be fully standardised, as that can hide very valuable service information and knowledge.

As a managerial implication, we suggest that a better insight into the employee's own schema is connected to the performance of the service process. In an ideal service system, time is not consumed in unnecessary issues. In practice, time is consumed in searching for right information, putting information pieces together, interpretation of information, and verifying the quality of information. Despite all these efforts, the resource configuration decision may be right or wrong, potentially causing even more costs. The results also indicate that adding new information or resource planning systems mainly increase time consumption if they are not tailored and adjusted to the perceptual exploration procedures of individual employees. This subject has significance for operations managers in service systems, and the challenge related to it cannot be solved by information technology experts alone.

This study has some limitations that require special attention. The first one deals with an engineer's capability to capture human behaviour. It is obvious that engineers can create a mechanistic view of the world too easily. However, moving forward in research and knowledge creation may require mechanisms and artefacts that can be disputed in the near future. Staying only on the abstract level will lead to a constantly expanding gap between theory and practice. The second limitation is created when abstract conceptualisations are reconceptualised with a different focus. The so-called customer experience is not a commonly accepted concept (Palmer, 2010), and therefore transforming it to capture employee experience may include fatal mistakes. Therefore we do not underline that employee experience itself provides a new insight, it is a conceptualisation that can be valuable when the employees' personal schemas are revealed. The third limitation concerns the empirical test phase and the validity of the achieved results. A single-context test represents an alpha-test in design science literature (van Aken, 2004). Its purpose is to provide results as inputs for further design reengineering.

On the basis of the results, we suggest that the research should extend the knowledge related to the experiential impact on service operations management. Our work-in-progress framework showed that the length of the event is different when it is described as an information system event or as a production system event. As the architecture literature suggests (Bass et al., 2003), there is no single architecture in any system, there are multiple architectures describing the same context with different perspectives. The most promising perspective is the experience perspective where the service is actually 'in use'. The experience perspective showed that service design has significant contextual and situational components, although they are difficult to identify and map. We intend to continue conceptualising the multidimensional experience-centric view further as a computer game. We propose that already today, modern game design tools allow switching between different perspectives and maintaining all elements within the system at the same time. Paper-and-pen models clearly lack this characteristic and that is why they remain on a high level of abstraction.

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Appendix

Structure of the thematic interview (subthemes included)

Theme 1	Personal, team and unit capabilities in daily activities
	• Employee's own role and relationship to other resources, problematic issues faced in everyday activity, popular and unpopular tasks and development of skills and capabilities
Theme 2	Work system, organisation of work and working procedures
	• Work system management, organisational culture, official procedures versus unofficial procedures and the main focus and objectives of daily activities
Theme 3	Who is the customer and what does the customer have to do with the service?
	• Official and unofficial customers, customer's influence on daily routines, customer feedback and relationship to customer
Theme 4	Decision-making as a part of daily activities
	• Employee's own decision-making situations and experiences, other powerful decision-makers within the organisation, official and unofficial decision-making chains and learning from earlier decisions – possible or not?
Theme 5	Manual and automated information systems
	• Information systems that you utilise, the role of information systems in daily activities and if you designed an information system – what would it look like?
Theme 6	Communication as part of daily activities
	• Internal communication procedures, external communication procedures and informal and emergent procedures
Theme 7	The future (personal, team and unit perspectives)
	• Objectives, challenges, personal ambitions, personal vision – in the next 5-, 10- and 30-year perspective

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A modular response model for increasing awareness of systemic variety in service operations

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Abstract: Successful service requires a responsive service delivery system with adaptive operations. People participate in services constantly in different roles, but it is still difficult to capture and transform the realisation into usable information for operative decision-making. The service literature provides insights into the design of a service system at the abstract level, but service operations are still managed in a less systemic manner. We propose that systems thinking has to be acknowledged in service operations, and therefore this study focuses on developing a framework for managing process-level variety in a service process through systemic response components. The developed framework is evaluated in two emergency rescue service systems by utilising the case study methodology. The main contribution of this study is providing a model for operational response creation through operational information. The practical implications encourage adding new competences for information processing as a part of service operations management in service systems.

Keywords: service process variety; service process response; service modularity; modular response; service operations management; emergency rescue service system.

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1 Introduction

A service system is defined in the service literature as a dynamic configuration of people, technology and organisations connected by value propositions and shared information. It arises, evolves and interacts with other service systems (Smith et al., 2012). Its nature is known to be characterised by observable and measurable properties that influence the service system boundaries (Ng et al., 2009). These characteristics are mixed with social system elements such as norms, values and beliefs (Edvardsson et al., 2011). While the interest towards service systems has increased in recent years, relatively little attention has been paid to the operations management perspective. What does efficient and systemic operations management require as a part of a service system?

A traditional process model consists of inputs, transformations and outputs, and it is based on a highly reductionist and closed system view (Batista et al., 2008). A more systemic view extends the reductionist model by creating state-awareness: the inputs create a disturbance that changes the prevailing state of the system (Godsiff, 2010). The inputs for a single activity may originate from multiple sources, and the outputs may similarly create new disturbances in several other systems (ibid.). The wider the variety of inputs, the wider the variety of responses should be in order to keep the system viable (Ashby, 1970). The traditional approaches to decreasing variety have focused on designing the system to accommodate variety or reducing it (Frei, 2006). Ng et al. (2009) state that service environments are changing towards more open systems, which require socio-technical system designs that emphasise adaptability in people and equipment. It has been suggested that managing variety requires new strategies, such as increased or amplified variety (Godsiff, 2010; Ng et al., 2011). This would mean that new states are identified and executed intentionally in the form of task, process or service solutions.

While recent developments in managing variety and responses have created additional insights into operations management, they have bypassed the role and usage of information in it. We propose that by finding an effective structure for response creation, service designs could be used as operational tools, and service organisations would be able to construct new responses as well as modify existing ones with designed functionalities. The proposed approach combines lessons learned in managing variety in the service context and the emerging field of service modularity studies. The modularity aspect has been previously studied mainly in service product (Voss and Hsuan, 2009) and service process contexts (Rahikka et al., 2011), as well as in a combination of them (de Blok et al., 2010). Modularity provides potentially a good platform for designing an operational response, because it enables adding new components through standard interfaces. Based on the arguments and motives presented above, we have set the main research question as follows:

> What kind of information describing a service system is utilised when a response to an input or a combination of inputs is formed in a service process, and do these information components form a modular structure?

The main objective of this study is to create a framework for producing modular process level responses in a service system where part of the situational (local) reasoning has to be done based on visual observations and qualitative interpretations. The study aims at enhancing the systemic and information usage-focused insight into the field of service operations management, in addition to the existing approach focusing on engineering service processes through simulations (Kaner et al., 2011). The modular response approach has been tested in the context of emergency rescue (ER) operations, and its potential has been evaluated in a severe traffic accident case, but the utilisation of the framework is not limited to these contexts.

The rest of the study is organised as follows: the second section focuses on the theoretical background and constructing the modular response framework. The third section presents the research design and methodology, and the fourth section the main findings of the case study process. The findings and implications are discussed in detail in the fifth section, and in the sixth section conclusions are made, and the practical implications and limitations of the study discussed.

2 Theoretical background

This section provides the theoretical background for creating a framework for modular responses. The literature review covers the existing knowledge related to the nature of variety, how variety is understood and managed in the service context, and how the modularity approach could provide a platform for creating advanced responses to variety in a service system.

2.1 Variety and variability

As a systemic phenomenon, variety describes the possible states that a system may possess (Shinners, 1998). Ashby (1970) has formalised a law of requisite variety which defines variety as the minimum number of states necessary for a controller to control a system of a given number of states. The inputs into the system and their processing can also be seen as disturbances that intend to change the current state of the system governed by a regulator (Godsiff, 2010). The complexity perspective provides detailed knowledge about the systemic nature of variety by focusing on mathematical modelling of system state alternatives (Bar-Yam, 2004), but transforming variety into managerial models remains challenging (Maull and Godsiff, 2011). Variety is often simplified to cover only design solutions and request characteristics (Slack et al., 2007) and it is managed through balancing between the degree of customisation and the volume of production, which can be operationalised by using the volume-variety matrix (Slack et al., 2007; Silvestro, 1999).

As a process characteristic, variety sets processing demands at an individual stage of the process (input variety) or as in the time taken to perform the activities, also known as processing variety (Slack et al., 2007). The input variety or request characteristics are often referred to as variability, though they are not synonyms. In this study, the term variety covers design characteristics, input or request characteristics and output variety, as well as the connection to the service system states (systemic view). deRaadt (1989) has tested the requisite variety hypothesis, and on the basis of the results he states that a successful response to variety is not a binary value, it is a ratio. The responses and states of a system are not equal; there may be more or less important states and responses within them (ibid). Maull and Godsiff (2011, p.8) describe variety as "the nature and impact of (the many dimensions) of the disturbance, and the likely actions in response by the regulator that have variety (a number of different states)".

2.2 Managing variety in the service context

The participatory role of the customer changes the nature of variety (Frei, 2006; Godsiff, 2010) and adds new state concepts. Service delivery aims usually at changing the state of the customer through interactions and independent activities (Maglio et al., 2009). The customer may participate in the production process, and the customer may also be a part of the service output. Each input and transformation during each individual stage of the process changes the state of the system, and can also change the state of the resources (Godsiff, 2010). The active management of customer performance and related variety may require using scripts (Eichentopf et al., 2011). The more complex the service delivery or design is, the more necessary it is to have the customer activities well scripted and visualised in order to make them learnable (ibid.).

Frei (2006) introduces five input variety types (variability) that are tightly connected to the customer: arrival variability (*customers do not all want service at the same time or at convenient times*), request variability (*customers have different requests*), capability variability (*customers' own capabilities differ*), effort variability (*how much effort customers are willing to apply*), and subjective preference variability (*customers vary in their opinions about what it means to be treated well in a service environment*). Frei (ibid.) offers two managerial strategies for each category to deal with the variety: accommodating the realisation based on it, or reducing the variety. The first four variety categories are input types, but the last one includes knowledge accumulated from activities and observations which have taken place in the past (Golder et al., 2012).

The source of variety can also be found on the provider side. The more central and independent the role of an individual employee is, the higher is the service process variation (Schmenner, 2004). Godsiff (2010) emphasises that variety is caused naturally through interacting systems, and the interactions change the 'prevailing state' of the participating systems constantly. He also argues that most often it is the provider who causes the triggering of variety by making a value-proposition for the customer. In contrast to most studies, Buzacott and Mandelbaum (2008) emphasise the role of unknown unknowns in relation to variety and response creation. Unknown unknowns are the occurrence of events which can be foreseen as possible, but there is no history or experience that enables meaningful assessment of their probability (ibid.).

2.3 Process-level perspective on variety

Veldman and Alblas (2012) have identified a connection between variety and design definitions. They define process variety as the difference between the intended process design and process execution, and therefore the first step is to understand how process is defined in the service context. The service process can be defined as the sequence of realised customer activities or episodes (Lillrank, 2010) that form the actual value and service for the customer. While service is a process (Sampson, 2012) from the realisation perspective, it forms a hybrid combination of process and product structures from the design perspective. An individual customer episode is derived from the service design (process) but represents only one version of it. The configuration alternatives of customer episodes form the service design (product), which is equal to product design or architecture in the manufacturing field (Sanchez, 2000).

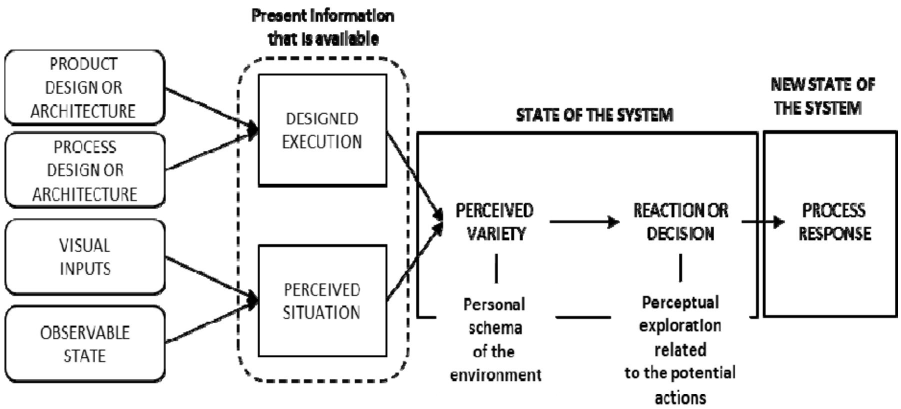
Service delivery processes and events are mobilised or launched through a mobilisation phase (Lillrank, 2010), where the customer input is received. The input can be a signal, scripted behaviour or negotiation, and it needs to be received, understood and acted on (ibid.). In addition to production events, the dynamic nature of service highlights the ability to connect episodes and transfer the correct information and materials from episode to episode (Frandsen, 2012), and to define or 'design' right process options while a customer or object is being processed (Buzacott, 2000). From the variety perspective, both designed and emergent mobilisation re present the interpretation of inputs and creation of an activity response based on it, in other words processing operational information.

The operational system must find a way of responding to each type of variety, and typically the focus is on eliminating as much as possible of the variety (Godsiff, 2010). The more information or system parameters are needed for describing the system state or state options (variety), the more the analysis begins to suffer from the curse of dimensionality (ibid.). Information is an input type that can be collected more than is likely to be used or known to be collected. However, developing innovative information technology (Azevedo and Ferreira, 2010) cannot be done without acknowledging the significance of information usage models, such as sharing information (Burch and Bellgran, 2012). In order to support more efficient information usage in the decision-making where both pre-set and situational information should be acknowledged, Plant and Stanton (2012) propose a perceptual cycle model for the analysis of decision-making. Their approach consists of three information types: present information that is available, personal schema of the environment, and perceptual exploration related to potential actions (ibid.).

2.4 Modular response framework

According to Sterman (2001), problems in any system are defined as the difference between the goals and observed situation in event-oriented contexts. When variety is considered as the problem, the comparison between the goals or expected actions (designs, architectures including both service process and service product structures) and what is perceived (i.e., observed, sensed) is here described as perceived variety. As a reaction to perceived variety (difference in system state) the decision-maker aims at reducing or amplifying variety by creating a process response which will change the state of the system. In Figure 1, the logic of the framework is illustrated as a combination of Sterman's (2001) event-oriented view of the world and the perceptual cycle model by Plant and Stanton (2012).

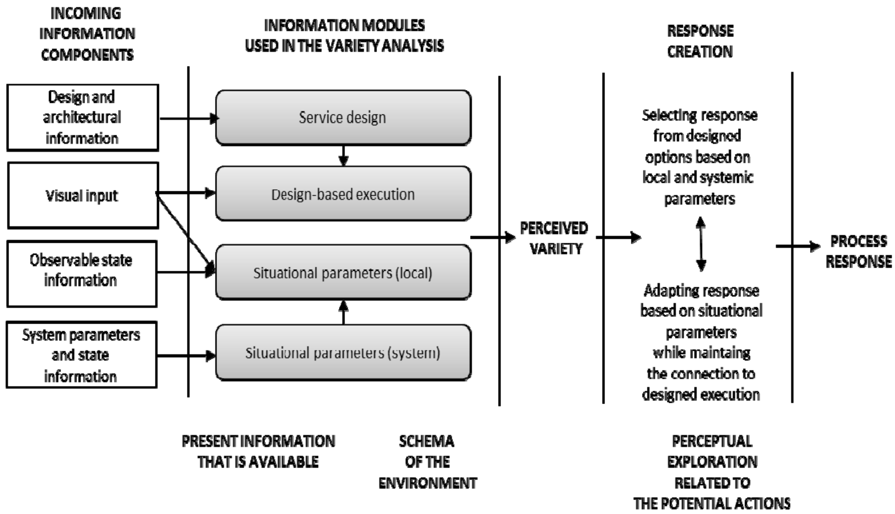
Figure 1 Event-oriented view of the variety-response situation



Langlois (2002) defines modularity as a set of design principles for managing complexity in large-scale interdependent systems. At the abstract level, modularity consists of breaking up the system into discrete chunks that communicate with each other through standardised interfaces or rules and specifications (ibid.). In this study, modularity refers to the separability and interchangeability (Schilling, 2000) of information components in the framework (e.g., design and situational information) when analysing and interpreting variety. In practice it means that information components with understandable interface to the event in question can be added or removed to provide right information for the decision-maker. In the existing service literature modularity covers approaches related to process modularity, product modularity and organisational modularity (Pekkarinen and Ulkuniemi, 2008), but this study extends the modularity approach to cover also service information creation and usage.

The conceptual framework, illustrated in Figure 2, follows the structure and logic of the event-oriented view of the variety-response situation illustrated in Figure 1.

Figure 2 A conceptual framework for variety analysis and response creation at the service process level

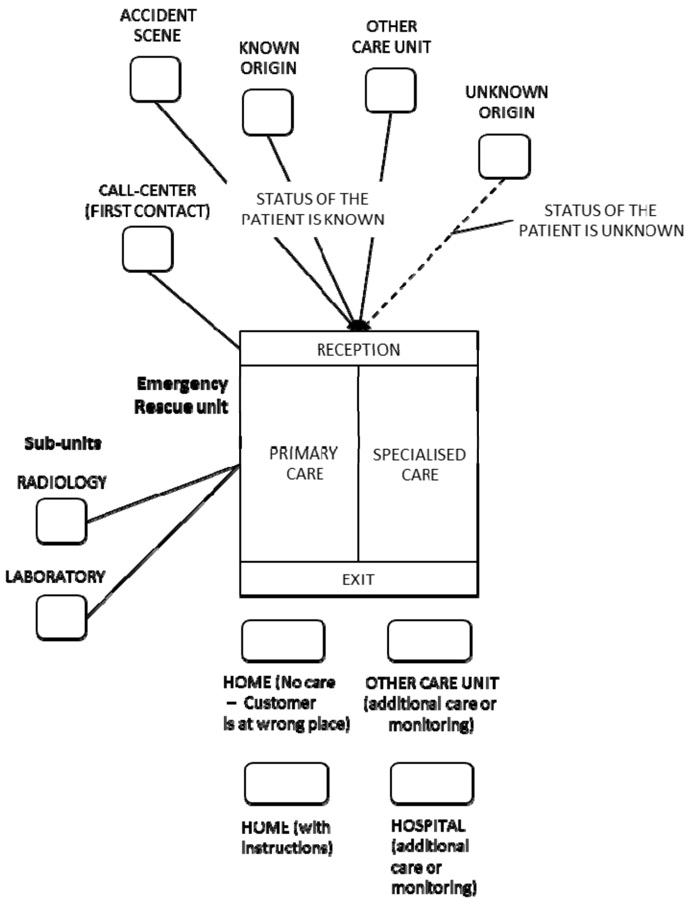


The modular structure consists of incoming information components such as system parameters and state information, the actual service process input and visual inputs, and design information. These components are used when information modules for the variety analysis are formed. The information modules share components and schema of the environment, but they fulfil the modular requirements as they can be used also independently. The information modules consist of a design module (designs, architectures and other guidelines), a design-based execution module, situational modules describing the service event where the process input such as a human, physical product or document is also transformed into information, and a situational module describing the state of the system where the service event is executed. The core idea is to use these information modules to select the right response from the design options and to adapt the response on the basis of the situational parameters while maintaining the connection to the designed execution.

3 Methodology and research design

The case study methodology was selected on the basis of the criteria and requirements set in the research question. Halinen and Törnroos (2005, p. 1286) suggest the case study strategy when "an intensive study of one or a small number of business networks, where multiple sources of evidence are used to develop a holistic description of the network and where the network refers to a set of companies (and potentially other organisations) are connected to each other for the purpose of doing business". In order to avoid some known limitations related to a single case study, such as poor basis for scientific generalisation (Yin, 2003), two different case systems were utilised.

Figure 3 Schematic structure of case system A



3.1 Case selection

- *Case system A* consists of an ER unit which provides acute care to patients 24 hours a day. The unit provides regular and specialised emergency care for approximately 130,000 inhabitants in a limited geographical area. In addition to the ER unit, the case system is extended to cover support service units that provide laboratory, radiological and call-centre services for the ER unit. The ER unit consists of four major entry paths to the service and four major exit paths from the service. An ER service including supportive units is an integration or combination of three resource types: people (service demanders and suppliers), processes (procedural processes and algorithmic processes) and products (physical and virtual). The system characteristics are similar to Complex Service Engineering systems where different types of processes occur simultaneously (Ng et al., 2011), and therefore also the responses are required to be systemic. The structure of case system A with selected extensions is illustrated in Figure 3.

- *Case system B* covers the actions of several ER units in a real scenario, which started when a 60 ton heavy truck loaded with paper rolls collided with a tourist bus carrying 36 passengers. The accident occurred in winter, at night time and in extremely slippery conditions causing additional requirements for the ER services to deal with several casualties and injured passengers while trying to activate the predesigned service system into the operational mode. The main focus in this study is on medical rescue activities, but also the rescue activities at the accident site are acknowledged as they influenced the medical rescue activities. In total, the dataset covers eight hours of the most encumbered decisions, communication and processes during the rescue activities. While the data focuses on activities that were executed during the ER scenario, the analysis also acknowledges the effects on the non-urgent service operations. In a normal situation the ER unit provides services for an area with 280,000 inhabitants.

3.2 Data collection and analysis

Abramsson et al. (2010) argue that though new information can be created through analysing past emergency cases and responses, the underlying values, the complexity of acting systems, the validity of information and the limiting conditions makes the task very difficult. The analysis phase of the present study focuses mainly on activities during the incident phase and recovery phase, but the contribution is aimed also at pre-incident phase operations (categorisation by Chen et al., 2008). The literature focusing on ER and response activities is rich but the service system perspective is less common.

In case system A, the data collection focused on acquiring as much knowledge as possible related to the operations as a part of the service system. Both qualitative and quantitative data were collected in three different phases. The first phase included 32 thematic interviews (questions in Appendix 1) with the service personnel in the ER unit, laboratory and radiology service units, between November 2010 and April 2011. The second phase included collecting mainly performance data and structural and process information about the information systems and communication technologies. Based on this data, an operational view was constructed and it was further compared with an internal view that the ER unit had created independently. The third main phase (phase 6) in the data collection was conducted a year later (November 2011–February 2012), in order to find out how many of the original observations were time-specific and how the service system had changed during a one-year period. Altogether 12 persons were interviewed in phase 6.

The data collection in case system B was based on an accident scene report by the Accident Investigation Board Finland (Investigation report A 1/ 2004 Y, 2005; see also Appendix 2). The report consists of three main parts,

1 actions and investigations

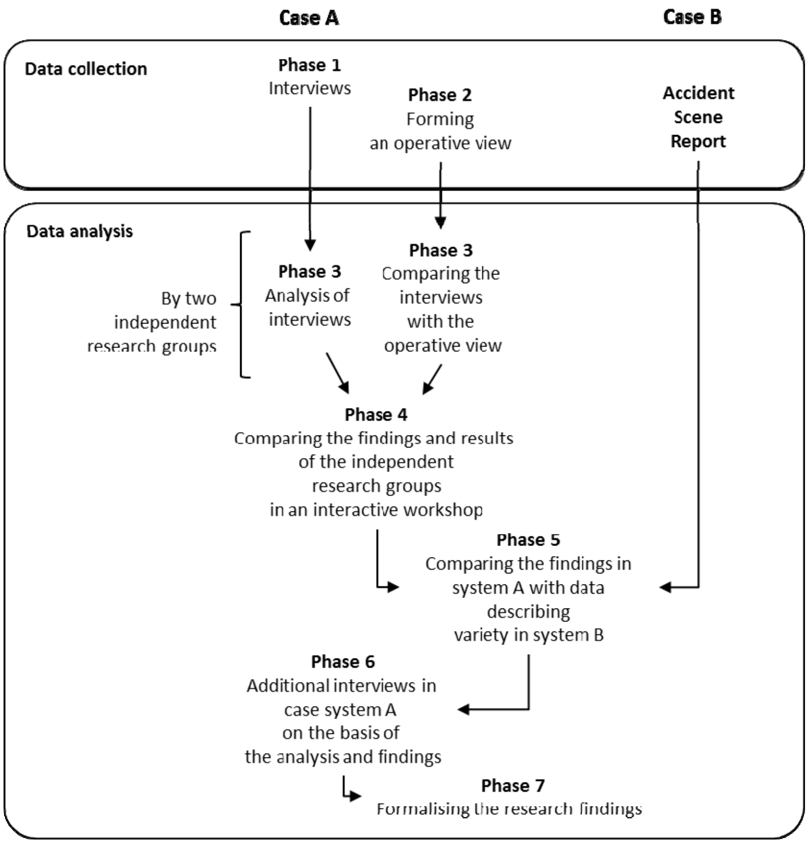
2 analysis

3 conclusions and suggestions.

Parts 1 and 2 and the suggestions for the ER system provided relevant information for this study. The data of case system B was considered as secondary data and it was used when the findings made in case system A were compared to responses in an emergency situation. Also some of the additional questions for intervention phase 3 in case system A were included on the basis of findings in the accident scene report in case system B. The accident scene report comprised altogether 147 pages, including also information that was not relevant from the selected perspective.

The schematic structure of research phases is illustrated in Figure 4.

Figure 4 Schematic illustration of the research phases related to data collection and analysis



4 Findings

The main findings are introduced below through four themes: identifying incoming information components, identifying and categorising response types, identifying response creation and identifying behavioural patterns that were observed during the analysis.

4.1 Incoming information components

It was observed that the incoming inputs causing variety may consist of a single input or multiple inputs. In case system A the inputs may include a human physically or not, the request may be familiar or not, the symptoms can be observable or not, the request arrival may be known in advance or not, the request may be urgent or not, and the request may be actual or false. All these categories have their own subcategories which can be presented as a tree structure, and they are usually transformed into information. Also the source that creates and sends the service request has a significant influence on its processing. If a doctor sends a patient from a hospital unit to the acute care unit, it will lead to different actions than when a common person enters the unit from the door.

The activities in case system B showed that false information, and especially expected and outdated information can cause variety in other parts of the service system. Also false activities and a chain of activities may accumulate the effects of variety (accumulated input). The seriousness of an injury or damage to a human being changes the patient status information, but as input there is no significant difference (even though the response would differ). Some of the inputs form a significant combination, such as the input flow rate of patients and their individual status information.

4.2 Response types in the case systems

Whereas inputs or disturbances can be categorised and harmonised as information inputs, the responses are a much more difficult and challenging category. In both case systems, the reactions for inputs varied a lot due to timing (night or day), the operational organisation on duty (work shifts), and the perceived urgency related to the service requests. The analysis also showed that the responses were less traceable than the inputs. In both cases when the service employees felt stressed they behaved in a manner which was not logical, designed for or desired in the specific activity.

In case system B the accident caused activation of an emergency situation design which focused mainly on creating a temporal organisation and managerial positions for the situation. The structural response made operations possible in the extensive accident situation. In a normal situation the organisational designs, operational processes and emergent activities are less formally known and they cannot be used when actual activities are compared with designed operations (case system A). Especially in the sub-system units, identifying the significance of the request and special characteristics related to the response were difficult to identify, and the responses were highly person-dependent.

4.3 Response creation

The ER unit operates as both a service provider and a customer. The researchers were able to map at least some relationships that were formed dynamically in operational situations. When these relationships existed in the hospital environment they were formed when needed. When relationships were formed with external actors, usually some types of agreements were used. However, an actor who had responsibility for managing these dynamic relationships or one having an operational view on the service system operations could not be identified or named. These relationships were partly traceable afterwards through accounting systems and the activity log, but clearly this information was not used in daily operations. The relationships were designed activities but they were activated based on person-dependent reasoning and mental models.

In a big and severe accident, all the participating rescue organisations have a clear plan for their own role and communication with the other actors. The plans include static checklists that are used once and based on which the operations should be executed. When the operations were managed at the accident scene, at the hospital, during patient and care personnel transportation and in other service systems, a significant part of the practical problems and mistakes took place in a system that covered more than one system part. For example information about the participants, their resources and their obtainable services were not fully available or used during the rescue activities. This information changed constantly, and an executed emergency design or plan could be outdated even before the scenario started.

4.4 Behavioural patterns in response creation

In case system A all service requests that can wait until the following morning and can be taken care of by regular care services are declined. The declined customers and customers who do not follow the call first-instruction can still enter and return later to the ER unit. Both the volumes of potential visits based on call-centre requests and potential returning customers (based on their behaviour history) could be traced, but the information was not used. The collected information was much richer than the information that was actually used in operational decision-making.

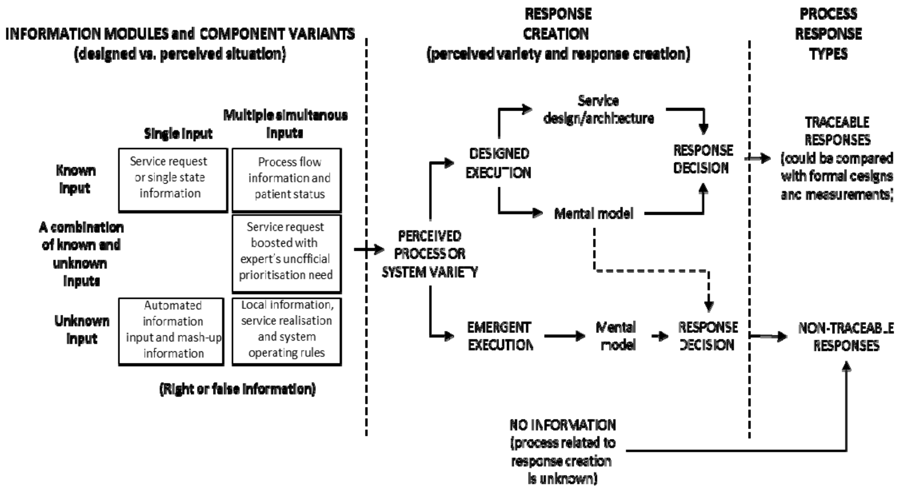
The data indicated that reactions or responses are sometimes created without any identifiable reason or due to false assumptions. In case system A, when a certain doctor requested a laboratory test, the system gave an unwritten priority to the request. Although the requests were made through the service order management system, an informal phone call to bioanalyst could change the way how things were done in the laboratory. In case system B the emergency-centre operator did not alarm all available helicopter units because of his personal estimate of the flight time to the accident scene. Interpretation of variety can be influenced through personal and contextual dimensions and unofficial communication interfaces.

Some of the responses were formed on the basis of visual observation only. In case system A, when a sick child is observed, the employees react on that observation without noticing that the mother of the child is even sicker. Or as in case system B, if a person could walk in the accident scene, the rescue personnel assumed that the person was not injured and reported him/her as not needing ambulance transportation. Observation-based responses seem to have two different characteristics – visual observation provides such a strong indication of relevant information that people do not question it, or the effects of reactions are not considered very significant.

The last category is formed by ‘no information’ responses. In the case of spotting process change, there is no clear indication where the change has happened or why, because the process is not traceable. In case system B this type of a situation was experienced when a less injured person was transported in a private car to the aerial health centre. Nobody could trace where this decision was made and who did it. This person was again rerouted to the main hospital by the aerial health centre personnel several hours after the accident. Reactions were performed but the decision-making context and the effects of the decisions on the rest of the system were not understood or acknowledged.

In Figure 5, the findings made in case systems A and B are organised to follow the structure of the framework illustrated in Figures 1 and 2.

Figure 5 Updated modular response framework based on the empirical findings made in case systems A and B



The findings and illustrating them as a decision-making process indicate that input that causes a change of state in a system can be a very complex structure consisting of a single input or a combination of multiple input components, a combination of known and unknown components (untraceable or not designed), and contain right or false information. A single input or multiple inputs are used also in the state interpretation resulting in the perceived variety. The findings also indicate that there are at least four different paths that can be implemented while making the response decision:

1 perceived variety is filtered through the designed execution and the response is adjusted based on designs (traceable)

2 perceived variety is filtered through the designed execution but the response is still created based on mental models or person-dependent reasoning (traceable)

3 same as path 2 but the response is non-traceable

4 perceived variety leads to emergent execution and the response is created through mental models or person-dependent reasoning (non-traceable).

5 Discussion

This section focuses on discussing the relevancy of the findings and comparing the obtained evidence with existing knowledge in the field of service operations management and service science. The section is divided into three sub-sections:

1 managing variety through responses at the operational level

2 improving process performance and responsiveness through modular responses

3 identifying distractions and process errors by utilising the modular response approach.

5.1 Managing variety through responses at the operational level

The ER system is a special type of a service system, but at the operational level it consists of inputs, reactions, outputs, and regulators or operators (Godsiff, 2010). Maull and Godsiff (2011) underline that in order to understand variety, the inputs should be analysed as systemic interactions. Previous studies have addressed the significance of responses when managing process level variety through managing relationships with other actors (Frei, 2006; Smith et al., 2012) or understanding the variety phenomenon through system artefacts and structures (Godsiff, 2010; Bar-Yam, 2004). These studies and results focus mainly on identifiable variety or variety that can be acknowledged in the design phase.

The results of the present study indicate that a lot more attention should be paid to the processing of formal and informal information during operations. Information processing refers to information-intensive actions that take place at the operational level during operations. They can be partly or fully automated or manual and human-centred. It seems that both computer systems and humans try to filter the most relevant information and neglect information that seems to be irrelevant, cannot be accessed or is unknown. Information processing follows a formula where information is added or deleted based on situational and personal preferences.

Automation does not necessarily improve the decision-making if the logic used in the processing is not right, or all relevant information sources are not utilised. A large part of the information about the activities is based on human interpretations and recording using structural components in computer-aided systems. While the idea is good, it may destroy the traceability of the variety-response, as the actual operational activity is recorded and transformed multiple times. The recorded activity might not describe the actual activity that was realised at all.

5.2 Improving service process performance and responsiveness through modular responses

The modularity of variety-related information requires further discussion. In the study, the design information in a regular situation did not contain formal designs or an operational model; it seemed to contain only mental model-based information instead. Also the situational information contained mainly filtered information based on a personal mental model. The mental model should here be understood as human-centric visions and ideas of how to realise a service activity. A real-time system state was not available for regular employees in the case systems while it was used by the rescue unit personnel and the police. This may have caused information asymmetry and additional variety in the operations. From the information perspective, modules could be found or defined, even if they did not include the ideal content. Connecting modular information together requires an interface which has to provide a link between locally meaningful information, personal mental models and systemic information.

Finding the right response option and making the selection based on available information follows the model of Stanton and Plant (2012). It links variety interpretation and response creation to service process performance. The use of information has a significant role as a time-consuming activity causing costs and constraints for operations. In the ER system the difference between the designed service, expected behaviour or execution and what actually happens is critical, and it sets additional requirements for the operational information. It is difficult to say why explicit designs have not gained success as a part of normal operations, though strict operational models can be found for several special scenarios. Embedding them into the information systems would connect the actual service delivery with the use of information and potentially increase the performance of the service process.

The most promising way of utilising the proposed framework is to use it in identifying process distractions and errors. As full traceability of activities can be utopian in several service delivery systems, we propose that a modular response structure could be used in defining what information components are missing. The modular response approach changes the relationship between information management and operations significantly, as it enables information tracking and response management from the service operations perspective, instead of applying only the information management view. In case system A, modular responses were transformed into computerised and graphical illustrations (Appendix 3) which followed the structure of the updated framework illustrated in Figure 5. The situations in the examples were created on the basis of interviews and operational data.

6 Conclusions

This paper has introduced an approach for managing variety at the service process level. In addition to existing knowledge related to service variety, the study contributes to the existing literature by combining operational information, the concept of system state, design inputs, and service execution. In contrast to computational models the proposed qualitative approach of modular response shows how operational information can be interconnected and utilised when constructing a process-level response. It is suggested that variety at the process level is a systemic phenomenon, and therefore also the response should utilise systemic information and structure even if the information is utilised in a single service event. A new insight was created through the idea of making the processing of operational information visible through a modular structure. It is further proposed that even though a service organisation would not need or utilise designs in normal routine activities, the modular response tool could be useful in analysing how the response is structured and what kind of modules are needed, and thus the number of false responses based on individual mental models could be decreased.

As a practical implication we suggest that decision-making should be made more transparent. Routine decisions can be executed without questioning the information quality or response requirement in detail. It is obviously not possible to do such an analysis in every single situation, but especially situations that consume lots of time, have severe and systemic influences or may cause significant costs should be highlighted. However, when single events are analysed at the operational level and if the structure of the response is redesigned, the response cannot be created independently from other relevant activities in the same system. Managers should also note that utilising information with system characteristics or so called 'mash-up' information does not make the response systemic. Instead, a systemic response acknowledges that an input is most often input for the next phase in the same service process and also input to several other events in the service system.

This study has some limitations that must be addressed. The first limitation concerns using the systemic view in the analysis when the actual analysis focuses on single decisions and events. The reductionist view on system properties may create a situation where relevant properties are not understood or accepted. Therefore the research methodology selection was focused on analysing existing case systems and not on designing new systems. The second limitation is the methodological construction. Although two case systems were used, this study was not a multiple case study as defined by Yin (2003). The roles of the case systems were clearly different and they were not fully comparable. However, they were considered to be suitable when studying variety-response properties in different types of systems. Although case system B was analysed from a written report, it should be underlined that the data used as the basis of case system B was much richer than the data available in case system A.

Based on the results and discussions, two further research themes can be identified. The first theme focuses on gaining more insight into and evidence about systemic properties from the service operations perspective. Researchers should focus more on system state information as an important part of service operations management and also on models that make this information available without unnecessary complexity. The second theme covers the relationships between technology, technological solutions and service operations management. We argue that certain outdated obstacles have to be removed in order to restore the operations management skills in the current service context, environments and ecologies.

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Notes

The analysis of case system B was based on

1 Investigation Report A 1/2004 Y. (2005) 'A head-on collision involving a heavy vehicle combination and a charter coach on highway 4 at Konginkang as near the town of Äänekoski, Finland on 19.3.2004' [online] http://www.turvallisuustutkinta.fi (accessed 14 February 2013), ISBN 951-836-164-9 (in Finnish, English summary is available).

2 Abridged translation of the original Finnish report ISBN 951-836-176-2 [online] http://www.turvallisuustutkinta.fi.

Appendix 1

Structure of the thematic interview (subthemes included)

Theme 1 *Personal, team and unit capabilities in daily activities*

- Interviewee's own role and relationship to other resources, problematic issues faced in everyday activity, popular and unpopular tasks, and development of skills and capabilities.

Theme 2 *Work system, organisation of work and working procedures*

- Work system management, organisational culture, official procedures versus unofficial procedures, and the main focus and objectives of daily activities.

Theme 3 *Who is the customer and what does the customer have to do with the service?*

- Official and unofficial customers, customer's influence on daily routines, customer feedback and relationship with the customer.

Theme 4 *Decision-making as a part of daily activities*

- Interviewee's own decision-making situations and experiences, other powerful decision-makers within the organisation, official and unofficial decision-making chains and learning from earlier decisions – possible or not?

Theme 5 *Manual and automated information systems*

- Information systems that are utilised, the role of information systems in daily activities, and if the interviewee designed an information system – what would it look like?

Theme 6 *Communication as part of daily activities*

- Internal communication procedures, external communication procedures, and informal and emergent procedures.

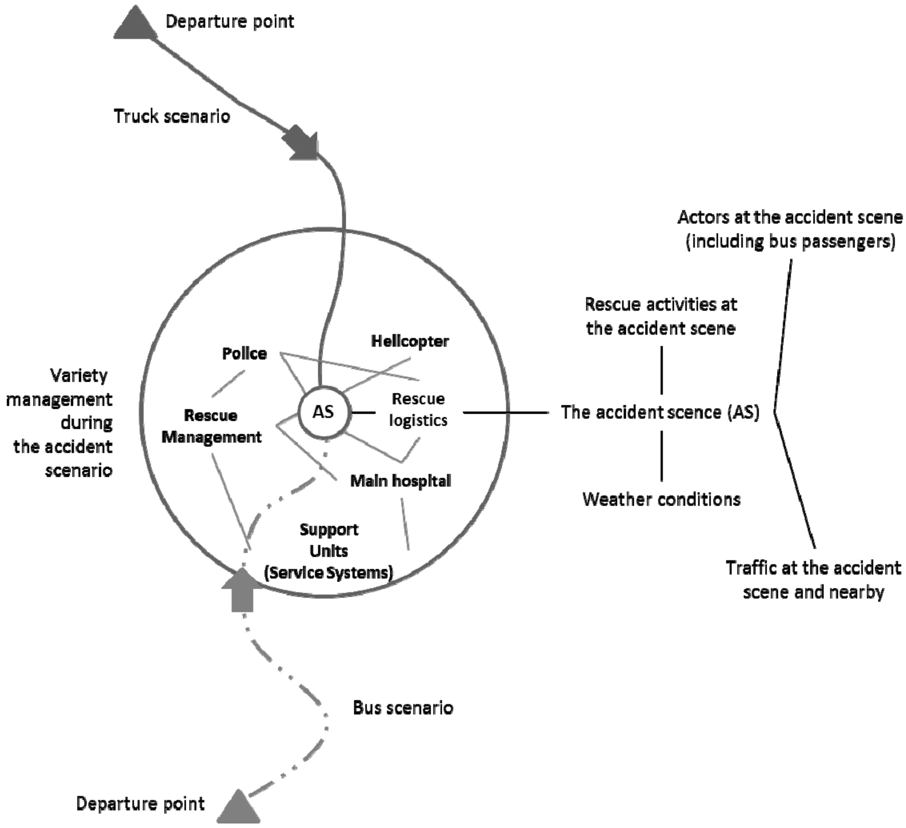
Theme 7 *The future (personal, team and unit perspectives)*

- Objectives, challenges, personal ambitions, personal vision – in the next 5-, 10- and 30-year perspective.

Appendix 2

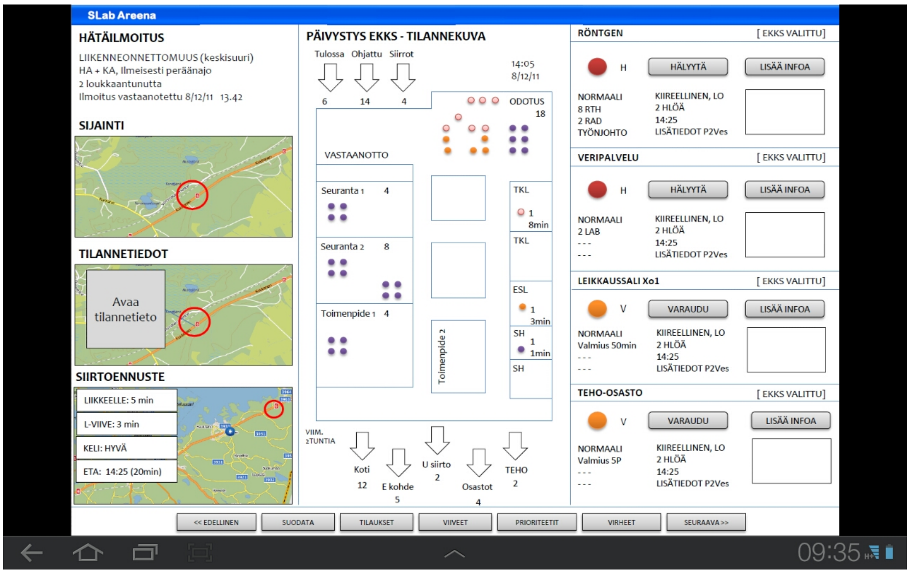
Schematic structure of case system B and the relevant actors and activities from the variety management perspective.

The activities preceding the accident were excluded from the analysis of variety.



Appendix 3

An example of a modular response provided for the employees in case system A (a screen capture from a tablet computer used in the phase 6) (see online version for colours).



Applied scenario: traffic accident involving a car and a truck, three injured patients

1 Content on the left side:
   - emergency announcement
   - situational information provided by the rescue team at the accident scene
   - estimated transportation time from the accident scene to the ER unit.

2 Content in the middle:
   - structure and information components based on service design
   - ER unit patient flows (internal), room utilisation, patient waiting times
   - incoming flow of patients (known but not yet arrived)
   - outgoing flow of patients (destinations).

3 Content on the right side:
   - the status of the sub-units/supportive units including graphical ‘traffic lights’ indicating the ability to receive new patients.

PUBLICATION 5 (accepted with minor revisions, in review process)

Karppinen, H., Huiskonen, J. and Seppänen, K. XXXX. Resource integration and production approach for managing a service-technology interface in service systems, *International Journal of Qualitative Research in Services*, Vol. X, No. X, pp. xxx-xxx.

RESOURCE INTEGRATION AND PRODUCTION APPROACH FOR MANAGING A SERVICE-TECHNOLOGY INTERFACE IN SERVICE SYSTEMS

ABSTRACT

Service is about integrating resources in a way that the integrator is able to create value for her/himself. In order to support value creation, the service provider has to produce value creation potential for the customer, and transform and communicate service logic into practical processes. In this study, the focus is on an understudied area in the service research, where the information perspective aims at connecting technology to abstract service design models from the service managers' and providers' perspective. Design science methodology and constructing a design artefact offer an approach for creating flexible and innovative service management solutions through advanced service information. The artefact was tested and demonstrated in two service systems in health care and transportation contexts. The results showed that resource management related information processing have a significant role in the service context, where multiple perspectives with artificial, real design, and realization elements should be managed simultaneously.

Keywords: service operations management, service system, resource production, resource integration, service information, technology, value creation, service-technology interface

1 INTRODUCTION

Technological solutions, as well as many other industrial applications today are designed to provide value in the context where they are applied (Edvardsson et al., 2011). The more the digital society becomes dependent on information and instant accessibility of services, the less service users and managers tend to understand or question how these solutions actually work. Reducing and viewing the role of technology only as static resource does not provide an acceptable basis for flexible service operations and developing sustainable business. Connecting technology with value-creation models and viewing it as a value facilitator in user-, usage- and context-specific situations has been suggested as a solution (Grönroos and Voima, 2013), but an understandable link to service management is often missed. van Riel and Lievens (2004) define this type of competence as the interface between service and technology which describes the decision-makers' non-technical insight in relevant technological developments, and the interface between the new service and technology.

Service involves at least two actor entities, one focusing on applying competence, and the other on integrating the applied competences with other resources (value-creation) and determining the value (Maglio et al., 2009). Alter (2013) defines service activities as the use of one or more resources, producing one or more products/services and using these products/services as resources for subsequent activities. Technology is often central to the resource integration process, and the role of people interacting with technology is therefore a key issue within service system research (Maglio and Spohrer, 2008). Alter (2013) argues that the literature related to service science tends to treat resources in a general and nonspecific manner. From the perspective of service-dominant logic, technology represents an operand resource in a service system. An operand resource is usually a physical element which does not create a fundamental source of competitor advantage like operant resources such as competence, knowledge and skill resources do (Vargo and Lusch, 2008). However, the categorization of resources into operand and operant may create unintended constraints for the innovative integration of technology and usage in a service system.

Kleinaltenkamp et al. (2012) state that there is much to learn about the practices of integrating resources and how to design and configure the integration process by arguing that technology could also be an operand resource in certain circumstances. Akaka and Vargo (2013) make a similar proposition by extending the scope of technology beyond the output of human action and by defining it as a collection of practices, processes and symbols. However, they select the service ecosystem perspective where the abstractness of the resource view is high and it is not decomposable into operational requirements. Vargo and Lusch (2011, p. 5) raise an additional challenge related to a too narrow view on resource integration: "as much as the idea of resource networks contribute to the understanding of value creation and context, its consideration sometimes lacks a critical characteristic of systems, which are dynamic and potentially self-adjusting and thus simultaneously functioning and reconfiguring themselves."

Managing the multiple roles of technology in service operations requires information where the service logic and service perspective are acknowledged. This type of information would support the flexibility and end-to-end traceability of service operations but also connect technological solutions into value-creation models and performance in a service system. In order to form this type of connection, the main objective of this study is to extend the service-technology interface -related knowledge to cover also resource integration and production activities as a part of service operations, and therefore we have set the following research question:

What kind of information can be extracted from the service-technology interface and how can it be used to support more flexible service operations?

Developing a qualitative tool for revealing and designing the role of technology through information was considered as the most beneficial solution. The tool was field-tested in two service systems: in a health care system and a transportation system. The rest of the study is organized as follows: the next section introduces the research design. The third section focuses on the theoretical background; the fourth section explains the design tool construction phase, and the fifth section the empirical testing and evaluation of the tool. The sixth section focuses on discussing the results and concluding the contribution, as well as presenting limitations of the study and further research interests.

2 RESEARCH DESIGN

The main purpose of the research design is "to describe plans and procedures for research that span the decisions from broad assumptions to detailed methods of data collection and analysis" (Creswell, 2009, p. 3). A service system context consists of a combination of real and virtual artefacts having static and dynamic characteristics. The selected methodology, design science, includes a pre-set requirement for designing artefact, testing it and evaluating the results while maintaining practical relevancy throughout the process. The design science method was supplemented by case study methodology, which is often used in the early exploration phase of the research (Yin 2003) and in contexts where problem solving is a dominant phenomenon, such as operations management (Voss et al., 2002). The design science approach has been previously utilized successfully in information system science studies (Hevner, 2007), and also in business and management studies (van Aken, 2004).

2.1 Design science and case study methodologies and the research process

In terms of the validity and rigorous content of the study, a research process defined by Peffers et al. (2008) was followed. The research process called the design science research methodology (DSRM) provides steps and strict guidelines for developing the design artefact and testing it. The rigorous approach requirements (Hevner et al., 2004) are fulfilled when the study is grounded on existing knowledge, executed and documented based on existing research method protocols and the final output, the design artefact, is tested and evaluated in two different contexts. Design science aims at constructing innovative artefacts that change the target phenomenon instead of just describing it (Hevner et al., 2004). In this context the phenomenon is the activity related to the resource production and integration of resources, and connection to more abstract value creation models and service logic.

Constructing design and information artefacts requires also access to relevant practical problems and data. Halinen and Törnroos (2005, p. 1286) suggest case study strategy when "an intensive study of one or a small number of business networks, where multiple sources of evidence are used to develop a holistic description of the network and where the network refers to a set of companies (and potentially other organisations) are connected to each other for the purpose of doing business". Though the main focus is in the construction of the design artefact, accessing and collecting data for pre-understanding, as well as the evaluation of the results require also a well-known methodological base, such as a case study. The selected DSRM process with the support of the case study method includes the steps presented in table 1.

Table 1. The research process phases and content, based on Peffers et al. (2008)

Research phase:	**Content:**	**Covered in section:**
Problem identification and motivation	Defining specific research question(s) and setting goals for the value of the solution	- Introduction section - Theoretical background sections
Defining the objectives for a solution	Defining objectives using either or both quantitative and qualitative measures, a direct connection to problem specification is required.	- Introduction section - Theoretical background sections
Design and development of the artefact	Creating the design artefact based on problem definition and objectives (may also include new properties of existing resources)	- Constructing the design artefact -section - Demonstration section
Demonstration	Use of the artefact to solve one or more relevant instances of the problem.	- Constructing the design artefact -section - Demonstration section
Evaluation	Evaluating the artefact and the problem solving capability through observations, measurements and interviews.	- Evaluation section - Discussion section
Communication	The problem and the artefact are discussed, the novelty and rigor of the design evaluated, and comparison to existing knowledge explained.	- Evaluation section - Discussion section

3 THEORETICAL BACKGROUND

Alter (2013) states that most of the resources in the service context are understood as static components. When it is assumed that the resource configurations or the way they are integrated form the key constructions in value creation (Edvardsson et al., 2011), then it can be proposed that the points where the resources are configured, as well as the relevant configuration processes should be identified and understood more extensively. Grönroos and Voima (2013, p. 138) define a service logic -based view on resources in the service context as follows: "a service provider may facilitate the customer's value creation by producing and delivering resources and processes that represent potential value or expected value-in-use for the customer".

The traditional view of managing or controlling technology in the service context focuses on the internal production system and the external customer. Arthur (2009) proposes a more active role for technology by including also the practices and processes by which new forms of value and solutions can be created. Bitner et al. (2010) has analysed how technology enables solutions by presenting four configuration options: enterprise-level strategies and perceptions, service design solutions, service delivery solutions, and service experiences. These arguments indicate that technology cannot be considered as static resources, but instead the focus should be on how these new role alternatives can be actually realized. In order to reveal the operational elements of value configurations as well as the role of technology, this section focuses on the following aspects:

1) The role of technology in service design and service innovation (strategy and design)
2) Characteristics of technology usage (delivery)
3) The role of technology in value creation (delivery and experience).

3.1 The role of technology in service design and service innovation

The main purpose of service design is to transform innovative ideas and strategy into life (Ostrom et al., 2010) through service delivery to the customer (Roth and Menor, 2003). Technology and equipment, as well as integrating technology in the service delivery are included in the design choices which should support the realization of the service concepts and which may additionally require different approaches to the design of service delivery systems (Ponsignon et al., 2011). Bitner et al. (2010) consider technology integration as a method for aiding service performance, a solution for customers to add value to their service experience, and also as an opportunity to define the customers' roles more clearly. Ponsignon et al. (2011) propose technology as a method for standardizing service delivery systems, and therefore service organizations should involve technology and automation based on the service concept definitions (ibid). If the concept includes a significant role of experience, the provider should focus on creating the prerequisites that enable customers to have the desired experiences with or without technology (Zomerdijk and Voss, 2010).

Technology enables offering new service delivery channels and options, and affects the new service concept and the ways of interacting with the service provider (Patricio et al., 2011). Campbell et al. (2011) state that the service designer should identify the possible uses of technology that can facilitate boundary shifting between self-service (customer does the most) and super-service (provider does the most) to increase value for both the provider and the customer. Brady and Fellenz (2007) argue that although information technology could have a significant role in service operation improvement and as a source of innovation, it has merely furthered efficiency-oriented automation in service supply chains.

3.2 Characteristics of technology usage and self-service technology

Orlikowski (1992) states that humans recognize interaction with technology as having two iterative modes: the design mode and the use mode. It is both the medium and the end result. Whereas the design or innovation approaches do not consider the actual implementation as important as the conceptual role, information technology, psychology and sociology provide a wide offering of models and methods for analysing and understanding the usage section (Venkatesh et al., 2003). Holden and Karsh (2010) reviewed five of the most often cited methods related to technology acceptance and found 14 variables that have an effect on technology acceptance: behaviour, use, behavioural intention, attitude, perceived ease of use, perceived usefulness, subjective norm, perceived behavioural control, effort expectancy, performance expectancy, social influence, facilitating conditions, real or perceived characteristics (image, job relevance, output quality, results demonstrability) and beliefs (behavioural, normative, control). Venkatesh and Davis (2000, p. 199) also point out that “in addition to designing systems to better match job-relevant needs, improving the quality of their output and making them easier to use, may provide important leverage for increasing user acceptance”. Another evaluation criteria, fit between task and technology, consists of task characteristics, individual characteristics and information systems/services (or other technology), which can be evaluated by the user as the task-technology fit (Goodhue, 1998).

The service literature provides most of the technology usage -related evidence for self-service technology contexts. Self-service technology (SST) is used to provide a greater choice of how and when to receive a service for a customer (Kokkinou and Cranage, 2013). “The addition of an SST alternative to the existing service delivery process can transform even the simplest system into a complex one with conditional logic and interactions” (ibid., p.435). Lin and Chang (2011) found that technology readiness influences the perceived usefulness, perceived ease of use, and the attitude toward using SSTs, as well as behavioural intentions. It causes an additional requirement for the service provider to identify their customers' varying levels of technology readiness (ibid.). The challenge is relevant also for the employees. It is essential that managers understand how to shape the employees' perceptions of technology (Fleming and Artis, 2013).

3.3 Producing resources for value-creation potential

Grönroos and Voima (2013) explain the difference between value facilitation activities (provider's sphere) and value creation through use activities (customer's sphere). In their model the provider's sphere activities include the production of value creation potential, and the role of the service provider is to facilitate the value creation. The customers do not necessarily have a role in the provider's sphere, and the customer's sphere consists of independent value creation through integration of resources. Only in the joint sphere the customer invites the provider to participate in the value creation process, and co-creation may take place. Value creation potential includes outputs from the provider's production process (Grönroos and Voima, 2013). Hibbert et al. (2012) describe the effectiveness of customer resource integration as the customers' proficiency in deploying resources when they are engaged in value-generating processes.

As configurations, there are at least two major roles that a service resource may possess:

1) **Production output:** A resource that is a result or output from a production process intended to provide value creation potential (potentially integrated by the customer).
2) **Integration input:** A resource that is a result or output from the production process and is integrated by subsequent phases of the service delivery process. The end user may not use or even know the original resources if the final resource for value creation is in another form.

Akaka and Vargo (2013) consider production and integration as new sources of innovation, but here they are considered as a challenge for service operations management. According to Grönroos and Voima (2013) these perspectives cannot be used simultaneously to cover value creation as a phenomenon, but we propose that it is possible to use both approaches when trying to identify and explain resource integration and production in the operations management context. Each resource integration activity is a production process. Integration indicates that there is a process that starts from individual resources and ends in integrated resources. The provider cannot know how the customer integrates the resources and whether the customer provides a new resource for some purposes through integration (figure 1).

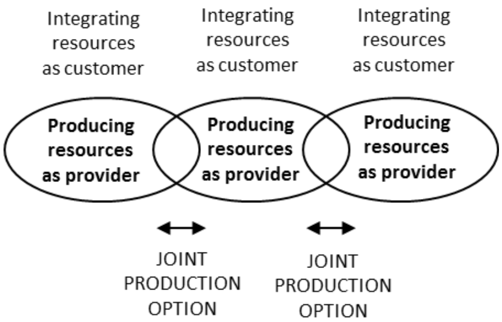


Figure 1. Resource integration when a customer is proposed to lead the producing of resources as a provider.

4 CONSTRUCTING THE DESIGN ARTEFACT

Whereas Akaka and Vargo (2013) focus on redefining the role of technology from the ecosystem perspective, the opposite view is taken in this study. The operations management perspective emphasizes the applicability of design solutions. A brief review of the relevant theoretical background showed that in addition to design and usage (Arthur, 2009), the roles of resources are changed by the value creation or service logic. The traditional way of defining service operations focuses on transformative processes where inputs, including also the customer or customer's object as input (Sampson, 2012), are transformed into outputs (Slack et al., 2007). Even if the level of analysis is lowered into the process or even to the task level, the activity remains mostly as a black box (Lillrank et al., 2011). Connecting service activities as black boxes to service resources does not provide enough valuable information for the needs of service management.

The reason for selecting the information perspective was the information nature of design, usage and value creation:

- **Design** solutions and designs are information. In general design information is created in two contexts: 1) when something new is created and 2) when design information is being reused (Zhanjun and Karthik, 2007). Design information is produced (new) and integrated (reused) based on the value creation model.

- **Usage** is action but only valuable for service operations management if it can be measured, recorded or observed as information. However, designed usage and actual usage should not be mixed. Transforming usage to information may improve the ability to deal with uncertainties, adapt the process based on exceptions, and evolve processes (Reichert et al., 2009).

- **Value creation logic or service logic** is design information if it is described or expressed in a format that is expected to be used somewhere. Value creation or service logic does not have to be expressed clearly or described at all since it is realized through possession, usage, or mental states and therefore transforming the actual value creation as information can be very difficult (Grönroos and Voima, 2013).

In the construction of the design artefact, the technology perspective as a specific resource type is bypassed for a moment. The focus is directed to two main issues: 1) analysing resource integration and resource production as activities, and 2) considering resources as resource integrators or resource producers.

4.1 Content of the design artefact

Integrating resources is an activity where specified resources are integrated together. In addition to creating something new, Akaka and Vargo (2013) state that also new contexts are created each time resources are combined or integrated. The existing abstract definitions are unable to explain the integration process, whether the resources change, and if not, what the integration means in practice. For example integrating information or capabilities is different from integrating two physical materials. Integration may involve using a pre-defined script (known inputs, integration, production and outputs).

Producing resources usually refers to changing something and that the results (resources) have already a pre-defined target and functionalities. Otherwise integrating resources and producing new resources will create resource inventories. In a service system integration and production may also be emergent activities without a pre-specified or controllable end result. Based on the nature of production and integration activities, the design artefact should support identifying the following characteristics: integration type and nature (including emergency), integration scriptability, utilization of input resources, resource production type and connectivity, customer/user of the produced resource, and characteristics and ownership of the produced resource.

During operations, some of the resources take the role of an integrator and producer and execute relevant interventions. In design artefact, integration visibility is used to describe how well the integration and interventions are actually visible in the service context. In a similar way, production visibility can be used to describe the visibility of resource production. In addition to physical visibility, these terms describe also the observer’s capabilities to understand the integration or production. Visibility is not a single value: visibility can be adjusted or it may change due to contextual factors. Based on technology acceptance and readiness models, it may also be user-dependent or if not acknowledged at all, also set on the basis of interpretations.

From the process perspective, the design artefact covers incoming resources for integration, resource integration described as integration logic, resource production described as a production process and outgoing resources for the next integration phase. Both the input sector and the output sector can be easily extended to cover previous and proceeding phases in the service delivery. The idea is similar to the one utilized in the process chain model by Sampson (2012). In the artefact, the resource integration and resource production describe the same phase simultaneously but they are considered conceptually as different issues. Presenting only one of them or presenting them as chronological steps could additionally hide some relevant elements or aspects. The potential resource inventories are covered in both the incoming sector and the outgoing sectors. The artefact aims at covering also the environment or context where the integration takes place, but the context is the integration and production context, not the service context. Increasing the understanding of the difference between the integration/production context and the context where service is expected to be delivered is proposed to be important in service management. The general structure of the design artefact is illustrated in figure 2.

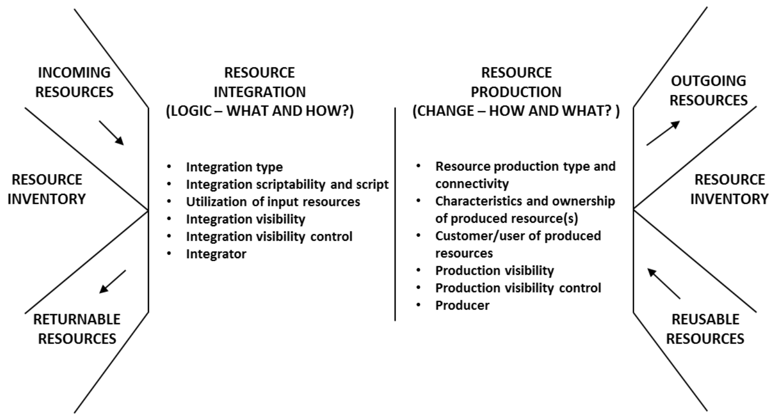


Figure 2. The design artefact for resource integration and resource production

5 EVALUATION OF THE DESIGN ARTEFACT

Based on the methodological principles set in design science, the design artefact requires a test and evaluation. Both the theoretical and practical need is to improve understanding and create improved solutions based on information received through the usage of the design artefact. The test section is divided into three main sub-sections: presentation of the empirical test contexts, the test procedure, and evaluation of the results.

5.1 Empirical test contexts

The empirical test contexts were selected on the basis of their service characteristics and high technology and information dependency throughout the service delivery. In test context 1 the customers were regular citizens and external from the service system perspective, whereas in test context 2 the customers were mainly doctors and nurses and internal from the service system perspective. Both contexts are briefly described below:

Test context 1 – Personal transportation system: organizing and providing transportation services for special groups on the basis of social and disability reasons. From the service perspective the most significant customer group are the end users whose travel needs are fulfilled. The whole system provides journeys 24 h/day for 1100 customers (about 25-30000 journeys annually). The end users were considered both as resource integrators and resource producers throughout the test procedure. The core functionalities and technological solutions consisted of 1) transforming the travel need into a transportation request, 2) organizing transportation network based on simultaneous requests and limited resources, and 3) managing transportation unit -based service network information.

Test context 2 - Diagnostic service centre: providing radiology and laboratory services for a regional hospital and health care district as an independent organizational unit. From the service perspective the most significant customer group are doctors who order laboratory tests and radiological tests and operations from the service unit. The unit produces approximately 1 100 000 tests and analyses annually. The patients as end-users were treated as a resource group throughout the test procedure. The core technological solutions consisted of 1) transforming material into a specimen, 2) transforming the specimen into data, 3) transforming data through analysis into result information, and 4) managing the supply chain of work-in-process and result information.

5.2 Test procedure and data collection for creating pre-understanding of operations in the test environment and for artefact evaluation

The test procedure consisted of four main phases based on the design artefact elements: 1) identifying the technology-centred events, 2) identifying incoming and outgoing resources, 3) clarifying the resource integrations and resource productions as processes or changes, and 4) generating and testing visualized descriptions where integration and production activities were presented as component and connection maps (CC-maps) without contextual elements and as integration context charts (IC-charts) with contextual elements for the test environment representatives.

Four main data sources were used in the identification of events where technology played a significant role. The first dataset (primary) was formed based on service walk-through analysis by two researchers, the second one based on information and production system descriptions, and the third dataset (secondary) by interviews. Altogether 34 thematic interviews (11 in context 1 and 23 in context 2) were conducted, in which daily routines and activities describing the service delivery were collected (appendix 1). The length of the interviews varied between 30 minutes and two hours and they were audio-recorded and further transcribed for the evaluation phase.

CC-maps were formed on the basis of the service walkthroughs and refined maps on the basis of the interview results. Tracking incoming and outgoing resources were done partly using datasets 1 and 3, and also by using information system descriptions and process charts if they were available (dataset 2). The fourth dataset was formed on the basis of evaluative interviews in order to get feedback from the service employees in the test contexts. These thematic interviews (appendix 2) were conducted during the year 2011, and in total 9 employees participated in context 1 and 13 employees in context 2. The complete test and evaluation procedure is illustrated in figure 3.

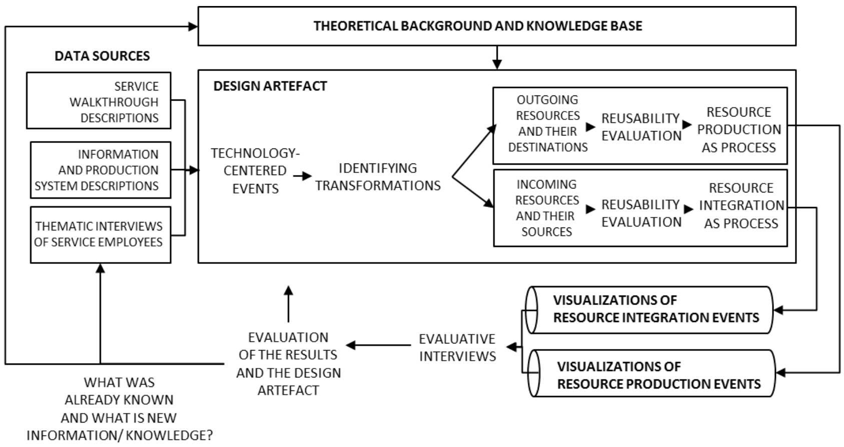


Figure 3. The complete process for testing and evaluating the design artefact

5.3 Evaluating the design artefact

The main objective in the evaluation part was to find out if the role of technology can and should be redesigned in the service delivery system. Both the applicability of the design artefact and the contextual variables based on the responses received from the service employees were identified. New information and insight gained through the design artefact was compared with the original role of technology in the service delivery system and the employees' responses. All datasets from both test contexts were utilized during the evaluation.

Evaluation criteria 1: Revealing the original purpose and functionalities.
The component charts visualized events where technology was used in an observable environment. The component charts showed also how technological and non-technological events were connected to each other. From the employee perspective, these events were easier to understand as they were connectable to visual objects such as computers and machines. The employees described the connections as “*changes, makes, tests, analyses, stores and creates*", indicating how they were utilized in the work system. Understanding the work system functionalities did not necessarily mean understanding the technical logic or information processing logic. By observing the work system, the artefact can be used to reveal information flows, but without technical system descriptions these

flows represent only the relevant or most often used information in the work system.

Evaluation criteria 2: Identifying the difference between resource integration and production.

Identifying incoming resources was divided into two subgroups: inputs that are actually input into the technical system and inputs that are used or should be used but are never input in the technological system. The inputs in the first subgroup can be identified through using technical system descriptions, as the technological system cannot receive and handle inputs that are in the wrong format. The second subcategory includes such inputs as procedures, skills, rules and norms which are well identifiable in cases where the work process can be traced and less identifiable where traceability is poor. From resource production, three resource categories were identified: directly traceable outputs, indirect outputs (for example learning) and information that is collected by the technical system and used by the technical system (log information). Additionally, resource integration may involve such a resource as information that is used but not changed.

Evaluation criteria 3: The role of technology in the service delivery system. Technological solutions can be categorized on the basis of event-dependency. In the laboratory context (context 2), an analyser can only be used in analysing samples and creating information based on the analysis, whereas the time management system or other office solutions can be connected with multiple service events. The event-focused analysis of technology shows that the service function of technology and the role in the service supply chain is much more difficult to identify. The design artefact test process emphasized this link, as adding or removing technological components requires also service supply chain and logic knowledge. From the service employee's perspective, identifying the service role was new information, but the connection between the roles of technology and service was considered less relevant.

Evaluation criteria 4: New information/insight that viewing technology as a service system produces.

The test procedure confirmed that describing a technology resource as a service system limits the knowledge creation to a single event. In order to have a more comprehensive view, the artefact itself has to be modified. When the original design artefact aims at explaining how technology-related resource integration and production takes place, the test and evaluation phases show that the artefact should include two different levels. The lower level artefact can be used to explain how technology resources are used in the service delivery. The higher level abstraction is used to explain how the technology resource is connected to the work system event. Finally, these two elements can be connected to a service supply chain description or service logic describing how the service is actually delivered. This multilevel construction can also be used as link to resource integration and production activities together, while maintaining the link to the service logic. However, the testing phase showed that this kind of information requires a computer-aided presentation, as the multidimensional content cannot be presented with two-dimensional techniques. The updated design artefact is illustrated in figure 4.

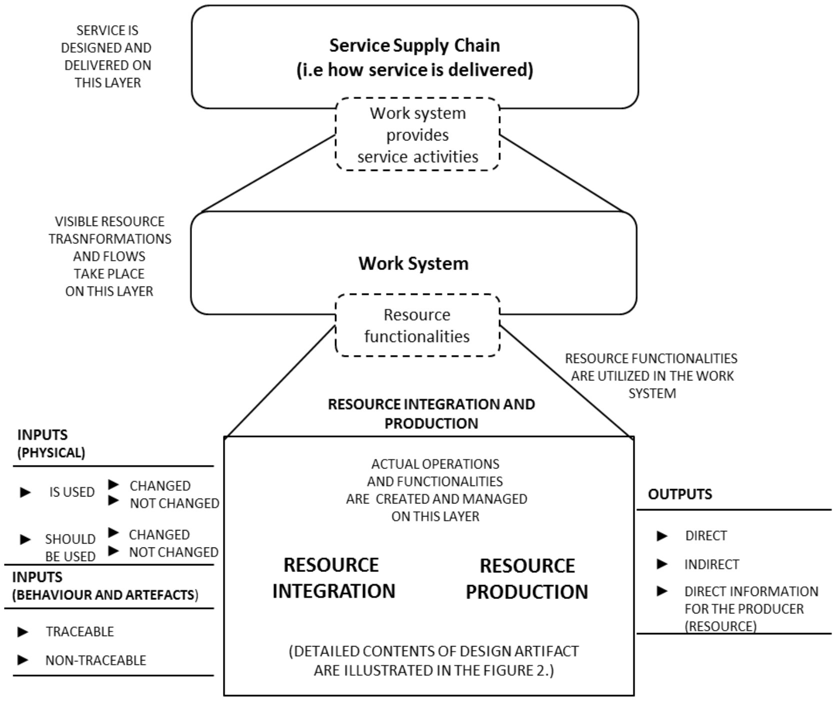


Figure 4. The revised inputs for the design artefact based on the test and evaluation phases.

6 DISCUSSION AND CONCLUSIONS

This section focuses on summarizing the design process and results related to the design artefact. The first subsection aims at explaining why considering a technology resource as a service system opens several new opportunities for managing resources in the service context. The second subsection describes the main contribution of the study, the practical implications, as well as the limitations of the study and future research topics.

6.1 Summary and discussion of the results

The developed artefact enables tracing and revealing how technology-related resources work. Compared with the traditional process model which includes inputs, outputs and process, the design artefact divides the process into two categories: processing incoming resources and processing outgoing resources. The evaluation phase revealed that resource integration is a much richer event than explained in service research. The artefact demonstrates how integration can be described without adding too much complexity. According to the results, technology resources may also cause additional inventories through integration and production, which can be both physical and virtual.

Redesigning or viewing technology as a resource and describing it as a service system adds new understanding and insight locally, but is unable to create an understandable link to the service logic and work system. As suggested in the evaluation phase, the design artefact should include at least two additional layers. The more detailed layer transforms resources into resource integrators and resource producers creating local insight. It enables identifying integrated resources and resources which are produced as results. The two more abstract layers create new knowledge which cannot be observed directly from the resources but which can be created through service information. This type of architectural knowledge (Baldwin, 2010; Kruchten et al., 2006) is expected to be valuable for all three layers of resource management, the work system (employees) and for service supply chain management.

The revised version of the artefact with three layers is potentially valuable also for other types of resources, including both operant and operand resource categories. By using the suggested approach, service resources can be additionally categorized into two groups: resources that have a pre-designed logic for resource integration and resource production, such as technology; and resources that have the ability to create an emergent logic for resource integration and resource production, such as humans. For example using technology requires integration of these two resource categories. The more detailed the analysis of resources is, the more layers have to be added. Even though the focus is on technology, the interface between technology and service is multifaceted. Abstractions where the technology interface is understood simply as matter of acceptance or usage, do not provide enough knowledge for operations management, which may differ from the needs of service system management.

6.2 Conclusions

The main contribution of this study is aimed at service operations management and service engineering disciplines. The design science-oriented approach takes the core processes of service marketing and service dominant logic, and resource integration and resource production as the starting point and adds significant new knowledge related to these activities. The contribution provides answers for the requests set by Kleinaltenkamp et al. (2012) and Vargo and Akaka (2013), who underline that resource management based on service logic is an understudied subject in the field of service research. The main contribution of the study can be summarized as follows: firstly, technology resources can be described as resource-integrating and -producing service systems, secondly, analysing individual resources is not enough, they have to be connected with the work system view, the service logic or service supply chain instead, and thirdly, the logic that describes how a resource integrates existing resources and produces new ones is different from how the resource is actually used, which sets role definitions for resource usage. Instead of just describing these differences, the operations should be managed by using information that supports acknowledging all layers. A similar but reverse approach has been proposed by Sampson (2012) when defining new roles for the customer.

The design artefact provides also several interesting aspects for practice. During the testing and evaluation process, conceptual constructions about resources in service systems were transformed into practical visualizations and application examples. According to the interviewed employees, the examples provided new ideas and innovations, as well as practical options for service operations management. The main implication for service managers is that all this information is already embedded in the service systems, but in most cases it just is not utilized or identified. Managing the customer interface and offering value creation potential for the customer through marketing is not enough, instead of that more service engineering-oriented experts are needed in service organizations, who can see beyond marketing and customer concepts, and translate them into practical elements.

This study includes a few limitations that need to be addressed. The first limitation concerns construction of a new artefact from artefacts which may create a potential risk of inventing non-relevant knowledge. However, by starting from the technology artefact, the connection to the real service context is tight, as both the technology and the related resources are at least partly physical. The second limitation concerns the testing and evaluation phase. Creating new knowledge in an environment where the competence related to service or technology is not very high may highlight wrong issues as new knowledge. Therefore the researchers kept the role of the test contexts relatively low and used empirical contexts only as environments which enable testing new ideas, without a need to develop the actual services in them. The third limitation is related to the concepts of resource integration and resource production. If the level of analysis is changed, these activities become not separable, and this may indicate that integration and production can be seen as a single activity in some circumstances.

The design artefact and achieved results provide answers to the research question and also to some previously set open questions, but creates also new questions. The developed artefact as a static construction enables describing resource-related phenomena, but loses its power when the objective is to manage architectural information related to resource integrations and productions as a system. One of the areas where further research should be focused is connecting state information to resource-processing events. This would potentially add complexity through an increased amount of information, but also link theoretical concepts more clearly with practical needs and also enable creating practical evidence.

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APPENDIX 1

Structure of the thematic interview (subthemes included)

Theme 1 Personal, team and unit capabilities in daily activities

- Employee’s own role and relationship to other resources, problematic issues faced in everyday activity, popular and unpopular tasks, and development of skills and capabilities

Theme 2 Work system, organization of work and working procedures

- Work system management, organizational culture, official procedures versus unofficial procedures, and the main focus and objectives of daily activities

Theme 3 Who is the customer and what does the customer have to do with the service?

- Official and unofficial customers, customer’s influence on daily routines, customer feedback and relationship to the customer

Theme 4 Decision-making as a part of daily activities

- Employee’s own decision-making situations and experiences, other powerful decision-makers within the organization, official and unofficial decision-making chains, and learning from earlier decisions – possible or not?

Theme 5 Manual and automated information systems

- Information systems that you utilize, the role of information systems in daily activities, and if you designed an information system – what would it look like?

Theme 6 Communication as a part of daily activities

- Internal communication procedures, external communication procedures, and informal and emergent procedures

Theme 7 The future (personal, team and unit perspectives)

- Objectives, challenges, personal ambitions, personal vision – in the next 5-, 10- and 30-year perspective

APPENDIX 2

Theme 1 Situational description through visualization

- Creation of situational understanding, successful elements in visualization, unacceptable elements in visualization, situational information vs. static information, and supporting a service mindset through visualizations

Theme 2 Decision-making situation and roles

- Changes in the decision-making situation when amount and quality of information is increased/ decreased, critical information and visualising it, sharing decision-making information and relevant stakeholders

Theme 3 State of the service system before and during decision-making

- The role of the service system view in: decision-making, situational understanding, service delivery, failure situation

Theme 4 Design artefact- based visualization vs. the existing situation: improvements and implementation of the proposed model

- Change needs, employee readiness, employee acceptance, user interface, integration to the rest of the work system, service supply chain view and understanding

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