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Designing Interaction Routines in Service Networks: A Modularity and Social Construction-Based Approach

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Abstract. Service networks made up of manufacturers and service firms to satisfy complex customer needs are proliferating. By exploiting their complementary competencies, such

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service networks enable their members to provide innovative and integrated solutions that could not be offered by any of the firms alone. The successful formation and operation of service networks requires the analysis and (re-)design of interaction routines that facilitate planning and coordination based on a mutual exchange of information. We argue that conceptual models are artifacts that enable networked organizations to improve how well they manage these interaction routines. Against this backdrop, this article makes four major contributions. First, a conceptual modeling language based on the design principle of modular decomposition of network complexity is developed for specifying interaction routines in service networks. Second, a workshop-based modeling method based on the design principle of social construction of networks is developed for the purpose of guiding the (re-)design process itself. Third, the developed language and method are embedded into a software tool, and the utility of this ensemble artifact is demonstrated and evaluated using cases of service networks in the construction industry. Fourth, a set of evaluation criteria is proposed for the purpose of assessing tool-supported conceptual modeling workshops and for evaluating other types of conceptual workshops.

Keywords: Interaction routines, service networks, modular design, social construction, business process management, conceptual modeling.

1 Introduction

The emergence and proliferation of service networks is part of a shift toward a network society (Castells 2010). A service network is a service-oriented cooperation of more than two legally independent manufacturing or service organizations that combine complementary resources and competencies in order to provide superior solutions to the customer (Dyer & Singh 1998; Evanschitzky 2007). For example, manufacturers of machines may team up with external service partners in order to offer integrated solutions, including consulting, financial, maintenance, and repair services (Kowalkowski et al. 2011) or service firms in the construction industry may cooperate with wholesalers, manufacturers, and local craftsmen to develop integrated solutions for planning, construction, and maintaining buildings. The integration of competencies enables these organizations to provide customers with innovative and integrated solutions that could not be offered by any of the firms alone (Basole & Rouse 2008; Dyer & Singh 1998).

The management of inter-organizational relationships and the integration and coordination of business processes across organizational boundaries are key challenges for service networks (Durugbo et al. 2010; Kindström et al. 2009; Lambert et al. 2005; Håkansson & Ford 2002). New interaction routines must be established across organizations that allow for an open exchange of information, common planning, and synchronization of activities (Cresswell et al. 2007; Skjoett-Larsen et al. 2003) so all participants in the service network deliver their products and services at the right time and in the right quality. Although previous research in the subfields of the information systems (IS) discipline, such as e-business, business process management, and service-oriented computing, has contributed to the design of inter-organizational information systems (Colombo et al. 2004; Becker et al. 2013), the current body of knowledge lacks methods and tools that facilitate the conceptual (re-)design and alignment of cooperative activities in networks (Smeds & Alvesalo 2003).

To develop this kind of method and tool support, we assume that interaction routines can be "codified or prescribed [. . .] and constrained through [artifacts such as] rules and written procedures" (Pentland & Feldman 2005, p. 796) and that conceptual models of interaction routines can be useful artifacts with which to manage a service network. We use conceptual models of interaction routines as "visually shared boundary object[s]" that organizations can use to imagine and negotiate their roles and responsibilities in a service network (Smeds & Alvesalo 2003, p. 369).

We argue that the negotiation of interaction routines and their documentation in conceptual models is affected by two key characteristics of service networks. First, service networks feature a high degree of complexity that is due to, for example, the variety of customer demands and the plethora of potential network configurations (Shaw & Holland 2010). Second, the formation of service networks is a social process that involves multiple actors with individual and possibly divergent aims (Holmström & Sawyer 2011).

Against this backdrop, this article reports on the development of the FlexNet Architect (FNA), a software tool that facilitates the cooperative modeling of interaction routines. The FNA is an ensemble artifact (Sein et al. 2011) that takes into account the characteristics of service networks through a dedicated conceptual modeling language for the modular design of interaction routines in complex service networks and through a workshop-based method that guides the use of the tool as a social process in which network actors jointly negotiate the structure and interactions of the service network.

The remainder of this article is structured as follows. Section 2 introduces the concept of interaction routines and discusses its application in service networks. Section 3 elaborates on the two key challenges of service network formation that inform the approach proposed in this article. The respective design principles are described in Section 4, and Section 5 presents the artifacts that we developed in accordance with these principles. In Section 6, the applicability of the proposed ensemble artifact is demonstrated using a realworld scenario from the construction industry, and the utility of the artifact is empirically evaluated based on criteria that we identified for this purpose by means of a Delphi study. In Section 7, we discuss the contributions and limitations of the study and give directions for future research. Finally, Section 8 gives a brief conclusion.

2 Interaction routines in service networks

We conceptualize service networks as inter-organizational alliances that are formed with the intention of building cooperative, interdependent, strategic, and comparatively long-term relationships (Takeishi 2001; Lank 2006). In service networks, one or more product-oriented organizations and one or more service organizations jointly develop, sell, and deliver integrated bundles of tangible goods and related services. In contrast to a tangible good, a service is "a time-perishable, intangible experience performed for a client who is acting as a co-producer to transform a state of the client" (Spohrer & Maglio 2008, p. 240). A service is produced and consumed simultaneously because the customer is involved as a co-producer (Das & Canel 2006), whereas goods can be stored for later consumption. The network partners' unique technical and human resources must be aligned and integrated with each other through routines that help to mobilize, share, and combine heterogeneous knowledge and capabilities (Sammarra & Biggiero 2008).

Management studies and the literature of organizational science have proposed organizational routines (Winter 1964) as a concept to investigate "behavioral regularities, which denote recurring analytic processes embedded in firms and performed by groups of individuals" (Salvato & Rerup 2011, p. 472). Organizational routines "depend on the connections, the stitching together of multiple participants and their actions to form a pattern that people can recognize and talk about as a routine" (Pentland & Feldman 2005, p. 793). Feldman and Pentland emphasize the dual nature of an organizational routine, which is considered to feature a performative aspect (specific actions) and an ostensive aspect (an ideal or schematic form of the routine) (Feldman & Pentland 2003; Pentland & Feldman 2008). The performative aspect of organizational routines designates actual performances by specific people in specific places, whereas the ostensive aspect denotes abstract patterns of how to accomplish a task (Salvato & Rerup 2011). The latter is connected to the actual performances of organization and people in three ways (Feldman & Pentland 2003): it guides behavior by serving as a template or normative goal, it legitimates desired or de-legitimates undesired behavior and thus accounts for specific performances in an organization, and it refers to complete sets of actions as routines that would otherwise be incomprehensible.

In this article, we conceptualize interaction routines as actions on the collective level that involve actors from networked organizational units (Becker 2004). In line with Pentland and Rueter (1994), we posit that interaction routines are "effortful accomplishments" (p. 489) that are adapted by individuals while performing a task such that the performance of routines is guided by their ostensive aspect, but workers can still decide to act in other ways. Further, we argue that interaction routines can be codified by artifacts (Pentland & Feldman 2005), like rules and written procedures which then "serve as a proxy for the ostensive aspect of a routine" (Pentland & Feldman 2005, p. 795). Since routines are processes (Becker 2004), process models are suitable artifacts for documenting and designing interaction routines even though routines can feature a significant tacit component (Feldman & Pentland 2003) that may render their codification incomplete.

The establishment of routines can have several positive effects on organizations (Becker 2004) and can provide reasons for describing and (re)designing interaction routines in service networks:

- *Coordination and Control:* Interaction routines help to coordinate actions that are dispersed across the network. They enable several actors to perform actions simultaneously while keeping those actions directed toward common purposes or outcomes.

- *Truce:* Successfully implemented routines facilitate smooth interactions, as they legitimate actions from the cognitive and governance perspectives (Nelson & Winter 1982). Actions performed by network partners are the accepted status-quo, so there is no need to question their authority each time they are executed.

- *Economizing on cognitive resources:* The network actors' capacity for information processing and decision making is limited. Routines economize on this capacity, allowing the actors to focus on non-routine activities in their individual areas of competence and responsibility.
- *Reducing uncertainty:* Routines provide norms that increase the predictability of how the different network actors will behave in situations of uncertainty.
- *Stability:* The establishment of successful interaction routines in a service network frees the actors from the need to repeatedly identify partners, make new contracts, and align understanding (Becker 2004), as long as negative feedback from performing interaction routines is not ignored. Since routine interactions are stable, IT artifacts can be implemented to foster the interactions, which would not be advisable for non-routine interactions because of high implementation costs.
- *Storing knowledge:* Routines are patterns that describe how to process certain inputs in order to achieve desired results by storing the (tacit) knowledge that organizations acquire over time during their interactions. Since routines are context-dependent (Becker 2004), they are difficult for competitors to imitate and can be a source of sustainable advantage—even more so in settings in which dispersed and complementary knowledge is integrated by means of the routines.

3 Challenges in designing interaction routines in service networks

Two central challenges that organizations face when forming networks are, first, organizational and technical complexity, which has been identified as a major management problem in networks (Shaw & Holland 2010; Ford et al. 2002), and, second, the social construction of networks that requires people and organizations to work together despite conflicting interests, dispersed knowledge, differing management strategies, and unequal resource endowments (Håkansson & Ford 2002; Simsek et al. 2003).

3.1 Service networks are complex

Generally, a network is a structure in which a number of nodes are connected by specific edges (Håkansson & Ford 2002). In a service network, these nodes are organizations or business units that manufacture goods and provide related services, and the relationships between them are the edges. Within such a network, complexity arises for two main reasons. First, *complexity by differentiation* stems from the number and heterogeneity of actors (i.e., the nodes) in the network. The formation of service networks requires organizations to mobilize and combine heterogeneous knowledge and capabilities (Sammarra & Biggiero 2008). Each organization has its own specialized routines, knowledge, terminology, objectives, orientations, and culture (Grandori

& Soda 1995; Smeds & Alvesalo 2003), and each organization has developed its own set of resources for accomplishing their tasks, such as the tools and procedures they apply to address certain problems that are specific to either manufacturing or service. From a technical perspective, complexity by differentiation may also arise from the number and diversity of IT systems in the network. Data that is relevant to multiple actors across the service network may be dispersed in the network, disturbing inter-organizational information flows.

Second, *complexity by interdependency* refers to the interdependencies and interactions (Baccarini 1996) between actors (i.e., the edges) that cause strategy formulation and implementation to be an interactive, evolutionary, and responsive process that cannot be done in isolation (Håkansson & Ford 2002). On an operational level, interdependencies manifest in coordination activities and in the need for information sharing (Thompson 1967).

3.2 Service networks are socially constructed

Service networks are a hybrid form of organization, apart from markets and hierarchies (Williamson 1975; Jones et al. 1997; Powell 1990). The relationships among the organizations in a service network go beyond arms-length transactions because they exist for a particular time frame (Jones et al. 1997) and they also develop over time (Håkansson & Ford 2002). There are different views (Alajoutsijärvi et al. 2001) on how networks are formed or developed. North American literature on strategic networks often assumes a purposeful arrangement by entrepreneurs, in most cases managed by a focal dominant organization, in order to obtain competitive advantage for their individual firms (Tikkanen & Halinen 2003; Thorelli 1986; Dyer & Singh 1998). In contrast, European researchers from the Industrial Marketing and Purchasing (IMP) group view networks as emergent structures, that is, as the result of continuous interactions between organizations (Tikkanen & Halinen 2003; Håkansson & Snehota 1989). We agree with the latter view and assume that networks are not the result of a single, dominant designer but are shaped by a number of actors (Håkansson & Ford 2002) who must negotiate how to coordinate their business activities and agree on adequate interaction routines. The absence of central ownership and hierarchical coordination makes the integration of non-harmonized ways of working and technical infrastructures a social construction process in which the service network forms a sense-making community (Simsek et al. 2003). Together, the actors envision potential business process designs, imagine and negotiate who will be responsible for which sub-processes and activities, and finally codify the overall set of routines (Smeds & Alvesalo 2003). Although the actors bring in their individual deliberations and aims, they must also understand how the networks functions from the others' perspectives (Håkansson & Ford 2002). The results of such negotiations tend to be rather socially than legally binding (Jones et al. 1997).

4 Design principles

In this section, we propose two design principles for the development of IT artifacts that support the design of interaction routines in service networks. We define design principles as justified statements or rules that guide or constrain design actions (Hevner & Chatterjee 2010). Design principles provide an abstract blueprint that is grounded in theory and empirical evidences and can be applied to build concrete artifacts (Gregor & Jones 2007). In other words, applying design principles facilitates the creation of further instances of a class of artifacts (Sein et al. 2011).

4.1 Design principle 1: modular design

Modular architectures have been proposed as a solution "to the problems that are generated by complex products or complex organizational systems" (Shaw & Holland 2010, p. 244). Modularity breaks a system into discrete pieces (i.e., modules) that communicate with each other only through standardized interfaces (Langlois 2002) thereby decomposing a system into fine-grained, interacting subsystems that can themselves be subject to decomposition. Simon (1962) introduced the notion of (near) decomposability and viewed *hierarchy* as a prominent organizing principle of nature. Decomposable and loosely coupled systems tend to be highly adaptable, as they require little coordination (Weick 1976; Sanchez & Mahoney 1996).

Langlois (2002) presented the concepts of architecture, interface, and standardization as the cornerstones of modular systems design. For example, if one thinks of the organizations in a service network as modules, electronic information flows (e.g., Electronic Data Interchange (EDI)) can be regarded as standardized interfaces between these modules. Individual organizations, in turn, can be decomposed into discrete modules (e.g., business units) connected via standardized interfaces (e.g., accounting and material documents in an ERP system). Similarly, we argue that the complex set of interaction routines between the network actors can also be structured by modules and interfaces between modules.

Accordingly, we formulate the design principle of *modular design*, where an artifact supporting the design of interaction routines in service networks should enable a modular decomposition of service network structures.

4.2 Design principle 2: social construction

Social construction involves "a stream of social, political and design events which connect ideas, artifacts, people, and institutions to yield a [. . .] specification" (Lyytinen et al. 2008, p. 2) of, for example, technical artifacts or organizational structures. The cooperative design of a conceptual model of service network interactions requires an approach in which the network actors can "jointly negotiate their new identity and meaning, understand their new role in the process and integrate new responsibilities into their practices" (Smeds & Alvesalo 2003, p. 363).

By drawing upon the social construction of technology (Howcroft et al. 2004; Bijker 1987), one can distinguish the key phases in the process of designing interaction routines in a service network into *design, sense-making,* and *negotiation* (Lyytinen et al. 2008). Design refers to the identification and definition of the interaction routines, including information to be exchanged and possible IT support to connect the service network actors. During sensemaking the actors evaluate the fit of the design with their individual objectives and requirements. Negotiations are needed to resolve conflicts and reach agreement on the network configuration.

Accordingly, we formulate the design principle of social construction, where an artifact supporting the design of interaction routines in service networks facilitates cooperative design, sense-making, and negotiation of interaction routines.

5 IT artifacts for designing interaction routines in service networks

The FlexNet Architect (FNA) is a rich internet application that has been implemented with Asynchronous JavaScript and XML (AJAX) and ICEfaces as the underlying application framework. The development was carried out by a project team of thirteen graduate students over twelve months. The FNA facilitates the design of interaction routines based on a conceptual modeling language, which we term the Service Network Interaction Modeling Notation, which is utilized in a workshop-based procedure. The design of the Service Network Interaction Modeling Notation was informed by the design principle of *modular design*. The adjuvant workshop-based modeling method was inspired by the design principle of *social construction*. The interrelationships among the challenges, design principles, modeling language, method, and tool are exhibited in Figure 1. In what follows, we illustrate the Service Network Interaction Modeling Notation and the workshop method, as implemented in and supported by the FNA, respectively.

5.1 Modular design of interaction routines with the FlexNet Architect

We argue that interaction routines can be codified, prescribed, and constrained by artifacts (cf. Section 2) that can serve as proxies for the ostensive aspect of an interaction routine. We propose that a conceptual service network interaction model can be one such artifact and present a conceptual modeling language that allows interaction routines in service networks to be codified. The Service Network Interaction Modeling Notation that we present consists of a set of graphical constructs and rules to combine these constructs (Recker et al. 2011). The language is made available through the software tool FNA so it can be used for developing, documenting, and redesigning interaction routines.

Figure 2 is a schematic representation of the modeling workspace in the FNA tool, which contains the following main constructs of the Service Network Interaction Modeling Notation: Actor, Area, Action, Interaction Space, Module, Brick, Interaction, Information Flow, Process Model, Project, and Scenario.

Actors are organizations whose members perform actions and interact with other actors in the network. Figure 2 displays four exemplary actors, all situated around the *Interaction Space*, where the *Interactions*, the central constructs, are modeled. In line with seminal literature on organizational routines (Section 2), Interactions refer to that subset of actions that depend on multiple actors, while an *Action* is performed by one actor only. The meta-model presents the

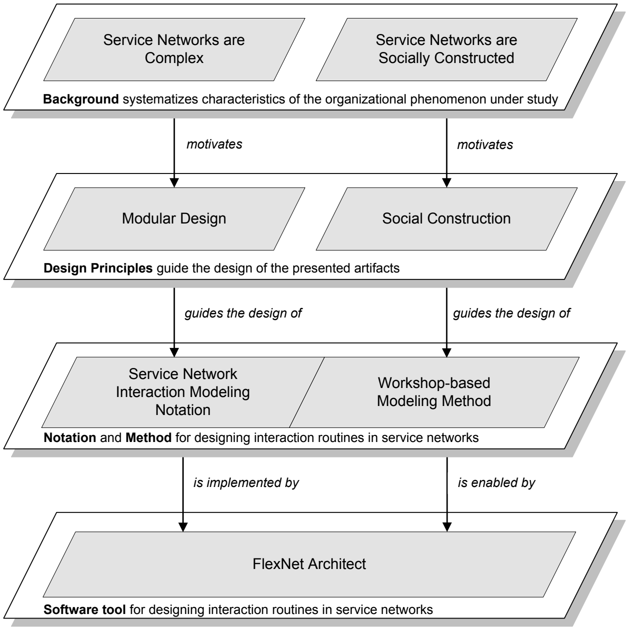


Figure 1: Overview of the challenges, design principles, and developed IT artifacts

constructs that are related to individual actors—that is, Actor, Area, and Action—and depicts constructs that focus on the interaction of actors in the network: Interaction Space, Module, Brick, and Interaction.

Actions and Interactions can be conceptualized on several layers, drawing from the concept of modularization and consistent with Simon's concept of hierarchy (Shaw & Holland 2010; Simon 1962). Each layer abstracts from non-salient information, forming a nested hierarchical structure (cf. Figure 2). On the lowest level, Action and Interaction are atomic constructs that cannot be subdivided. On the next higher level, Actions and Interactions can be composed into *Process Models* that outline how either Actions or Interactions are related to each other. Collections of Interactions are encapsulated in *Bricks* (assigned to the Interaction Space), whereas collections of Actions are encapsulated in *Areas* (assigned to Actors). In the spirit of modular design, this is done in order to be able to refer to collections of Actions and Interactions separately on the FNA modeling workspace instead of depicting all Actions and Interactions that are present in a network at the same time. On level three, Bricks are grouped into *Modules*, which are meaningful clusters of business logic that group several areas of interaction. An example is the Module "Service Marketing," which may be comprised of Bricks like "Order Management," "Service Configuration," or "Pricing."

Actions, Interactions, Bricks, and Modules are interconnected by means of *Information Flows*, pointing at requirements for information exchange. The information that is shared and used across the service network can range from transactional or operational information (e.g.,

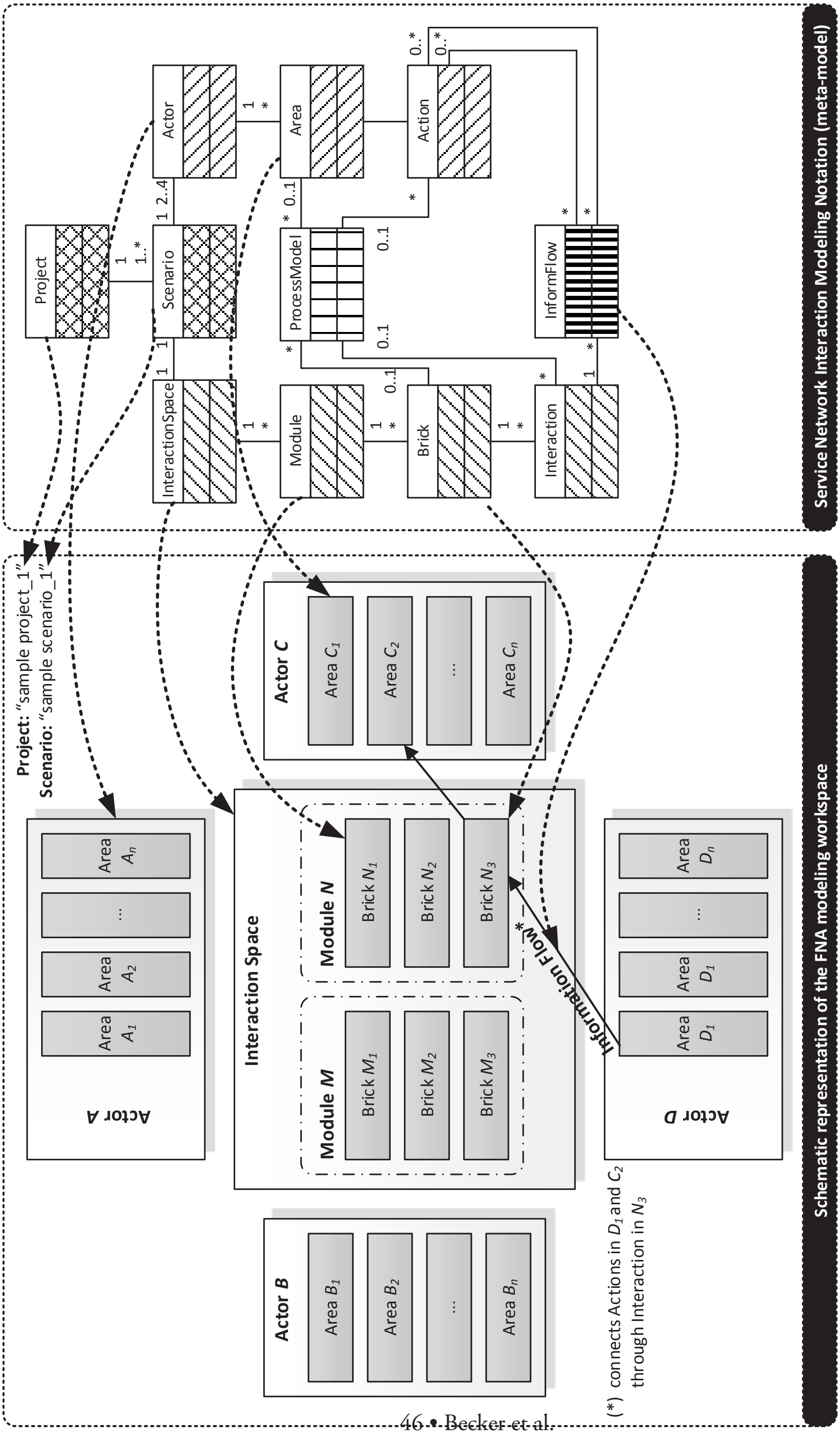


Figure 2: Schematic representation of the FNA modeling workspace and the meta-model of the Service Network Interaction Modeling Notation (excerpt)

orders, invoices, product or service master data) to tactically and strategically relevant information (e.g., financial data, demand forecasts, customer data). The source and sink of an Information Flow are at the Actions and Interactions.

5.2 Social construction of interaction routines with the FlexNet Architect

We argue that a method for modeling interaction routines in service networks must adhere to the design principle of social construction, which can be achieved through a workshop-based approach (Herrmann 2009; Smeds & Alvesalo 2003). Herrmann et al. (2004) proposed the socio-technical walkthrough that is comprised of a semi-structural modeling method for the step-by-step inspection and improvement of information systems. Smeds and Alvesalo (2003) reported on the successful use of process visualizations in workshops for designing business processes across the units of a multinational organization. A workshop outline is ideally suited for the cooperative design of interaction routines for various reasons, in part because it allows the verbal and face-to-face exchange of ideas that is critical during the early stages of design.

Accordingly, we suggest a workshop-based method for the cooperative analysis and design of interaction routines. The FNA tool, operated by a facilitator, is used for this method and is made visible to all workshop participants (e.g., via a projector). The method is comprised of the phases of Initiation, Diagnosis, and Conception (Kubr 1986; Strasser 1993) (cf. Figure 3). The conception phase incorporates the three steps of the social construction process: design, sense-making, and negotiation. Following this workshop method allows the cooperative design of a service network interaction model and the integration of the participants' perspectives into a larger picture (Herrmann 2009).

In the *initiation* phase, the participants set the objectives of the project by restricting the scope of the project regarding, for example, certain network actors, cooperation scenarios, offerings, or interaction routines.

In the *diagnosis* phase, the network actors are identified and their actions, given that they are relevant to the service network, are modeled in the FNA on several levels of abstraction using the Service Network Interaction Modeling Notation. Existing information flows from one actor to another are documented. The initial model can be developed cooperatively in a workshop or can be prepared in a distributed manner prior to the workshop. The resulting model is the first reference point for documenting interaction routines in the service network.

In the *conception* phase, the actors discuss the division of work in the network and cooperatively develop interaction routines and information flows that integrate their actions using an iterative process of design, sense-making, and negotiation. With respect to the division of work, actors answer questions like "which actor should be responsible for this activity in the future?", "what IS support is needed for this activity?" and "which actors should be informed about the execution and the outcome of this activity?" The answers are collected by a workshop facilitator who is responsible for modifying the model accordingly (design). The interaction routines are modeled using the modular constructs of the Service Network Interaction Modeling Notation. The visualized model allows all participants to reflect on changes and their consequences for their organizations (sense-making), after which participants can discuss any conflicts that need

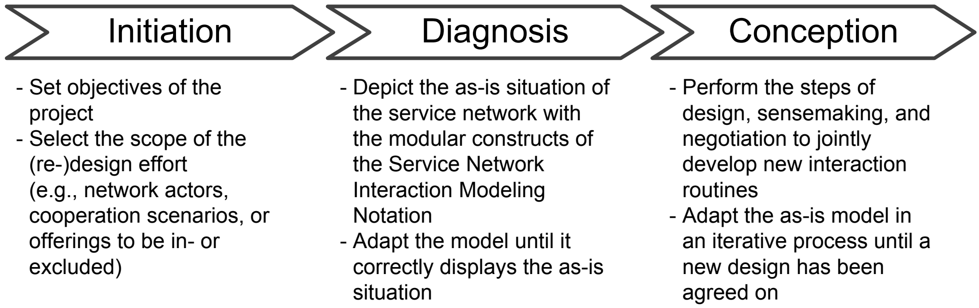


Figure 3: Steps of the proposed workshop-based modelling method

to be resolved in workshop discussions (negotiation). These three steps are repeated in an iterative fashion until a final agreement about the interaction routines is reached.

The overall process may span a series of workshops. At the beginning of each workshop, the facilitator presents the current state of the (as-is/to-be) model as a starting point for the next step. The design that resulted from the previous meeting is copied into a new FNA scenario sheet so it can be incrementally modified and refined without losing intermediate results. Thus, the complete history of the design process can be tracked in a series of diagrams.

Two specific modeling constructs of the notation particularly refer to the workshop process (cf. Figure 2). *Projects* are conglomerates of model elements used to administrate all elements assigned to one service network. *Scenarios* describe alternative service network interaction models and can refer to other scenarios (e.g., in terms of predecessor and successor relationships or representing alternatives for the same problem area). Hence, scenarios are used to represent the as-is model of the service network that is then developed into to-be models, including alternative scenarios.

6 Demonstration and evaluation

We hypothesize that the FNA tool, its implementation of the Service Network Interaction Modeling Notation, and the accompanying workshop method form an ensemble IT artifact (Sein et al. 2011) that is useful for the design of interaction routines in service networks. The literature of information systems design science advocates that artifacts should be subject to demonstration and evaluation in order to assess their utility. During a *demonstration*, which serves as a proof of concept to show that the general idea works, the artifact is applied to solve one or more instances of a given problem (Peffers et al. 2007). An *evaluation* uses formal measurement instruments and empirical observations to determine how well an artifact solves a problem (Peffers et al. 2007).

We adhere to these guidelines. First, we demonstrate the utility of the proposed artifacts by reporting on the application of the FNA for analyzing and designing interaction routines in a real-life service network. Then we evaluate our approach based on an analysis of feedback from workshop participants. Since previous literature was short on evaluation criteria that fit to our workshop-based approach, we identified suitable evaluation criteria through a Delphi study beforehand. Table 1 summarizes our demonstration and evaluation.[1]

6.1 Demonstration

We applied the FNA in a service network in the facility construction industry. The service network is composed of small and medium enterprises, with the bathroom vendor IBS holding the role of integrator or coordinator. IBS brings manufacturers of sanitary goods and service companies (local craftsmen and wholesalers) together. In the service network, they jointly deliver bathroom solutions to hospitals, hotels, and student accommodations. IBS positioned itself as an integrator of complementary resources and competencies by establishing a novel platform concept that is based on an innovative wall panel on which additional bathroom components can be installed. The IBS bathroom platform replaces traditional tiling with a component-based concept that is designed to meet the requirements of large-scale refurbishment projects. Major parts of the bathrooms can be pre-produced. Each organization delivers its components directly to the construction site where they are assembled so on-site logistics and assembly processes are improved and downtimes can be reduced. While the administrative business processes are carried out by IBS, the revenues generated by the network are shared among all partners according to pre-defined interaction routines. Next, we illustrate how IBS used the FNA tool to redesign these interaction routines.

Initiation: Preparation for re-designing the network's interaction routines

When it entered the new business model, the service network around IBS started with business processes that used an ad-hoc mode of coordination. Beginning in 2008, the network executed several large-scale construction projects, each comprised of several hundred bathrooms. Early in 2010, IBS identified seventy more potential projects, with a total volume of around 4,500 bathrooms, so IBS wanted to re-design the service network's interaction routines to improve its ability to exploit the market potential. For the re-design, the focus was set on "barrier-free bathrooms" for hospitals.

Diagnosis: Initial analysis and design of the service network

In order to generate an initial model of the interaction routines, we were granted access to the IBS Customer Relationship Management system (Microsoft Dynamics CRM), where the communications with all service partners are stored. We documented the present mode of coordination using data from one large-scale reconstruction project, compiling an "activity list" of 132 activities, the Microsoft Dynamics CRM term for any email, task, meeting, phone call, fax, or letter. We were provided with information on sender/recipient, date, subject, content, and attached documents for each activity, and we added activities that we identified from complementary data sources (e.g., back-office activities like "requesting planning data," "sending planning data," and "compiling planning data") that were not documented in the CRM system.

	Demonstration: Field test	*Evaluation 1: Delphi study*	*Evaluation 2: Modeling workshops*
Purpose	Demonstrate applicability of the artifact in a natural setting.	Develop a set of suitable evaluation criteria; assess the expected effects of the artifact on workshop quality (pre-use).	Measure the perceived effects of the artifact on workshop quality (post-use).
Setting	Real-life service network from the facility construction industry	Expert panel with academics and practitioners	Development of facility management reference models with facility management consultants
Time	June – September 2010	November 2009	November – December 2009
Method	Field study (including online access to FNA)	Delphi study (including online access to FNA)	Workshops (including online access to FNA); post-use questionnaire and interviews
Data sources	Eight workshops with a total of six practitioners; two preparatory field visits	Thirty-three panel members	Five workshops with a total of eight practitioners
Inputs	FNA; initial conceptual model of the service network	FNA; list of initial evaluation criteria; Delphi questionnaire; round-toround feedback	FNA; workshop task; questionnaire with the eight most relevant evaluation criteria
Outputs	Protocols regarding FNA usability and usefulness	Set of thirteen criteria for assessing the quality of conceptual modeling workshops; quantitative measurements of the expected effects of FNA on workshop quality (using the eight most relevant criteria)	Quantitative measurements of the perceived effects of FNA on workshop quality
Key findings	The FNA helped to chart the as-is situation of the service network, stimulated discussion among participants, and facilitated the design of new and improved interaction routines.	Panel members expected the highest impacts on productivity, time efficiency, and workshop structure.	Users' evaluations exceeded experts' expectations in all dimensions; the highest impacts were perceived with regard to workshop structuring, focus on results, and communication.

Table 1: Overview of demonstration and evaluation of the FNA

Next, we transferred each activity on the list into one or more Actions in the FNA model. Based on the senders and recipients of information flows (e.g., who sent an email to whom), we identified and modeled all actors in the network as Actors and assigned each Action to one Area of the Actor in charge. From the list of activities we also identified Interactions, activities in which two or more actors were involved, and placed them on the Interaction Space. Each distinct type of document/information transfer was modeled by one Information Flow. The modeling process was supervised by an IBS employee to ensure correct depiction of the as-is situation.

Several key actors identified during the diagnosis phase were placed in the Interaction Space:

- *Coordinator:* IBS plays the role of the coordinator who performs the overall planning, control, and monitoring activities of the network.
- *Industry Partner:* Industry partners contribute products contained in a bathroom, such as sanitary components, faucets, doors, door cases, and handles, and perform the sales activities that win new reconstruction projects from potential customers. They supply relevant technical parameters, dispatch staff if needed, produce the bathroom components, and deliver them to the construction site.
- *Solution Center:* Solution centers autonomously account for order fulfillment at the construction site by collecting technical data during planning and construction. Solution centers provide industry partners with all the technical parameters they require for a specific customer project.
- *Sanitary Product Distributors (Wholesale):* Distributors supply regional markets with sanitary products, account for consignment and material logistics of stock goods (ceramics, accessories), and perform logistic services, including delivery to the construction site.

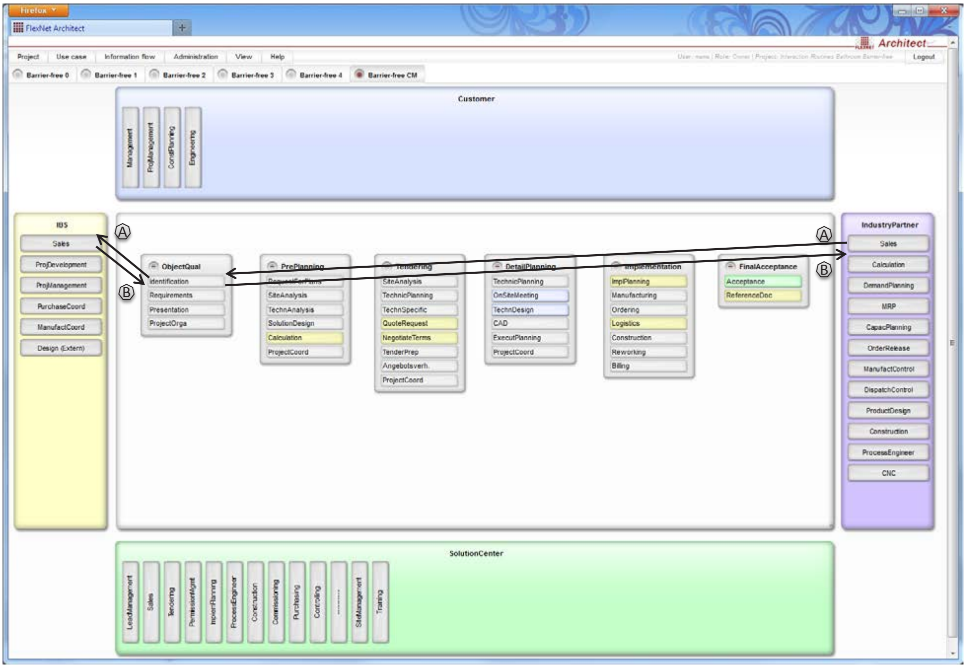
Conception: (Re-)design, sense-making, and negotiation

We applied the FNA workshop method in eight workshops held from June to September 2010 with several representatives from IBS and their partners to redesign the interaction routines in the network. An external facilitator of IBS whom we had trained in the FNA tool and method moderated the workshops. One representative each from four industry partners, one solution center, and one distributor participated in the workshops. Participants were informed about the structure of the workshops in advance and were provided with a detailed agenda.

Lasting 45-120 minutes, the workshops began with a brief definition of the focused subject area, a presentation of the FNA software, and an introduction to the most relevant elements of the modeling language. At the beginning of each workshop, the facilitator recapitulated the models that had resulted from previous workshops in a walk through. Actors and their functional Areas were discussed first, after which the focus moved to specifying Modules and Bricks on a more detailed level and discussions about the current interaction routines in the network. Here, we concentrated on the information to be exchanged among the network actors and the cooperative activities. The participants' comments were summarized and documented in workshop protocols for each workshop. The protocols and the conceptual models constitute the documentary evidence for the observations we discuss next.

The workshops led to the design of new interaction routines, which are comprised of the specification of new Interactions (IA) and the required additional Information Flows (IF). A stylized excerpt of the resulting model is depicted in Figure 4. The key benefits of this new arrangement of interaction routines can be summarized as follows:

- *Customer approach:* In the as-is scenario, the industry partners tended to approach customers in an uncoordinated manner and sometimes contacted them multiple times. To implement a one-face-to-the-customer approach, an additional Interaction (IA-1) was designed to share information on potential project opportunities throughout the network. However, while contributing complementary products to the network offering, industry partners still compete in other areas—even on the same construction project. Therefore, IA-1 was incrementally modified so IBS traces the identified opportunities and checks them for overlaps so the reports do not disclose information to competing industry partners. The design of IA-1 facilitated a discussion about which pieces of information about construction objects should be shared during pre-sales activities, and this discussion led to the definition of a new information flow (IF-A in Figure 4) from the industry partners to IBS. IF-A was technically specified by prescribing the structure of a master data document, "construction project," that was then adopted and implemented by the industry partners. Based on the new definition of IA-1, IBS was given the authority to prioritize identified opportunities based on profitability and time restrictions. Double-contacting is avoided because the industry partners agreed to wait for a sales trigger from IBS before initiating sales contacts (Interactions 2-4, Information Flow B in Figure 4).
- *Efficiency in tender preparation:* The workshops defined the Interaction "cost calculation" (IA-5) as a central cost calculation that is controlled by IBS. Now IBS receives parametric pricing models from its industry partners so it can set up a preliminary estimation of costs and can send out tenders quickly on behalf of the whole network. For the respective Information Flow, the industry standard GAEB DA XML (http://www.gaeb-da-xml.de/) was adopted.
- *Integrating the processes of detail planning and implementation:* An additional "planning" Interaction (IA-6) was designed that is performed by IBS. IBS now generates partner-specific material demand dispositions and delivery dates and transmits them to its industry partners in a standardized electronic document. Logistics centers are embedded into the planning, speeding up the assembly process at the construction site, which had often been delayed because of late deliveries of material.
- *Integrating external drawers:* The technical drawings of bathrooms are done by external agents, who require the technical data of all components in order to prepare an exact blueprint of the bathrooms. IBS had coordinated the flow of these data manually, which was mentally challenging, error-prone, and time-consuming for all actors. Thus, the interaction was changed (IA-7) through the workshops. In the change, the industry



Legend:

Interactions (Module: Identification)	
1	Share identified construction project
2	Prioritization (profitability)
3	Prioritization (time)
4	Trigger industry partners to initiate contact

Information Flows (Module: Identification)	
A	Identified construction project (construction project)
B	Sales trigger (Key customer data, information on prioritization, indication of possible conflicts of interests in the network)

Figure 4: Interaction routines of the IBS service network (screenshot; URL blinded; information flows, and legend, including the content of subordinated windows, were added manually for improved readability)

partners committed to providing technical data to IBS in a standardized format and to inform IBS in case of changes.

In sum, the demonstration of the FNA tool was successful. The tool was particularly helpful in charting the as-is interaction routines and in shaping the to-be interaction routines of the IBS network. Table 2 links our observations from this specific service network to the categories of expected positive effects, as outlined in Section 2.

6.2 Evaluation

In order to assess to what extent the FNA tool supports workshops for the cooperative design of interaction routines, we developed a two-step evaluation strategy. First, we conducted a Delphi study to identify evaluation criteria for tool-based workshops and asked the Delphi panel members (who had no prior modeling experience with the FNA) about their ex-ante expectations of how the FNA tool would impact the workshop quality in regard to these criteria. Second, we asked the workshops participants who used the FNA ex-post how they perceived the FNA affected workshop quality.

Identification of evaluation criteria

Despite a detailed literature search, we did not identify a suitable evaluation framework or metrics for assessing the quality of design workshops. Some work, most of it only remotely related, was found in the area of education (e.g., Kirkpatrick & Kirkpatrick 2006). We also consulted ten scholars from a variety of academic fields (e.g., didactics of informatics, psychology, and communication science) about suitable evaluation criteria and received nine responses, none of which contained any additional advice. We concluded that no adequate evaluation criteria were available from the literature.

We decided to identify evaluation criteria ourselves by means of a Delphi study, as this approach has been applied to reach consensus between researchers and practitioners on a common quality framework for data models (Moody 2005). Delphi studies follow an anonymous, written, multi-stage survey process (Delbecq et al. 1975), and in the run-up to each stage, the panel members are given consolidated feedback on the results of the previous stage.

The members of the expert panel were invited via email to participate and were contacted by telephone in advance of the study, which was conducted in November 2009. The panelists were informed about the study's goals and overall procedure and background information on the FNA, and were given links to further information (including a login for the FNA software tool) and to the Delphi questionnaire. In the first round, the experts were provided with an initial list of eight quality criteria (cf. Table 3) that we had adapted from items used to study the perceived usefulness of information systems (Davis et al. 1989) so the items fit the objectives of our workshop-based method. The panelists were asked to rate the relevance of each criterion for assessing workshop quality on a 6-point Likert scale, ranging from "completely disagree" (0) to "completely agree" (5). One open-ended question allowed the panelists to mention additional items. The results of the first round were analyzed and compiled into a document that was sent back to the panelists as feedback. For each criterion, the median (M), arithmetic mean ($\bar{x}$), interquartile range (IQR), and standard deviation (SD) were given to the panel.

In the second round, the participants once again rated the relevance of these and the other criteria that had been mentioned. They were also asked to provide an argument if they chose a rating that differed significantly from the opinion of the panel majority. We finished the study after the second round because the results provided a satisfactory degree of consensus and because of indications that the respondents were not willing to participate in another round (Schmidt 1997).

Thirty-three experts participated in the first round, thirty-one of whom also participated in the second round. The initial response rate was 80 percent of the invited experts. Seventy-six percent of the first-round panelists had a corporate consulting or business strategy consulting background, and 24 percent held an academic position (information systems, management science, or psychology). All panelists stated that they regularly participate in conceptual work-

Categories	*Expected effects of implementing the revised interaction routines*
Coordination and Control	IA-1: Double-contacting potential customers is avoided. IA-5: Speed of tender preparation is increased. IA-6: Provision of material by the several industry partners is scheduled and sequenced. IA-7: Technical drawing and technical data transmission are temporally decoupled.
Truce	IA-1: IBS is not authorized to share data on potential customers with other industry partners. IBS is authorized to restrain the pre-marketing activities of industry partners. IA-5: Industry partners authorize IBS to send tenders. IA-6: IBS is authorized to calculate partner-specific material demand dispositions and delivery dates.
Economizing on cognitive resources	IA-1: Industry partners can focus their sales approaches on the potential customers to which they have the best access. IA-5: Industry partners do not have to provide case-specific information to cost calculation. IA-6: Calculation of required material is centralized. IA-7: IBS and industry partners are unburdened from case-tocase processing of data requests.
Reducing uncer-tainty	IA-1: IBS can trust in the commitment of industry partners to inform IBS about all pre-marketing activities and identified opportunities in a standardized manner. IA-7: Projects are not interrupted as drawers wait for data.
Stability	IA-1: A fixed constellation of actors is agreed upon. IA-5: A parametric model fixes the parameters of the calculation. Application of industry standards supports selected categories. IA-6: Industry partners deliver to few logistic partners only and do not have to cater to project-specific delivery requirements. IA-7: IBS can focus on business aspects of the project and is no longer involved in the detailed construction by the drawers.
Storing knowledge	IA-1: The construction project report is comprised of all attributes of a construction project that the actors identified as relevant. IA-6: Containers are loaded to cater on-site logistic processes. Industry partners do not need to acquire this knowledge themselves.

Table 2: Expected effects of interaction routines on service networks compared with the observations from the demonstration

shops. Seventy-one percent of the panelists stated that they frequently used software (other than presentation software), such as mind-mapping tools and business process modeling tools, in workshops. The documentation of workshop results and conceptual models was viewed as the most important reasons for using software tools. Almost half of the group (48%) had experience

Criterion	*Description*
	A very good workshop is characterized by . . .
Time efficiency	. . . using the available time efficiently.
Productivity	. . . generating a multitude of productive ideas and proposals.
Communication between participants	. . . all participants being integrated into the conceptual design of the solution.
Structuring	. . . a comprehensible structure that serves as a guideline for problem solving.
Problem focus	. . . all participants being focused on the problem to be solved.
Participants' interest	. . . all participants' interests being stimulated and upheld.
Participants' amusement	. . . all participants taking pleasure in the conceptual design and discussion in the workshop.

Table 3: Potential criteria for evaluating the quality of workshops

with evaluating workshops. Common instruments used for such evaluations were questionnaires, feedback cycles, and one-on-one interviews.

During the study the experts added several items to the initial list of criteria: *focus on results* (mentioned eight times), *in-advance preparation of participants* (mentioned five times), *moderator's performance* (five times), *composition of the group* (three times), and *practicability of the results* (three times). Table 4 shows the complete set of quality criteria sorted by relevance, as assessed by the panel. The primary sort key is the median as stated in the second round of the Delphi study (M_2), followed by the arithmetic mean and then standard deviation (ascending). The results show that none of the items that were initially provided was rejected by the panelists, so their relevance remained undisputed ($M_2 = 4$, $\bar{x}_2 \geq 4$).

Ex-ante expectations

In the second round of the Delphi study we asked the panel about their exante expectations of the effects of the FNA tool based on a selection of the Standard deviation Arithmetic mean identified evaluation criteria. Five criteria, that are not impacted by the use of a software tool like the FNA (e.g., the composition of the group), were excluded. The Delphi panel assigned the highest values to the effects of the tool on productivity, time efficiency, and the overall workshop structure (cf. Figure 5).

Relevance	*Second Round of the Delphi Study*		
from 0 (low) to 5 (high)	M_2	$\bar{x}_2$	SD_2
Productivity	4	4.13	0.56
Time efficiency	4	4.10	0.65
Structuring	4	4.10	0.79
Participants' interest	4	4.06	0.73
Moderator's performance	4	4.03	0.66
Focus on results	4	4.03	0.71
Communication	4	4.00	0.73
Advance preparation of participants	4	3.77	0.72
Composition of the group	4	3.74	1.03
Practicability of the results	4	3.42	1.26
Problem focus	3	3.45	0.62
Participants' amusement	3	3.19	0.70
Working atmosphere	3	3.13	0.76

Table 4: Results from the Delphi study

Ex-post evaluation

In November and December 2009, we observed a series of five workshops in which the FNA tool was used. The purpose of the workshops, which were attended by a panel of domain experts, was to design a facility management reference model (referring to the management of real estate along a building's entire lifecycle). After each workshop, the participants were asked to rate the workshop quality in terms of the five criteria. Eight domain experts and one information modeler responded.

Overall, the workshop participants perceived that the FNA tool had a positive impact on the workshops (Figure 6). Our own observations of the workshops reinforced this view especially in terms of the effect of the FNA tool on workshop structuring, that is, tracking workshop progress and results. Qualitative feedback from the participants also indicated that the FNA incorporates the design principles of modularity and social construction (Table 5).

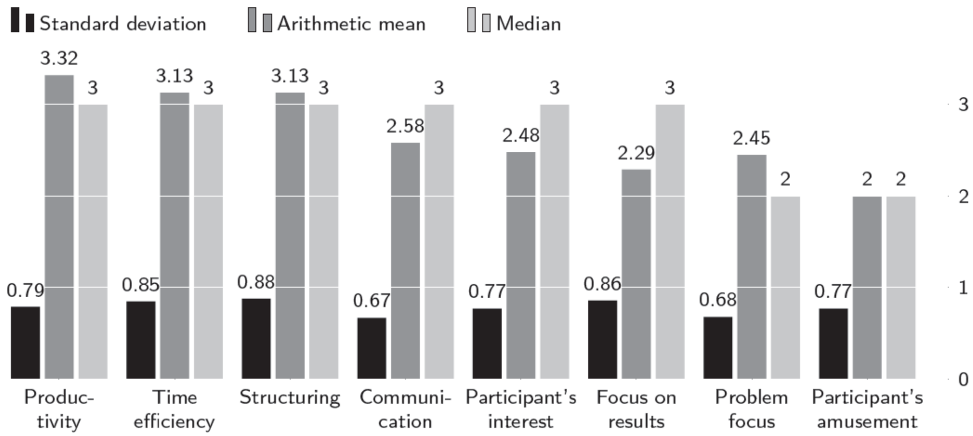


Figure 5: Expected impact of the FNA on workshop quality

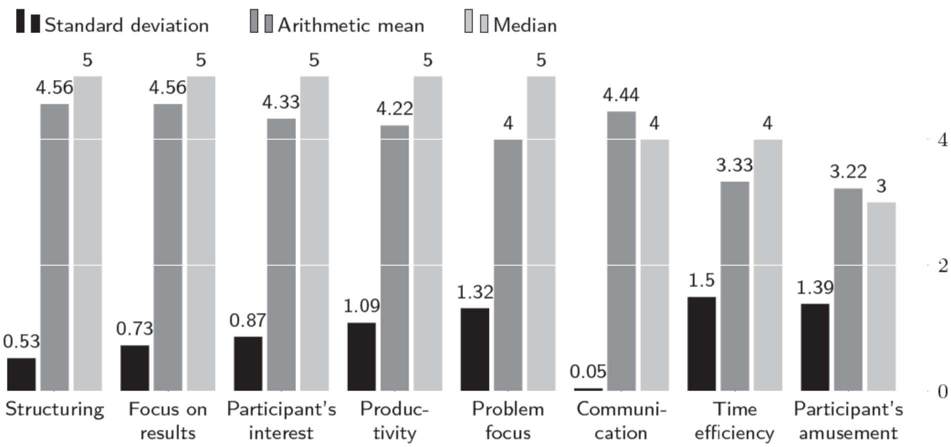


Figure 6: Overview of the perceived effects of the FNA on workshop quality

Participant	*Quote (translated from German)*	*Related design principle*
Facility Management Consultant	"The course of the discussion was visually traceable at all times."	Social construction
Architect	"I was able to directly assess whether my arguments were understood by the other participants as intended."	Social construction
	"I was able to trace the changes in the model at once and intervene, if necessary".	Social construction
Facility Manager	"[The FNA is] a good support for breaking down the complex problem of modeling cooperation in value creation into smaller sub-problems, which allowed us to focus the discussion on these sub-problems. This improved idea generation."	Modularity
	"All relevant actors are represented in the model. Therefore, the respective spokespersons can argue for their own points of view if their items are affected."	Social construction

Table 5: Exemplary quotes from feedback interviews

Comparison

Next, we compare the ex-post workshop evaluations with the ex-ante expectations provided by the Delphi panelists (Figure 7). The data indicates that the workshop quality, as it was perceived ex-post by the workshop participants, was better than the ex-ante expectations of the expert panel (Except for time efficiency, all differences in the mean ratings are statistically significant with $p < 0.01$). The Delphi panel members and the workshops participants disagreed on the top effects of the FNA: while the Delphi members expected the strongest effects to be on productivity, time efficiency, and workshop structure; the workshop participants perceived the strongest effects to be on workshop structure, focus on results, and communication. Other noteworthy differences between expectations and perceptions included the tool's perceived impact on time efficiency, which the workshop group rated relatively low, although the Delphi panel expected the greatest impacts here. The largest discrepancy concerned the focus on results. On the basis of these findings, one might argue that the use of the FNA improves effectiveness in terms of workshop results, but not necessarily overall productivity and time efficiency.

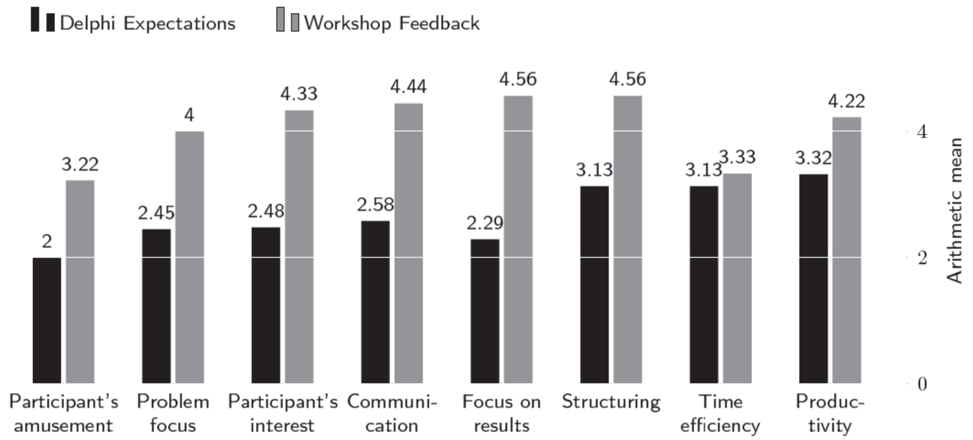


Figure 7: Comparison of ex-ante expectations and ex-post evaluations

7 Discussion

7.1 Contribution

The results developed in this paper render four major contributions. First, the Service Network Interaction Modeling Notation adds to the theoretical conceptualization of interaction routines in networks. Whereas the academic discussion on interaction routines often takes place on a comparatively coarse level of detail, the developed modeling language provides a fine-grained conceptualization of the major theoretical concepts and organizes them in a hierarchical manner that can be used to inform the design of the ostensive aspect of interaction routines in network constellations. Many other modeling languages in the service science discipline focus on describing service business models, the structure of service offerings, web service orchestrations, or aspects of resource utilization (Becker et al. 2010; Razo-Zapata et al. 2012; Kohlborn & La Rosa 2012). For instance, the interaction part of the comprehensive Universal Service Description Language (USDL) is geared toward orchestrating web services based on specifying interaction protocols (Kylau 2012), whereas the Business Collaboration Design Framework (Orriens & Yang 2005) provides modeling constructs for business collaborations on a business model level, a conceptual level, and a logical level. Our modeling language differs from these approaches in that it focuses closely on systematizing interaction routines in service networks on nested hierarchical levels (including Interactions, Bricks, Modules, and the Interaction Space, as well as Actions, Areas, and Actors), following the tradition of conceptual modeling frameworks, such as the Supply Chain Operations Reference Model (SCOR) (Supply Chain Council 2012). Our approach also differs in several ways from the method presented by Colombo et al. (2004), which can be used to specify the coordination and control requirements of business transactions on a dyad level with a strong focus on the implementation of e-services. For example, our approach aims at designing interaction routines in cooperative network settings that can include more than two actors, instead of focusing on hierarchical scenarios of "*vertical quasi integration*" (Colombo et al. 2004, p. 372, italics contained in the text). Our approach is also geared to the conceptual level, without the intention to develop executable web services, although the resulting models can inform the design of e-services. For this purpose, our approach allows for the inclusion and analysis of process models (including event-driven process chains, UML activity diagrams, and business process modeling notation diagrams) on a detailed activity level and for the identification and specification of appropriate e-services (Beverungen et al. 2008). Therefore, our ensemble artifact represents a new tool that is ready-to-use for practitioners to design interaction routines on varying levels of abstraction and detail. For researchers, the here developed and evaluated modeling language builds a flexible foundation to describe and analyze interaction routines observed in practice, for example, in order to identify and explain variations in the performative part of routines (Gaskin et al. 2011; Thummadi et al. 2011).

As a second contribution of this study, our workshop approach was designed to guide the interactive modeling process in which interaction routines in service networks can be analyzed and (re-)designed by involving all relevant network actors into the process. Other approaches have outlined the benefits of a participatory design process (Sanoff 1973) based on a social process of teaming with the relevant stakeholders, which has some of its roots in the Scandinavian research tradition (Loebbecke & Powell 2009). For instance, the concept of the Future Workshop was originally proposed as a means for citizens to contribute to public planning (Jungk & Müllert 1987), but it was also adapted to system development (Kensing 1987), where it consisted of critique, fantasy, and implementation phases. Our approach differs in that it is aided by a software tool and in that it builds on the social construction of technology approach, including iterative cycles of design, sense-making, and negotiation. In addition, the approach involves actors who are peers in the network, whereas participatory design is traditionally geared toward facilitating interactions between designers and users (Loebbecke & Powell 2009). Our approach provides practitioners with a proven blueprint for the organization of productive workshop sessions. From a research perspective, the presented approach and tool provide new opportunities to study the social processes taking place in such workshops by automatically logging performed design activities and digitally capturing the resulting conceptual models.

The third contribution of our work is that it takes a step toward integrating the research streams of modular design and social construction. Modularity has been identified as a strategy to cope with network complexity, and the social construction process has been identified as a means to address the social and emergent nature of service network formation. Together, these two core design principles guided the development of the Service Network Interaction Modeling Notation; the FNA, as the software tool that provides an environment for using the notation; and the workshop method in which the modeling process is carried out as a social design activity. In combination, the resulting ensemble artifact features a built-in socio-technical approach to the design of interaction routines in networks that simultaneously accounts for the complexity and social design of service networks. The approach we present is innovative since much of the current literature favors either a technical or a social construction standpoint, without integrating both views into one coherent approach.

Finally, we contribute by developing a set of evaluation criteria by which workshops can be evaluated, remedying the lack of accepted evaluation criteria. The evaluation criteria, which were constructed in a Delphi study with a panel of thirty-one experts, will be used in additional evaluations of our approach. In addition, they can also guide evaluations of other workshop approaches that are supported by computer-aided design tools.

7.2 Limitations and Future Research

Our study is not without limitations, which suggest opportunities for future research.

We tried to provide an authentic demonstration and evaluation of the FNA using natural settings and potential real users, rather than controlled settings and random participants (e.g., lab experiments with students). While such an authentic evaluation contributes to ensuring the relevance of our research, it also poses a potential risk in terms of validity and reliability. Therefore, future evaluations should focus on measuring the effects of the FNA using more controlled settings, such as true experimental designs that use additional observational data like arguments outlined to justify a proposed design, opposing design proposals, negotiation mechanisms, or facilitation interventions that lead to or fail to lead to a consensus among participants. This data could be triangulated with the resulting model of interaction routines in order to analyze how network participants go about designing network interaction routines and to extend the guidance offered by the workshop method. Along with this, the required skills and behavior of the workshop facilitator, who operates the FNA, call for detailed investigation in the future.

Another limitation relates to our focus on specific service network configurations. We assumed that competitive advantage can be generated from a service network and that the interaction routines are performed with sufficient frequency so the additional design efforts will pay off. These assumptions pose the question whether the proposed approach is also valuable to other network configurations, such as arm's length, market-based interactions (e.g., sourcing of logistics services); networks that are focused on the development of new offerings (e.g., strategic alliances in the telecommunications industry); and networks that are focused on the distribution of standardized goods or services (e.g., retail supply chains). In this context, similarities and differences in designing interaction routines for service-oriented versus product-oriented networks should be researched in future. In this regard, current theory and literature, such as the service-dominant logic (Vargo & Lusch 2004), suggest that service networks call for more intensive interaction.

A limitation of this paper can also be seen in the case that we reported as it was characterized by a strong focal firm (i.e., IBS) that promoted the workshop-based application of the FNA. While this power asymmetry helped to promote the use of the tool and fostered the social construction process, power asymmetries may also present barriers to collaborative design, sensemaking, and negotiation. Therefore, a further particularly promising phenomenon to be investigated in future research is the role of power in developing network interaction routines, as the question concerning to what degree social construction processes of interaction routines are affected by an asymmetric distribution of power remains to be examined. Existing theory, such as agency theory (Eisenhardt 1989), suggests such effects.

8 Conclusion

The purpose of this study was to develop and evaluate IT artifacts to support the design of interaction routines in service networks. We addressed this objective in a design science research project that was informed by two core design principles: that modular design is a viable strategy for coping with the complexity faced in service networks, and that a model that documents the structure of a network must be socially constructed by the network participants. Based on these design principles, we designed three IT artifacts that facilitate the analysis and design of suitable interaction routines in service networks: a hierarchical conceptual modeling language, referring to the design principle of modular design; the FNA software tool as a modeling environment that designers can use to depict, analyze, and design interaction routines in networks by using the modeling language; and a workshop method that guides the use of the modeling language and the FNA in a social construction process. We outlined how this tool-based workshop concept has been successfully demonstrated and evaluated in service network scenarios and reported results obtained from investigating the case of a service network in the construction industry. This investigation suggested that the workshops enabled the participants to analyze and design adequate interaction routines with which to exploit their organizational complementarity.

Notes

1. For presentation purposes we present the demonstration and evaluation out of their original chronological order. We demonstrated the FNA also in other scenarios prior to the evaluation (earlier in 2009), but we decided to report on the demonstration of the FNA at IBS (in 2010) as we consider this case to best illustrate the utility of our ensemble artifact.

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