ARCHITECTURE CONCEPTS FOR VALUE NETWORKS IN THE SERVICE INDUSTRY

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ARCHITECTURE CONCEPTS FOR VALUE NETWORKS IN THE SERVICE INDUSTRY

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Abstract

Value networks are one of the main forms of value creation today. Suppliers, manufacturers and customers form a dynamic collaboration structure. Networks and companies alike are always subject to external and internal influences which require changes in the way things are done. To make sure that the required changes take their intended effect, they have to be implemented on all levels of the enterprise architecture (EA). Research with respect to EA in value networks in the service industry (VNSI) is only in its beginnings. To understand the state of the art, we analyzed 88 papers with respect to the architecture layers in VNSI. Since we base on the fact that a successful introduction of change, e.g. new IT solutions, requires a holistic view on EA, we analyzed the papers according to their covering of the different levels of an EA. Our hypothesis is that most of the papers only cover very specific aspects without positioning their proposed solution in a holistic context. We propose a reference model based on a literature review as well as the results of the paper analysis. This reference model allows for a positioning of solutions in a holistic context and with that adds to a better basis for implementing change in VNSI.

Keywords: Value Network in the Service Industry (VNSI), Enterprise Architecture (EA), Architecture Concepts, Literature Review
Introduction

The quest for ways of changing an organization successfully is ongoing. The current discussion agrees upon the fact that organizational change needs to be driven by integrating all relevant layers of the organization (Aier et al. 2009). Typical examples for this are customer relationship management (CRM) projects. Most CRM projects fail because of the one-sided view on information and communication technology (ICT). Most organisations concentrate on the implementation of the new CRM system, but they do not adapt their processes or corporate culture. Without this, the CRM project is bound to run for a longer time than anticipated and can be very expensive and difficult. The main problems of failed CRM projects are the missing adoption of a customer-driven culture and customer-driven processes. Before implementing the CRM system, most organizations do not think about and define the business problem. In this case, the change process cannot be implemented successfully. The organisation has to take a holistic view on all relevant aspects a customer-driven orientation requires (Krügsman 2010). This implies that the change process has to cover all aspects from strategy to processes and ICT as well as corporate culture. These layers represent the constituents of enterprise architectures (EA) and serve as a basic model for dealing with the change process (Winter & Fischer 2006; Kluge & Dietzsch & Rosemann 2006). The representation of the system “organization” by using EA models enables a systematic and holistic management of the intended changes. It is neither necessary nor efficient to always define a comprehensive, i.e. all-covering, EA model. However, it is considered beneficial for a proof of concepts and solutions to validate them in the context of the “whole picture” (Aier et al. 2009). This means that each proposal or solution which deals with a specific architecture layer should be embedded in a comprehensive EA model. The interdependencies and consequences for the whole picture should briefly be discussed and the contribution of the solution set into perspective. We have observed a major gap in the current literature: very interesting concepts and solutions are discussed, but there are only very rarely set into perspective within a holistic framework. Considering the fact that change can only be successful if it becomes effective on all organizational layers (Winter & Fischer 2006), there seems to be a need for an EA model that supports the holistic view.

However, the different organizational models for value creation often require different solutions with respect to the supporting architecture. To focus the analysis, we concentrate on one specific form of organizing value creation, i.e. value networks. Value networks integrate different suppliers of goods and services, very often also a service integrator, and most important of all, the customers. A value network thus is a cooperation of legally independent organizations which create value based on collaboration (Allee 2008). As a consequence, we find a certain resource dependency related to value creation, but normally also less transaction costs and risk allocation within the network. The value network offers an extension of business activities and a possible focus on core competencies for each single organization. At the same time, the integration of customers in the value creation process plays an important role for its quality. There has been some research on how more traditional value networks, e.g., in the automotive industry, can be managed and how they can be supported by architectural concepts (Liu et al. 2004). However, little work has been done so far on holistic architecture concepts for value networks in the services industry (VNSI). Owing to the importance of networks in today’s value creation and the gap in the current research, we focus our analysis on VNSI. The aim was to identify the focus of the proposed solutions for the different architecture layers in VNSI. Moreover, it was our aim to propose a conceptual EA model for positioning solutions in a holistic context and analyze the papers with respect to the already existing adherence to the model. This EA model aims to be a reference model not only for positioning specific solutions on the layer it addresses, but also to show the effects a certain solution has on the other layers and even the EA as a whole. This helps to identify and possibly reduce undesirable side effects within the VNSI. For example, if an organization in the VNSI detects security gaps in its technical infrastructure and a solution is proposed to close these gaps, it has to be considered that the solution might have an effect on the processes and with that maybe even on the way collaboration happens in the VNSI.

As a consequence, the research question aims at proposing an adequate reference model for positioning solutions dealing with different EA layers within a holistic context. The contribution of this paper is first of all the proposed reference model, which is in a first step derived from general EA literature and then checked against the analyzed literature which deals specifically with VNSI. Secondly, we present the state of the art of research on EA for VNSI and the focus of the proposed solutions. Based on that, the rest of the paper is organized as follows: After having presented a short introduction of the EA approach, we propose a conceptual EA model with three layers in the context of VNSI (section 2). It serves as a frame of reference for the literature review we conducted to gain an overview of the state of the art of research on EA for VNSI. We have analyzed 88 papers with respect to the architecture layers addressed and the solutions presented (section 3). With this step we test our hypothesis that in most of the papers, we do not find an embedding of the solution within a holistic EA model. Additionally, we
analyzed the main topics of these papers to identify the most important requirements the EA model for VNSI has to meet. In the next step, we improve the conceptual EA model for VNSI which then includes all aspects for positioning architecture solutions for VNSI in a holistic context (section 4). We then present some implications of our results (section 5) and conclude with a short summary and an outlook on the next steps of our research (section 6).

We used the indicator method (Bailey 1994) to develop our EA model. In his three-level measurement model Bailey (1994) described the conceptual level as a deductive method with theoretical value. The empirical method is the non-theoretical counterpart of the conceptual method. The indicator method is a combination of the conceptual and empirical method. First, we have developed the three levels of our EA model based on general research literature (Figure 1) and then we conducted a focused literature review to refine the EA model (Figure 2). We base our literature review on the concept-centric approach of Watson and Webster (2002). The aim of this approach is the conceptual determination of the organizing framework instead of the school of thought of the author. As a consequence, this method is classified as a qualitative review (King & He 2005). The six-step model by Cooper et al. (2009) is used to select the sources, evaluate and analyze the data as well as to interpret the results (section 3). Accordingly, we identified and formulated the underlying problem, selected the leading journals and conferences by considering three widely respected rankings for IS journals and IS conferences: Association for Information Systems (AIS), Verband der Hochschullehrer für Betriebswirtschaft (VHB)-Jourqual, and the Wissenschaftliche Kommission Wirtschaftsinformatik (WKWI). From each of these rankings, we selected five top-rated journals. We removed from these 15 journals three duplicates and three journals with focus on technology aspects only. We included five leading journals with focus on service management to take into account the focus on VNSI. As a result, we gained 14 journals. Furthermore, we added four IS conferences and one service conference considered important. The results are listed in Table 1. The selected time frame spans the years between 2000 and 2008, since during that time the majority of contributions with a focus on EA could be found.

<table>
<thead>
<tr>
<th>Table 1. Selected journals and conferences</th>
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</thead>
<tbody>
<tr>
<td>Journals</td>
</tr>
<tr>
<td>Conferences</td>
</tr>
<tr>
<td>European Conference on Informations Systems (ECIS), Hawaii International Conference on System Sciences (HICSS), International Conference on Informations Systems (ICIS), Services Marketing Special Interest Group Research Conference (SERVSIG), Wirtschaftsinformatik (WI)</td>
</tr>
</tbody>
</table>

**Definition of an enterprise architecture for VNSI**

Since the success of a change initiative is based on the coordination of all architecture layers and their interaction, we base upon system theory to define the term EA. According to IEEE (2000), the rules for the design of an architecture base on the specification of the components and their attributes and relationships. As a consequence, an EA is a system formed of specific components which have distinct attributes and are interrelated. Each change initiative unbalances the system which reacts with an adaptation process on each layer.

Most EAs base on frameworks like, the Zachman- (Zachman 1987) or the CIMOSA-Framework (AMICE 1989). Winter and Fischer (2006) defined five hierarchical architecture layers which they deduced from frameworks found in literature (e.g. Schekkerman 2006, Lankhorst 2005, Ross 2006, Bernard 2006, van der Torre et al. 2006, Simonsson et al. 2006, Lindström et al. 2006, Johnson & Ekstedt 2007, Balabko & Wegmann 2006, The Open Group 2007): Business architecture, process architecture, integration architecture, software architecture, and technology architecture. To effectively use the concept of EA, it is required to respect the interdependency of the architecture layers, because a change on one layer affects the others. However, we reduce the number of layers in the context of VNSI to three (Brown & Karamouzis 2001) to facilitate the analysis of the selected papers and to provide an “easy-to-use” framework for an integrated view on solutions (Figure 1).
The process architecture integrates the business architecture since the focus of the EA for VNSI is on the support of the network processes which operationalize the pursued strategy and thus are essential for the analysis of effects within a holistic context. As a consequence, organizational aspects, e.g. roles or sales channels, are also assigned to this layer. The application architecture incorporates the integration and software architecture. It represents applications, application domains, functional services, information system functionalities, information objects and information flows as well as interfaces (Winter & Fischer 2006). Additionally, it includes software components and data structures. The system architecture describes the technical infrastructure and related concepts, such as required hardware components or security concepts.

Analysis of the state of the art of architecture concepts for VNSI

In this section, we present the results of the review of EA models and solutions for VNSI found in academic literature. We have analyzed the papers according to the coverage of the architecture layers and the topics. First, we present the results according to the coverage of the architecture layers to show that most of the papers do not take a holistic view on EA. After that, we analyze the main topics, the architecture layers have to support. These topics are at the same time “requirements” for being able to understand the implications of the proposed solution in a holistic context. From that, we deduce an EA model for VNSI which includes the important requirements each architecture layer has to deal with.

Architecture concepts in literature for VNSI

The analysis of the papers showed that the process architecture is in the focus of attention of many papers. There are some researchers who explicitly deal with challenges and solutions for the process architecture (Gittel 2002, Gellrich et al. 2005). They focus on relationships and dependencies within the VNSI. Other research analyzes the process architecture with respect to change management in VNSI (Enquist et al. 2004) and investigates possible implications for change management. All these papers focus solely on process architecture. Some authors additionally take into account the application architecture to support process integration (Larsen & Klischewski 2004, Brohman et al. 2005, Tyler 2005). The main focus here is the IT support for value creation processes. For example, Saatcioglu et al. 2001 concentrate on the design of an internet portal. In this context, the application architecture plays an essential role for supporting value creation on an internet portal. None of these papers explicitly consider the system architecture as a layer to implement the processes or applications.

Moreover, workflow management seems to be a common topic when dealing with the process layer. Many research papers concentrate on this special issue (Stricker et al. 2000, Klischewski & Wetzel 2001, Meng et al. 2001, Seifert & Wimmer 2001, Stormer & Knorr 2001, Barretto et al. 2002, Hess 2002, Shin 2002, Stroeken 2003, Benlian et al. 2005). In combination with this topic, we found a very strong connection with application architecture. Workflow management coordinates the tasks in a VNSI and for this not only the right process design is essential but also the right IT support. Based on the impact of internet technology, some authors examine collaborative processes in the
context of e-commerce (Nambisan 2000, Welty & Becerra-Fernandez 2001, Stehling & Moormann 2002, Fairchild & Peterson 2003, Borman 2004). In this context, most authors also consider the application architecture for the implementation of the different requirements concerning value creation processes in the VNSI.

The next important topic we found with respect to VNSI is the information flow between the members, i.e. organizations, in the network. The information flow in a VNSI is usually facilitated by ICT which is represented in the application architecture. When dealing with the information flow, most papers consider the process architecture as an information producing and consuming entity as well as the application architecture as a facilitator. The data or information integration is one focus which can be found with respect to the information flow (McGrath & More 2001, Chi et al. 2004, Pan & Vina 2004, Pardo et al. 2004, Gil-Garcia et al. 2005, Shore 2006), information sharing is another focus (Grimson et al. 2000, Itala et al. 2005, Li & Lin 2006, Horan & Schooley 2007, Madlberger 2008). Some solutions presented also deal with data quality to guarantee an effective and efficient use of information (Shankaranarayanan & Cai 2005).

Knowledge management is also in the focus of some of the papers which deal primarily with the information flow (Kortzfleisch & AlLahar 2000, Pedersen & Larsen 2001, Levy et al. 2003, Taylor & Levitt 2005, Eriksson et al. 2007, Hustad 2007, Lertpittayapoorn et al. 2007, Yang & Kim 2007), others extend the scope and concentrate on decision support (Dutta & Heda 2000, Rao & Turoff 2000, Pullman & Thompson 2003, Cheung et al. 2005). Communication and coordination between the network partners is an additional topic in collaborative environments (Kwok et al. 2001, Ayad & Sol 2002, Ramesh & Dennis 2002). Although the technical infrastructure plays an essential role with respect to an effective and efficient information flow in a VNSI, only few papers implicitly consider the system architecture, but none of the authors discusses the technical infrastructure explicitly, e.g. with respect to security concepts.

Many of the identified research papers discuss special applications as, e.g., customer relationship management (CRM) systems (Geib et al. 2005) or group support systems (Appelman & Qureshi 2001) as solutions for the application architecture. Most of these papers also consider the process layer, but none of them explicitly integrates all layers in its approach. Sherlock & Chismar (2006) try to transfer the findings on airline reservation systems on electronic healthcare records, to share and store huge amounts of information via the internet. Data warehouse systems offer limited support for decentralized organizations. Sinz et al. (2001) conceptualize a data warehouse system for universities, which has special architecture attributes for the support of a VNSI. Bajwa et al. (2003) analyze seven IT clusters (e-mail systems, audio teleconferencing, videoconferencing, data conferencing, web-based tools, proprietary groupware technology, and electronic meetings systems) to support collaborative tasks in a VNSI. They collected data from 259 Australian and US organizations to analyze adoption patterns. Moreover, authors found that the dependencies in a VNSI influence relational investments of an organization and its electronic collaborations. The more dependent an organization is from other organizations in the network, the more it spends on relational investments and means of electronic collaboration (Léger et al. 2005). Concepts like enterprise application integration (EAI) found much attention in research papers. The concepts reach from implementation methods (Tomann & Steck 2005, Khoubati et al. 2005) to reference architectures (Puschmann & Alt 2001). Most of these papers implicitly consider all layers of the EA but they do not embed their approaches explicitly in an EA model. The same can be said with respect to service-oriented architectures (SOA) (Homan et al. 2004). Even researchers focussing on ICT mainly present a non-technological view on these issues (Peterson et al. 2000, Spanjers et al. 2001, Hengst & Sol 2001, van Laere et al. 2001, Stare et al. 2006, Kuo & Chen 2008, Davidson & Olfman 2004, Krishnan 2001, Schubert & Leimstoll 2007). Most of these papers consider the information flow in VNSI which is necessary for the value creation processes, but do not explicitly explain technical aspects for implementing the infrastructure. Mostly, these papers do not integrate the process architecture in their approaches.

Only a few research papers explicitly take into consideration the system architecture. Kwok & Chiu (2004) discuss the system architecture with respect to web services (connecting it to the application architecture) to support content management in VNSI. Moreover, a focus on system architecture with respect to services, interfaces (Ayad & Verbraeck 2003), and security aspects (Schmaltz et al. 2005, Chiu & Hung 2005) can be found. Another perspective which was discussed in the paper is the implementation, change, or governance of system architecture (Salmivalli et al., 2008, Forman & Gron 2005, Homburg-Bekkers 2002, Regio 2002).

Only a few of the analyzed papers propose solutions for all architecture layers or embed their approaches in a holistic context. They primarily explain process integration within VNSI and position it in the context of EA. Thus, they take on a holistic view and consider the effects on and support of the whole value creation process within VNSI (Papazoglou et al. 2000, Brenner et al. 2001, van der Aalst & Kumar 2003, Baltacioglu et al. 2007, Janssen &
Table 2. Results of the analysis of the research papers according to their coverage of the architecture layers

<table>
<thead>
<tr>
<th>Additional Architecture</th>
<th>Primary Process Architecture</th>
<th>Application Architecture</th>
<th>System Architecture</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>Process Architecture</td>
<td>3</td>
<td>34</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Application Architecture</td>
<td>21</td>
<td>6</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>System Architecture</td>
<td>2</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All</td>
<td></td>
<td></td>
<td></td>
<td>12</td>
</tr>
</tbody>
</table>

To sum up, it can be said, that most of the research papers focus on processes in combination with application architecture. 34 papers could be found with a main focus on application architecture to support the processes for value creation and 21 with a main focus on process architecture supported by application architecture. Implicitly, some of these authors have considered system architecture, but they do not explicitly discuss the technical infrastructure in their approaches. Three papers focus only on process architecture and six solely on application architecture. Only four of the authors who primarily examine the process or application architecture also address system architecture explicitly. The main focus on system architecture could only be found in eight of all relevant research papers. Only 12 of the relevant sources discuss all layers of the EA.

**Topics of architecture concepts in literature for VNSI**

As mentioned, the main goal of our EA model is the facilitation of positioning solutions for value creation in VNSI in a holistic context. Therefore, requirements have to be defined which specify the qualitative and quantitative attributes for each layer of the EA model. These requirements are deduced from our literature review. We analyzed the main topics (a-g) on each architecture layer (Table 3) to identify the important aspects, which have to be considered in a VNSI.

In the next chapter, we complete the conceptual EA model for VNSI by considering the three architecture layers explained in Figure 1 and integrating the important topics or requirements, respectively. (Table 3) we have identified based on our literature review.
<table>
<thead>
<tr>
<th>Primary architecture layer</th>
<th>Topics</th>
<th>Author/Year</th>
</tr>
</thead>
</table>

**Enterprise architecture model for VNSI**

The requirements relate to tasks and activities which are crucial for supporting value creation of a VNSI: the production of services. As we can see for the process architecture, the main topics are process integration (cf. Table 3, a), workflow management (cf. Table 3, b) and e-commerce (cf. Table 3, c). Here, the main tasks which have to be supported by the EA model are the identification of service components and subsequently their evaluation and selection as well as the compilation of full service packages (Baldwin & Clark 2000; Hoogeweegen et al. 1999). In this context, the time and complexity of the integration have to be defined and customer needs have to be considered (Basole & Rouse 2008).

To support the production of services, the facilitation of the information flow between all members of the VNSI and their respective communication, are a main requirement. It has to be defined, who needs which information, how often and in which form the members have to deliver and receive it. As a consequence, information integration, information sharing and management of data quality are important requirements for application architecture (cf. Table 3, d). Moreover, the communication process between the network members and with the customers has to be defined (Karmarkar 2004). In this context, many authors consider the information flow with respect to knowledge management or decision support (cf. Table 3, e). In addition to that, special solutions (e.g. EAI, SOA) for this layer have to deal with methods used to standardize activities when developing the application landscape and its supported information and communication technologies (cf. Table 3, f) (van Heck & Vervest 2007).
The requirements for the layer of the system architecture relate to the operation of the technical infrastructure. Here, solutions for VNSI have to deal especially, e.g. with management of services and interfaces and the management security concepts like access authorization or the definition of user profiles (cf. Table 3, g) (Basole & Rouse 2008).

Figure 2 shows the different layers of the proposed EA model for VNSI completed with the identified requirements for each layer (cf. Table 3). It supports a holistic view on EA solutions and helps to position each solution according to the requirements it intends to address. Moreover, it helps to analyze the overall consequences of a solution (e.g. a change solution) within the EA.

**Figure 2. Enterprise architecture model for VNSI**

**Implications of the results**

The framework presented above can be used as a reference model to position solutions and discuss their overall effects within an EA. This is especially important in a VNSI because each change does not only affect one organization but normally all organizations within the network.

Both, the EA model and the holistic view for solutions are helpful mechanisms in a VNSI to implement flexibility, agility, consistency, compliance, and efficiency. Moreover, it is the main facilitator of systematic change driven by new solutions. An EA model represents an integrated framework for the change process within a VNSI. However, it is not efficient to model each layer in detail, when solutions are discussed for a specific layer. Nonetheless, it is necessary to ensure the success of the whole definition, implementation and change process of a VNSI to position even very specialized solutions within the whole framework to consider side effects and possibly unintended consequences. For example, if the approach focuses on process integration in a VNSI, it is necessary to understand, how this will affect the information flows and communication in the network and also the aspect of security measures. Missing security measures like access authorizations or defined user profiles could cause undesirable effects for the whole network and could endanger the whole ICT infrastructure in the network even though the proposed solution is beneficial.

The second open point in the analyzed literature is the technical perspective of supporting a VNSI. Here, conflicting goals can be found: on the one hand, a network becomes more valuable if organizations can be easily added or removed. This poses complex requirements for the system architecture with respect to capacity and also security. Without having solutions on this level, all the other approaches cannot be successfully implemented. This means that more research effort should be invested into the implication of current research for the technical perspective and the overall feasibility of proposed solutions.
Flexibility in a VNSI is an important topic. Organizations cooperate to reduce costs, risks and extend their competitive advantage. They should react fast and efficient to changing environmental influencing factors. An EA model helps to implement standardization and simplification in a dynamic environment of VNSI. These topics should be explored in even more detail than can be found in the existing literature.

For example, the research paper by Sherlock & Chismar (2006) does excellent work analyzing computerized reservation systems (CRS) of airlines and adopts the results on electronic health records (EHR). The main focus is sharing and storing huge amounts of information, based on internet technology. Sherlock & Chismar (2006) consider the turbulent evolution of CRS and show their mistakes. Adopting these results on EHRs they argue that the development of EHRs can be achieved much more easily because of identifying similarities between the two systems and because of the knowledge about the mistakes from CRS. The paper primarily considers the application architecture. In addition, it shortly discusses effects on supporting process integration through workflows and considering the customer needs. It also shortly discusses the management of interfaces. But it does not take a holistic view on the EA. Explicitly considering the process integration on the process architecture and the establishment of security measures on the system architecture would support a more effective development on EHR. It would also help with a better understanding the interdependencies between single requirements on each layer of the EA and for reducing mistakes in change processes.

Conclusion and outlook

The importance of EA and respective models is mirrored in a high number of papers dealing with various challenges of EA with respect to support the value creation process. Especially when solutions for inter-organizational value creation are concerned, EA plays an important role for driving this effort. The success of developing and changing a VNSI is dependent on a holistic approach considering each layer of the EA. However, the analysis of 88 papers from relevant sources showed that most of the papers address parts of the EA, but only rarely consider the whole picture and the effects and consequences. Most papers focus on process and application architecture. Only four papers also address the system architecture to show investment and security measures. Eight research papers mainly focus on system architecture and only 12 of 88 papers consider all architecture layers of the EA. We have also identified different topics on single architecture layers to support the value creation in a VNSI. For the process architecture we have identified process integration, workflow management, and e-commerce. For the application architecture mentioned topics were information flow, information integration, information sharing, data quality, communication, knowledge management, decision support and special applications, EAI, SOA as well as ICT. For the system architecture we have identified services, interfaces, and security. We propose that papers dealing with solutions in the context of VNSI should position their approach within the three-layered EA model and briefly discuss the interrelation to and the consequences for the layers their approach does not explicitly address. With this, the prerequisite that successful change has to be effective on each layer of the EA can be taken into account.

Moreover, the analysis brought to light that the layer of the system architecture seems to be neglected although it is important for finally implementing the solutions and concepts from other layers. This implies an open field for more research, e.g., on technical management as well as security concepts, in this area. A next research step could be to verify our EA model for VNSI by an empirical analysis based on interviews with CIOs and executives of organizations in VNSI.
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