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Classification Criteria for Governing the Implementation Process of Service-oriented ERP Systems – An Analysis based on New Institutional Economics

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ABSTRACT

Service-oriented ERP systems promise to allow for a fine-grained alignment of IT with the specific functional requirements of an organization's business processes. In this regard, studies particularly emphasize the potential to flexibly exchange services by means of market-based transactions. One important aspect widely neglected, however, is the endeavor of governing the implementation process of this new kind of information systems. Having applied New Institutional Economics, our research reveals that this implementation process, on the contrary, even calls for rather hierarchical modes of governance. However, different types of activities relevant to implementing a service-oriented system have to be taken into account. Hence, in this paper we present a set of criteria enabling organizations to classify these activities in more detail and to choose a suitable mode of governance. We demonstrate the approach by means of an example and indicate directions for future research.

Keywords:

Service-oriented architectures (SOA), Enterprise Resource Planning (ERP), Implementation Process, New Institutional Economics, Transaction Costs Theory, Principal-Agent Theory

INTRODUCTION

Service-oriented architectures (SOA) are expected to bring forth a new generation of application systems. Whereas current systems were chosen and operated as self-contained systems of individual vendors, service-oriented architectures allow for the integration of application functionality from different sources internal or external to a company according to individual needs within a specific context. The basic idea of SOA – which this paper is focusing on – is the increased possibility of IT-Business Alignment that is enabled by loosely coupled systems (Venkatraman and Prescott, 1993).

Service-orientation enables the realization of “best-of-breed” ERP systems (Themistocleous, Irani, O’Keefe and Paul, 2001) where Web service-based software modules of different vendors are connected to a system that supports the business processes of an applying organization (vom Brocke, Sonnenberg and Thomas, 2008). When managing the inherent complexity of a service-oriented ERP system properly, the expected benefit is estimated to be significantly higher when compared to conventional ERP systems (Rettig, 2007).

As the number of service-oriented ERP systems increases, SOA becomes a relevant and important subject for companies to decide upon. GARTNER predicts a massive increase in Web service enabled IT-services in the upcoming years (Gartner, 2008). Such IT-services will – according to a Gartner survey – reach a market volume of 261 billion US-Dollars at the beginning of the year 2009. This represents 30 % of the worldwide IT-service market. This leads to a vast number of prospective SOA implementations to be managed in practice.

Managing the implementation process of a service-oriented ERP system brings up new challenges. We have learned from former studies that – apart from technical issues – also the role of the partners involved in the ERP implementation process changes (Schelp and Winter, 2002). More specifically, the implementation process is split up into many micro-

implementation processes for integrating individual services (vom Brocke, Schenk and Sonnenberg, 2008). The implementation of conventional ERP systems was subject to intensive research in the past. The main focus was on analysing the trade-off between system adaptation and business process redesign. Furthermore numerous classifications of implementation processes have been proposed (cf. Brehm, Heinzl and Markus, 2001; Brown and Vessey, 1999; Parr and Shanks, 2000). However the analysis of implications caused by SOA on the implementation process has not been thoroughly conducted yet. With this work we want to identify a first set of criteria that could be used for classifying the sub processes of a SOA-based ERP system implementation process due to its optimal mode of governance of service exchange.

For this purpose we take the perspective of the New Institutional Economics (Williamson, 2000) in order to assess different forms of interaction between vendor, consulting company and applying organization in the implementation process of SOA-based ERP systems. The contribution of this paper is the development of such criteria and their verbal description to make them applicable for usage in further scientific research and for practitioners at the same time. The contribution for the scientific community is an improved understanding of the phenomenon “SOA-based ERP implementation process”, for practitioners a tool to develop suitable institutional arrangements for exchanging implementation services needed to execute sub processes of implementation.

As a research method we mainly rely on a literature review complemented by conceptual-analytical reasoning. As we are in an early and exploratory stage in our research we consider this to be a suitable practise to start with. To our knowledge, little research has been conducted on this topic so far. We therefore analyse existing literature in the field of software implementation of service-oriented ERP systems and synthesize these findings by applying the perspective of New Institutional Economics.

The paper is structured accordingly: First, an analysis of related work on service-oriented ERP systems and their implementation is provided. Subsequently, the fundamentals of New Institutional Economics are presented. Based on this, different types of institutional arrangements between the partners involved in the implementation process are analyzed. The findings of this analysis are synthesized by means of qualitative assessments and criteria for choosing an optimal model of governance for the execution of implementation sub processes with an illustrative example are presented. The paper concludes with summarizing the major results and highlighting the demand for further research.

RELATED WORK

Within the literature many contributions on the topic of implementing conventional ERP systems can be found. Besides proposing critical success factors (Finney and Corbett, 2007; Soja, 2006) much attention is being paid to the integration of end users and increased acceptance of the implemented solutions (Peslak, Subramanian and Clayton, 2008; Ramayah and May-Chiu, 2007; Thamhain, 2004). The adaptation of the ERP system by means of customizing parameters and extended adaptation like the development of add-on programs at defined interfaces in the software is frequently addressed within the literature (Kirchmer, 1999; Parthasarathy and Anbazhagan, 2007; Vathanophas, 2007). Furthermore the realization of competitive advantages through a *business process-oriented* implementation of ERP systems is analyzed (Dai and Duserick, 2006; Sedera, Gable and Chan, 2003; Vathanophas, 2007).

Another important topic in the literature is the trade-off between massive adaptation to business processes and minimal customizing to retain a highly standardized ERP system. Pre-SOA constructs of intensive business process-driven alignment by using components from one or more vendors are covered under the term best of breed approach in the according literature (cf. Themistocleous et al., 2001). Another option is the usage of highly standardized and therefore easily maintainable systems which is described by the term “vanilla approach” (Brehm et al., 2001). SOA is identified as a promising alternative to overcome the trade-off between business-process driven alignment and standardized ERP-systems (Rettig, 2007)

The rising complexity caused by deploying a service-oriented ERP system must be outweighed by the benefits of the SOA solution, therefore justifying an investment in a SOA initiative (Kumar and Van Hillegersberg, 2000; Rettig, 2007; Scott and Vessey, 2000; vom Brocke, 2007).

Prior work focused on implementation and adaptation of conventional ERP systems. However, we noticed that research on service-oriented ERP systems is focused on configuration at run-time only. This could be due to the assumption that the implementation process of service-oriented ERP systems does not differ significantly from the implementation process of conventional ERP systems. We consider this as a critical assumption.

Hence, we started research on the organisational dimension of the implementation process of service-oriented information systems. Within a first approach we analyzed various institutional arrangements for the implementation process-based on transaction cost theory (vom Brocke et al., 2008) and found out that – opposed to the widely cited vision of a move towards a market-oriented coordination – the implementation process on the contrary calls for hiercharchical coordination mechanisms.

However, on that basis, we learned that indeed the implementation process is split up into many sub-processes which vary significantly according to their organizational requirements. Consequently we enriched this concept towards a comprehensive analysis based on new institutional economics (vom Brocke, Schenk and Sonnenberg, 2009). In this paper we continue on this path of research by defining criteria for analyzing single parts of SOA-based ERP system implementation processes based on new institutional economics.

ON THE IMPLEMENTATION PROCESS OF A SERVICE-ORIENTED INFORMATION SYSTEM

New versions of existing ERP suites are technologically based on SOA. However, this fact does not qualify them to be a service-oriented ERP system in the sense of this paper. These web-service enabled suites can be seen as a *hybrid SOA* solution that enables applying organizations to integrate existing third-party applications. However, they remain ERP suites that work best when only components of the same vendor are deployed because they contain proprietary elements.

The implementation process of an ERP system comprises all activities prior the run-time phase of the software lifecycle, e.g. business process analysis, software evaluation and training. As the implementation process of conventional ERP systems is based on the ERP-software and its built-in predefined business processes, we therefore name the implementation “*software-driven*” for the purpose of our analysis.

This is an important aspect to keep in mind when dealing with the implementation of service-oriented ERP systems. In the case of hybrid-SOA-based ERP suites the implementation process does not differ significantly from the implementation process of conventional ERP systems. As for our analysis, these suites are therefore considered conventional ERP suites.

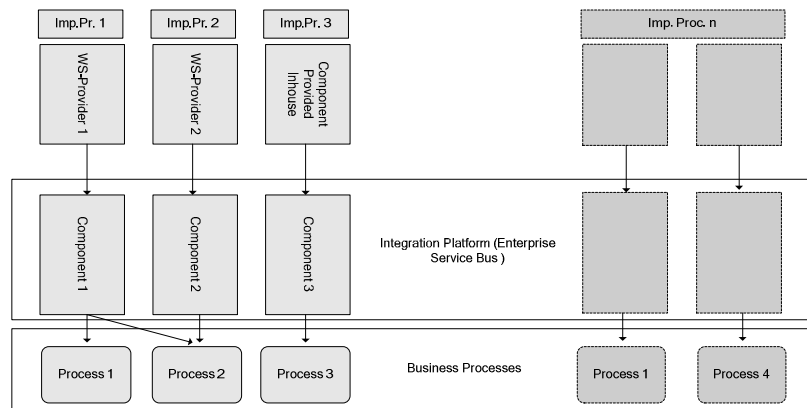


Figure 1. Business Process-driven Implementation Process

A *fully service-oriented* ERP system allows for the integration of services from any kind of service provider. With fully service-oriented ERP systems the exchange and integration of know-how – which is considered as the main implementation transaction – is split up into many smaller transactions (see Figure 1). For selecting and integrating particular services both technical as well as business process-oriented know-how is required. These know-how requirements are expected to differ among the various implementation processes since different business needs, business processes and the service provider have to be considered. SOA-based ERP system implementation overcomes the software focus necessary for conventional ERP system implementation. We will call the implementation of SOA-based ERP systems therefore “*business process driven*”.

THEORETICAL FOUNDATION

Foundations of New Institutional Economics

New Institutional Economics (Laffont and Martimort, 2002; Williamson, 1985; Williamson, 2000) serves as a means of identifying suitable institutional arrangements for the execution of transactions and the exchange of property rights. In particular, it explains economic relationships and the development of organizational settings in a world of imperfect actors characterized by bounded rationality and opportunism (Laffont and Martimort, 2002; Williamson, 1985).

The term agency cost describes the difference between the value of possible First-Best (information available at no cost) and Second-Best solutions (real information retrieval situation). According to the three information problems considered within the PAT (i.e. Adverse Selection, Moral Hazard and Hold-Up), three types of agency costs can be identified (Laffont and Martimort, 2002):

- Signalling cost of the agent (Adverse Selection).
- Monitoring cost of the principal. (Moral Hazard).
- Remaining loss in welfare (Hold-Up).

When considering the Principal-Agent Theory for the design of institutional arrangements, a major design objective should be to minimize the agency cost by finding the Second-Best solution that comes closest to the First-Best solution.

The contribution of the PAT is the integrative analysis of questions concerning the division of labour and specialization on the one hand and questions of exchange and agreement on the other hand. It explicitly takes into account the cost of suboptimal solutions. Not concluded agreements as a result of the prohibitive costs of information are also covered. Furthermore, PAT provides a link to transaction costs, as the costs of initiating a contract (i.e. transaction costs) are covered by signalling and monitoring costs. Through the application of PAT, suitable organizational settings can be identified in order to reduce unexpected actions of contracting parties and therefore to minimize agency cost.

Implications for the Implementation of Service-oriented ERP Systems

As our analysis is based on new institutional economics theory it is of great importance to clearly define the specific transaction that we focus on in this paper. Considering the implementation process of ERP systems the transaction is then defined as:

The transaction of property rights on know-how that is useful for getting an existing application running in a specific applying organization.

The know-how that is subject to this transaction can be divided into skills and methods - where skills are targeting human resources with their inherent implementation knowledge and methods are seen as well described procedures that have been proven in prior implementation processes. Know-how is in this case not only technical knowledge about the application and its integration but furthermore knowledge about the specific industry and its special processes and needs. These specificities also have an influence on the design of the implementation process.

For evaluating different modes of governance for the implementation process, the characteristics of transactions as stated in the Transaction Cost Theory have to be evaluated:

- *Characteristic of Specificity:* Investments in human capital are required to build up the necessary knowledge of methods and domains (Williamson, 2000). The implementation of service-oriented ERP systems requires a higher degree of specific investment in know-how for business process analysis. Prior to the technical implementation, business processes have to be analyzed and selected according to their specific service requirements in a particular situation. Specificity is additionally increased through the individual orchestration of software components.
- *Characteristic of Uncertainty:* Implementation processes are generally exposed to varying degrees of uncertainty (Kirchmer, 1999). With the implementation processes of conventional ERP systems pre-defined sets of methods can be employed in order to reduce uncertainty and increase process quality (Scheer and Köppen, 2001). Due to the uniqueness of a SOA-based solution such pre-defined method sets can hardly be established (Schelp and Winter, 2002).
- *Characteristic of Frequency:* The frequency covers the number of subsequent transactions between the ERP adopter and the consulting company. The implementation of conventional ERP systems usually constitutes a single (even though long lasting) transaction which deploys the chosen system throughout the company (Sahai and Graupner, 2005). As stated above, using SOA the implementation process is split up into many specific micro-implementation processes, therefore leading to a higher transaction frequency (Schelp, 2008).
- *Characteristic of Strategic Relevance:* The characteristics of strategic relevance address the importance of an implementation process for the participating actors. A high strategic relevance is given, if the implementation process is aimed at establishing a competitive advantage. As service-orientation is considered as an instrument of business process reengineering and business process improvement aimed at creating a competitive advantage, the task of implementing SOA as such is of high strategic relevance.

Below, characteristic values for the two transaction types “implementation of conventional ERP systems” and “implementation of service-oriented ERP systems” are illustrated (Figure 2). The comparison of characteristic values may help to recommend a suitable mode of governance for the execution of a transaction.

Comparison of characteristic values in an ERP implementation process		
Characteristic	Conventional	Service-oriented
Specificity	Middle	High
Uncertainty	Middle/High	High
Strategic importance	High	High
Frequency	Low	Middle/High

Figure 2. Comparison of characteristic values of ERP implementation transactions

The increase in uncertainty shows one important contribution of the Principal Agent Theory to our analysis. Uncertainty in that case is the main driver of an efficient design of institutional arrangements. The conclusion must therefore be to enable settings that reduce uncertainty and enable the parties to gain trustworthy information about each other. Long-term relationships as can be established in a hierarchical mode of governance enable such relations.

Referring to PAT, the most important characteristic of the principal agent relationships addressed in the following analysis is the unequal distribution of information between the two contracting parties.

A *first-best solution* would lead to an exchange of services without any transaction cost. This type of solution would be realized if information is available at no cost. However, the assumptions of Principal Agent Theory show that this is not the case in reality. Because of limited rationality and opportunistic behaviour the contractual parties are left with a *second best solution* caused by unequal distribution of information and a trade-off between residing uncertainty and the agency cost of signalling (on agent side) and monitoring (on principal side).

With rising uncertainty about the outcome of the contractual agreement the necessity for a monitoring effort on the principal side and the freedom of acting on the agent side increases. The principal’s ability to realize if the result of the contractual agreement is reached because of the agent’s behaviour is decreasing at the same time. In such situations he therefore cannot or only at a high cost, employ proper monitoring mechanisms. The evaluation of agency costs in market-based and hierarchical-oriented contractual relations is shown in the following figure.

Development of agency cost in dependency of relational situation of contracting parties		
Agency costs type	Market-based contractual relations	Hierarchical oriented contractual relations
Signalling	High	Low
Monitoring	High	Middle/Low
Welfare Losses	Ambiguous	Low

Figure 3. Development of agency cost in dependency of relational situation of contracting parties.

Applying the perspective of PAT the conclusion can therefore be stated as follows: the more specific the required information, the higher the agency cost of signalling and monitoring and the higher the potential loss in welfare because of non-optimal second best solutions will be. Following this conclusion the non-availability of highly specific information on both sides could furthermore be a *prohibitive factor* for contractual agreements (as described in the Hold-Up problem) regarding the implementation of service-oriented ERP systems in a market-based mode of governance.

As we can see from our argumentation from a transaction costs perspective, the specificity of necessary information increases when moving from implementing conventional to service-oriented ERP systems – as service-oriented systems are implemented along business processes of a specific applying organization.

An efficient way to cope with this effect and reduce agency costs is the establishment of a long-term relationship between principal and agent. This can be most easily achieved when combining both parties in a hierarchical relation. Hierarchical

relations enable easier monitoring and signalling and therefore enable efficient contractual agreements for the implementation process of service-oriented ERP systems.

Following this argument our former conclusion of a shift towards hierarchical modes of governing the implementation process of service-oriented ERP systems is also supported from a Principal-Agent Theory perspective.

DERIVING CLASSIFICATION CRITERIA

Although our analysis shows an overall move towards hierarchical arrangements in the implementation process of ERP systems caused by SOA we are aware that the implementation process must be segregated into sub processes. These sub processes can be classified due to their optimal form of organization on the basis of the characteristics developed in this section.

The choice of a suitable form of organization for sub processes of implementation is determined by the actual combination of characteristic values of the dimensions presented in the section above

In the first part of this paper we have stated that every SOA-based ERP system consists of hybrid-SOA and full-SOA components. This distinction is the basis for the subsequent section. The findings of applying new institutional economics to a SOA-based ERP system implementation process are now used for developing criteria to classify sub processes of business process driven implementation processes. The criteria we have formulated follow in their naming dimensions of Transaction Cost theory and PAT cost types. A detailed definition of them is given in the section below:

- *Specificity*: Depending on the specificity of the sub process it can be reused in many implementation processes of one or many organizations. The criterion of specificity furthermore considers the availability of required implementation services on the market. Unspecific services can easily – and at a low cost – be derived from the market. Highly specific services however are necessitated to be produced in house as the resources are not available on the market.
- *Uncertainty*: Although uncertainty is a distinctive characteristic of all implementation processes the level of uncertainty differs. Uncertainty is best described by the prior knowledge about the expected process result. If the expected result can be clearly defined the service of process execution can be obtained from third parties on the market. With increasing uncertainty about the outcome of the process – as for an example typical in explorative processes – a more hierarchical mode of governance should be chosen.
- *Frequency*: A low frequency suggests a market-based form of exchange. With an increasing frequency the needed competences for executing the process can be developed in the applying company at low cost (see above).
- *Strategic Importance*: The successful execution of a sub process can support the establishment of a competitive advantage for the applying organization. On the other hand there are sub processes which execution is – although an important contribution to the project – of no strategic importance. A highly strategic important sub process should be executed in a hierarchical setting to ensure its proper execution and control.
- *Non-availability of information about expected result*: The criteria of uncertainty describes a general level of uncertainty about the process outcome which can arise from different reasons (e.g. insufficient know how on side of the applying organization). This criteria focuses on the unequal distribution of information between principal and agent. The more unequal the distribution of information about expected process outcomes is, the stronger the tendency towards hierarchical modes of governance.
- *Necessary level of task execution control*: Unequal distribution of information could become a problem if the principal cannot evaluate the agent's contribution to the process result. Another aspect of a principal – agent relationship is the level of desired control over the methods applied by the agent during process execution. There are processes where a clear definition of the outcome and an agreed price are sufficient controls. However, other processes require a control by the principal of all steps executed.

The criteria stated above show a guiding line to characterize sub processes of SOA-based ERP system implementation. This enables a specific decision about suitable institutional arrangements on the fine-grained level of sub processes. Furthermore these criteria can be used to compare and cluster sub processes to demand packaged services on the market and realize cost-advantages.

APPLICATION EXAMPLE

To illustrate the application of the developed characteristics we will apply them to a sub process of implementation both of a conventional and SOA-based ERP system.

For this purpose we will analyze a core process of implementation – the adaptation of the system to the applying organization's needs.

In the case of conventional ERP systems this is the process of *customization*. This process encompasses a business process analysis to identify the adaptation need between the baseline processes and the business processes of the applying organization. Customization uses the “built-in flexibility” of an ERP suite and – if necessary – the possibility of individual programming at defined user exits. The degree of adaptation differs (cf. Parr and Shanks, 2000). After customizing, the system is transported to the test and afterwards to the productive client of the system.

When looking at SOA-based ERP systems the core process of system adaptation lies in the activity of *orchestration*. Orchestration consists of an extensive business process analysis to get a comprehensive view of the applying organization. The result of this analysis is the basis for next step, called service selection. The services that are necessary to cover the company's processes are defined and available software services evaluated. In the service selection phase standardized services, available on the market and highly specific services that are individually designed are brought together to build the optimal solution for this single case. The process of technical orchestration which follows the selection connects the software services according to business needs. During the technical orchestration standard software services from third party vendors like accounting modules are connected with highly specific services as for example legacy system integration services or other self developed components.

The following section shows the characteristic values of both processes according to our criteria

- Frequency: *Customization* is an activity that should only be executed very rarely. The higher the degree of customization the less often it is repeated. Customization settings can have tremendous effects on the whole system. Therefore changing customizing settings in a productive system always makes an intensive precedent test phase necessary. *Orchestration* on the other hand, is a natural process of system development and is understood as an ongoing process of system adaptation to changing circumstances.
- Specificity: With *Customization* specificity can be said to be middle to high. Although it considers the business processes of an applying organization the possibilities of adaptation are clearly defined. The process concentrates on reducing existing gaps between the baseline processes that are inherent to an ERP suite and the business processes of a company. *Orchestration* enables to start system design from scratch. The explorative business process analysis enables the applying organization to define its needs with a comparably higher degree of freedom.
- Uncertainty: Due to the reusability of *customization* settings consulting companies are able to develop tools and methods that ensure a proper process execution. In the case of *orchestration* the degree of uncertainty is considered to be higher. The individual combination of the chosen modules has not been realized so far for another company. It is therefore always the first time that this specific orchestration process takes place. Furthermore it is executed regularly, as stated above.
- Strategic Importance: *Customization* of an ERP system allows only defined adaptation. It is therefore very different to build-up competitive advantage by implementing an ERP system as the usage of the system can easily be copied by competitors. The *orchestration* of a SOA-based ERP system enables the applying company to use its process expertise and build up a sustainable competitive advantage by realizing an individual solution with a comparably higher value contribution.
- Non-Availability of information about expected result: For the *Customization* of ERP systems many models, methods, and tools have been developed. Best-practice solutions are available that support the optimum system adaptation. The expected results of the process can therefore be precisely defined in advance. For *orchestration* no such means are available. The expected results can only be defined on a very high and insecure level.
- Necessary level of task execution control: *Customization* is done in an existing system using the adaptation possibilities predefined by the system vendor. There is the possibility of misbehaviour of consultants customizing the system, e.g. when copying a whole set of customizing settings from another client without proper check and test procedures. However ERP systems usually have built in protection systems to avoid such behaviour. In the case of *orchestration* the whole process of adaptation is done between initially independent software services. The possibility of misbehaviour during the orchestration process can therefore be considered much higher.

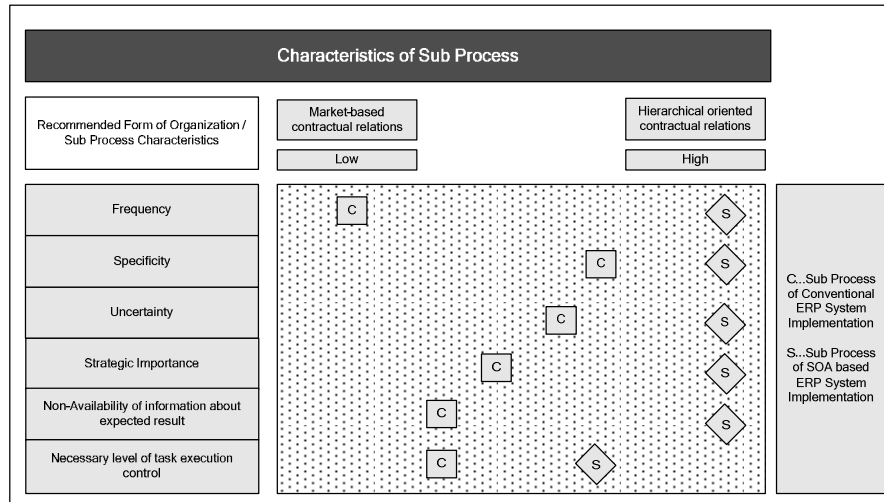


Figure 4. Application example - characteristics of a sub process of conventional and SOA-based ERP system implementation

The application example, although simplified illustrates our findings. The results are summarized in the figure below. An implementation sub-process that is typical for full-SOA ERP system components show a strong tendency towards hierarchical modes of governance. However, a real life ERP system implementation process will contain full-SOA and hybrid-SOA components at the same time. The criteria developed and explained in this work can assist in the classification of these components and design a suitable organization of the needed service exchange.

SUMMARY AND OUTLOOK

With this contribution we addressed the topic of implementing service-oriented ERP systems from an organizational perspective. The comparison of conventional and service-oriented ERP system implementation processes on the basis of New Institutional Economics suggests that implementation tasks in the context of service-oriented ERP systems are better conducted within a hierarchical mode of governance. The overall implementation process of service-oriented ERP systems is split up into many micro-implementation processes for single services and these micro-processes are much more likely to occur frequently compared with conventional ERP system implementations. The practical implications are that the institutional arrangements between applying organization, consulting company and software vendors have to be reconsidered when implementing service-oriented ERP systems. Also, the services offered by consultancies might have to be augmented. Independent consulting companies have to prepare for the demand of more specific knowledge in the field of business process analysis, therefore complementing their technical know-how. Furthermore, our results suggest that consultancies might embark on micro-implementation projects in the future characterized by a much shorter planning horizon. Consulting companies have therefore to specialize not only on the software side but also on the business process management practices relevant for the domains these consultancies are active in. With the applying organizations competences to analyze their business processes and align the ERP solution accordingly have to be built-up. The responsibility of the overall implementation project remains with the ERP adopter (Schmidt, Vogt and Richter, 2005).

Furthermore, as SOA opens up the possibility of integrating third-party software vendors, leading software companies try to protect their dominant position in the market by developing enterprise service buses which contain proprietary components (concerning the case of SAP cf. (Nüttgens and Iskender, 2008; Zencke and Eichin, 2008).

As our research is in an early stage, we only considered key concepts of the Transaction Costs Theory and Principal-Agency Theory respectively. We understand our analysis as a starting point into the field of implementing service-oriented ERP systems. Future research should extend this limited scope, e.g. by considering additional organizational theories. A further limitation of our paper is the basic qualitative assessment of the implementation process based on the New Institutional Economics. Future research demand is therefore the extension of this assessment by means of empirical evidence and a sound quantitative analysis of relevant data. To this end we are striving to formalize the assessment of the implementation process by means of a quantitative model.

However, first examples may already provide evidence for our suggestions. The increasing number of consultancy service providers which maintain close relationships with the applying organizations (e.g. Porsche Consulting, Siemens Consulting, Wuerth Consulting) can be regarded as a possible outcome of this development. In particular, business processes should

constitute the focal point of any implementation process, therefore requiring an in-depth business process analysis by a service provider. Coordinators complement the firm's methodical knowledge about business processes and their implementation within ERP systems through the mediation of independent specialists for specific problems (Schmidt et al., 2005).

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