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Norbert Frick

University of Koblenz-Landau, norbert.frick@uni-koblenz.de

Petra Schubert

Copenhagen Business School, psc.caict@cbs.dk

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Process and Service Orientation in ERP Software

Norbert Frick

University of Koblenz-Landau
norbert.frick@uni-koblenz.de

Petra Schubert

Copenhagen Business School
psc.caict@cbs.dk

ABSTRACT

CIOs and CEOs are confronted with the key challenge of choosing the right ERP software for their company. Packaged software has become so powerful in recent years that after a thorough customization process it can fulfill the requirements of companies from different industries. However case studies and anecdotal evidence show that in many cases ERP implementation projects are demanding and results do not meet expectations. Companies are often forced to change their business processes because the new software system does not provide the flexibility to be adjusted to the company's needs. The paradigm of service orientation, on the other hand, promises to break this vicious circle. This leads to the question whether and how ERP vendors are addressing the perceived problems of ERP adaptation possibilities. The topic stimulated an in-depth study of the German-speaking ERP software market. In a qualitative study based on thirty interviews with ERP vendors we draw a picture of the value proposition of future ERP software in the area of process and service orientation.

Keywords

ERP systems, software development, requirements, IT value, packaged software.

INTRODUCTION AND LITERATURE REVIEW

Integrated business software (ERP systems) covers all relevant aspects of an enterprise (Davenport, 1998). Still, the remaining question is whether companies should develop enterprise systems individually or purchase a standardized solution from a software house. Business information systems can be either designed as custom applications or purchased as off-the-shelf standard solutions (Scheer and Habermann, 2000; Soh and Sia, 2005); the latter is called "packaged ERP software" in this article. According to the literature, most companies turn to packaged software when looking for an enterprise solution (Schubert and Leimstoll, 2004). Holland and Light already recognized this trend almost 10 years ago by arguing "companies are radically changing their information technology strategies by purchasing pre-packaged software instead of developing IT systems in-house" (Holland and Light, 1999).

Therefore many enterprises rely on external partners when it comes to business software. In recent years, researchers in the field of business software investigated new architectural concepts and technologies for ERP systems such as service-oriented architectures (SOA), Web services, XML or modularity. These are keywords which have been circulating in the business software world for some years. According to experts, modern enterprise systems should be service-oriented and constructed in a modular form, communicate via Web services and the overwhelming variety of different interchange formats for business documents should be brought to an end by recognized XML standards (McGovern, Sims, Jain and Little, 2006; Yucesan, 2007). This is an extraordinary development for a software type which originally started as a monolithic cube of business applications (Camarinha and Afsarmanesh, 2003).

There are many systems in active use that are more than 6 years old (Schmitt, 2007; Winkelmann, Knackstedt and Vering, 2007) and follow hardly any or none of the desired principles mentioned above. So for ERP vendors and ERP customers alike it is of reasonable interest to know about future challenges respectively future potentials. Especially in small and medium-sized companies, the introduction of a new system, or rather the migration of the old system to a new platform is accompanied by high costs in relation to turnover and, naturally, by associated risks (Scott and Vessey, 2002; Winkelmann and Klose, 2008). For selecting a new system, one should exactly know what the system can achieve in terms of performance and how it will achieve this performance. A study confirms that "(...) companies often face the dilemma of whether to adapt

to the software and radically change their business practices or modify the software to suit their specific needs.” (Dalal, Kamath, Kolarik, and Sivaraman, 2004)

In a business context, “enterprise agility” is understood as the readiness of a company to adapt to new market requirements e.g. with the help of its ERP system. Enterprise agility is a topic which has been discussed in academic literature in recent years (Gattiker, Chen and Goodhue, 2005; Sambamurthy, Bharadwaj and Grover, 2003). Especially concepts such as Service-Oriented Architectures (SOA) (Jankowska and Kurbel, 2005; Liebhart, 2007) and Business Process Modeling (BPM) call loudest for research on flexible systems that can adapt themselves to user needs (Newcomer and Lomow, 2005).

In order to be able to draw a picture of the state-of-the-art in ERP research we started our research process with a preliminary query of the EBSCO database using the search word “ERP”, “enterprise resource planning”, and “enterprise systems”. The search resulted into more than 40 articles of which 21 were interesting in the context of our project. Most of the papers stem from three special issues on ERP/enterprise systems (two in EJIS and one in CACM). Among the ones that we did not include, there were many articles on performance measurement/cost-benefit analysis which are important topics for ERP but were not within the scope of our research. It is interesting to note that many authors underline the unvaried importance of enterprise systems for the competitiveness of companies and thus the importance of the topic for IS research. The following list contains an overview of the topics treated in the selected papers:

- ERP implementation: 10
- Process modeling: 3
- ERP system agility: 3
- ERP adoption: 2
- Miscellaneous (cultural aspects of ERP: 1, open source ERP systems: 1, ERP integration: 1)

The vast majority of the articles deal with ERP implementations (Akkermans and van Helden, 2002; Biehl, 2007; Gosain, Zoonkyd and Yongbeom, 2005; Holland and Light, 1999; Markus, Tanis and van Fenema, 2000; Scott and Vessey, 2002). Two reports are on ERP implementation failures (Iacovou and Dexter, 2005; Wei, Wang and Ju, 2005), two papers are specialized on upgrading ERP systems (Beatty and Williams, 2006; Khoo and Robey, 2007). There is a noticeably large number of case studies used in the articles to illustrate the findings. Process modeling (Dalal et al., 2004; Delen, Dalal and Benjamin, 2005; Scheer and Habermann, 2000) and ERP adoption (Hwang, 2005; van Everdingen et al., 2000) focus on the need of the company to plan and adapt to the possibilities of the software system. The articles dealing with system agility show the need for flexible systems with regard to future requirements (Overby, Bharadwaj and Sambamurthy, 2006; Smith David, McCarthy and Sommer, 2003; van Oosterhout, Waarts and van Hillegersberg, 2006).

Most of the articles focus on the user perspective describing requirements of companies for the support of their business processes. Against this backdrop, we were interested in the view of *developers* of standard software packages. We wanted to investigate what they perceive as important and how they are going to design their systems in the next years. The underlying research question for our survey was the following:

What are future packaged ERP systems going to look like?

In order to answer this question, an empirical study of the ERP market in the German-speaking area of Europe was performed. We applied an explorative approach (interviews with ERP vendors) as suggested by Mayer (2004) in combination with an evaluation approach following Mühlfeld (1981) and Miles and Huberman (1994).

BACKGROUND OF THE EMPIRICAL STUDY AND RESEARCH METHOD

Since the study was geared at future requirements of packaged ERP software in the German-speaking market we chose an explorative research approach due to the unknown correlations that might affect our research object. The study provides a structured overview of the different influential aspects such as technology or architecture and to reveal interdependencies among these components. We chose an empirical research method (Eisenhardt 1989; Mayer, 2004) because we wanted to collect knowledge from industry experts.

Both suggest a general approach which starts with the development of a model. According to Mayer (2004) five sources of information (theories, expert knowledge, common knowledge, literature and similar studies) are necessary to create a *theoretical model* which describes the research realm (the relevant part of reality). The next step includes the *definition of all relevant concepts* represented in the model followed by a *dimensional analysis* which deepens our understanding on a granular level. In the last step, the method of investigation needs to be selected (qualitative approach vs. quantitative

approach). Since we intended to follow an explorative approach we selected a *qualitative-oriented method*. We created an interview guideline based on our theoretical model and *evaluated the collected results*.

Theoretical Model

The research was initialized by a preliminary query of the EBSCO database which gave us a general overview of relevant articles in the European Journal of Information Systems, Communications of the ACM and IEEE Software (mentioned above). In an initial workshop with an established ERP vendor and several other experts, key areas and relevant research questions were systematically identified. Areas of interest in the field of ERP systems such as business process modeling, SOA, Web Services and system architecture in general were discussed during the workshop.

The first version of the emerging theoretical model was based on practical experiences of the *software vendor* and the *ERP experts* who took part in the workshop. *Architecture, technology and operations* were identified as the initial three abstract model components. A consecutive literature analysis focusing on these three aspects of ERP systems revealed that there are many publications which deal with architecture (Camarinha and Afsarmanesh, 2003), technology (Soh, Sia, Fong and Tang, 2003) and operations (Fortune and Aldrich, 2003; Furht, Phoenix, Yin and Aganovic, 2000) but there are additional studies which focus on *market share and market development*. We thus added the dimension *Market* to the model. The more detailed development of the model was performed by the authors based on existing ERP literature. In this phase, we found a similar ERP study from 2007 with a focus on the *user side* with the title “Future development of packaged ERP-software” (Felley, 2007) which provided us with valuable insights from the opposite perspective –the customer’s viewpoint.

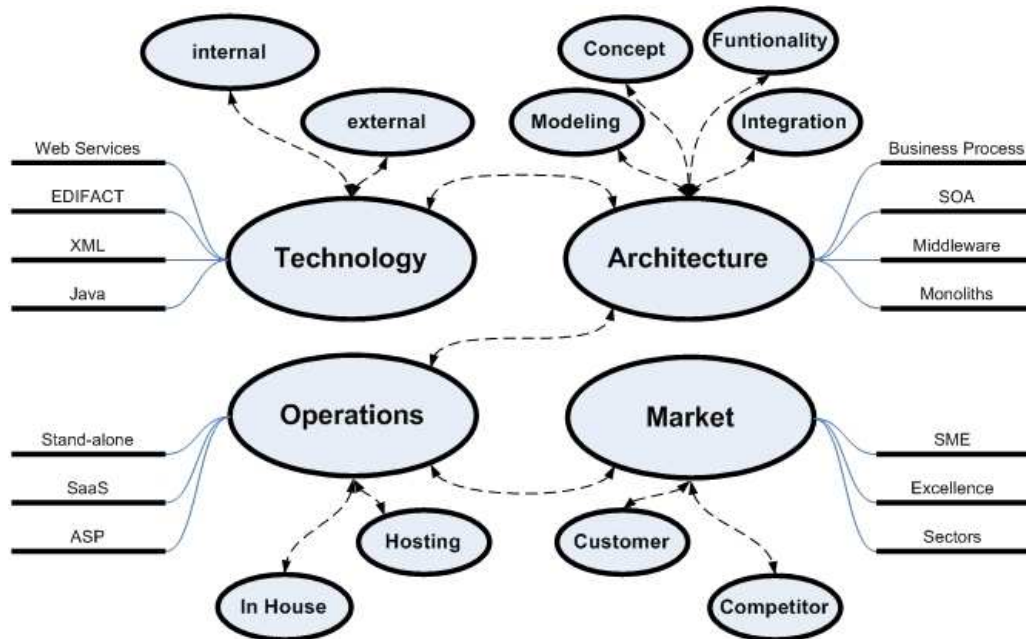


Figure 1. Theoretical model from which the interview guideline was developed

The final result of this preparatory phase was a comprehensive multi-layer model which served as the basis for the development of the interview guideline (cf. Figure 1). The model includes all five sources mentioned by Mayer (2004) (theories, expert knowledge, common knowledge, literature and similar studies).

The research questions for the analysis of requirements regarding ERP systems can be classified into aspects which contain conceptual and technical aspects as well as examined possible application scenarios and market-relevant developments. The framework represents herein all of the characteristics of an ERP system which the authors intended to study. In total, four aspects of an ERP system were defined:

- *Architecture*: This aspect contains the general concept, modeling as well as functional and integrative mechanisms.
- *Technology*: This aspect highlights necessary tools for internal operation and external integration (Volkoff, Strong and Elmes, 2005).
- *Operation*: This aspect investigates the place of the software installation, maintenance and license models.
- *Market*: This aspect includes the study of customers and competitors – the market environment which the commercial software provider faces.

Definition and Dimensional Analysis

In the next step we defined the relevant concepts of the theoretical model (Architecture, Technology, Operation and Market) followed by a dimensional analysis (Mayer, 2004) which describes the sub-categories of the main components in more detail (e.g. for the dimension “Architecture” the elements are SOA, monolithic, client-server etc.). The sub-categories have been explained in detail in a previous publication (Frick and Schubert, 2009). Due to limitations in space the sub-categories will not be described further in this paper.

Qualitative Research

In order to identify new patterns and correlations between the aspects of our theoretical model we followed an explorative research approach. Following Mayer (2004) we interviewed industry experts (*ERP software providers*) in the German ERP market. We conducted 32 interviews with company representatives in 8 different roles: 7 CEOs, 6 marketing directors, 6 product manager, 5 sales manager, 3 software development manager, 3 project manager, 1 business development manager and 1 key account manager. Every interview was preserved in a written transcript. Afterwards all transcripts were analyzed using recommended techniques by Mühlfeld (1981) and Miles and Huberman (1994).

The Interview Guideline

Questions for the four aspects of the model were summarized into an interview guideline. The partial outline of the questions can be found in Table 1. We refer to (Frick, 2008) for the full questionnaire. The relevant questions for our evaluation are displayed in the following table.

Main component	Detailed aspects of the component			
A1: Architecture	Modeling	Concept	Functionality	Integration
	<ul style="list-style-type: none"> • Do reference processes exist in graphical form in your system?* • If yes, are they used to generate code?* • Are existing industry standards used?* • Can business processes also be adapted by the user? 	<ul style="list-style-type: none"> • Does the architecture follow a general concept?* • Is the software platform independent? • Which middleware is used? 		
A2: Technology	Internal usage/External Usage			
A3: Operations	In-house/Hosting			
A4: Market	Customer/Competitor			
*Bold questions are used in the forthcoming evaluation				

Table 1. The interview guideline

The interviews were conducted with representatives (experts) in each company. Every interview partner can be identified as expert “who provides in his defined area of expertise pure and repeatable knowledge.” (Mayer, 2004).

In the summer of 2007, the questions of the interview guideline were trialed in three pre-tests with selected ERP vendors in Germany and Switzerland in terms of completeness and length of the interviews and subsequently optimized regarding content and time-effectiveness. The questions were then used for the following interviews with selected ERP vendors. 17 interviews were conducted until December 2007, further 12 experts were interviewed in January and March. Overall, 130 ERP system vendors active in Germany were invited for an interview of which 32 companies agreed to conduct an interview. This corresponds to a response rate of 24.6 %. All interviews were stored as written transcripts for later evaluation.

Evaluation

The evaluation was based on an empirical content analysis (Kromrey, 2002). We applied the method suggested by Mühlfeld (1981) to analyze the transcripts. First, every answer to the question was marked within the written text. In a second step, the answers were categorized according to a general scheme. After that the single pieces of information were combined logically so that similarities but also controversies could be discovered. The resulting text represented a first analysis from the interview guideline. In the next step it was enriched by selected citations expressed by the interview partners. In addition, similar answers were summarized and evaluated based on the *Conceptually Ordered Display* approach by Miles and Huberman (1994). Instead of focusing on one interview we condensed the answers in a cross-case analysis. The results of these steps serve as the basis for the following discussion of the findings.

THE FUTURE PROMISE OF PACKAGED ERP SOFTWARE

Altogether, several important trends emerged from the interviews and the subsequent responses to the interview guideline. Due to the large amount of data (192 pages of transcript material – 6 per interview) this paper can only present some selected results, namely (1) process orientation, (2) service orientation, and (3) flexibility/agility. The complete study results can be found in (Frick, 2008).

The following table (cf. Table 2) contains information from the study referring to the bold questions in Table 1. The table shows the correlation between the available *capabilities of process modeling* and the discussed *architectural model* of the vendors. The underlying assumption for the table is that both, the design and implementation of processes as well as service orientation, enable a software package to be more flexible regarding changes (→ agility).

		Service Orientation	
		SOA	SOA-capable
Process Orientation	<i>Flexibility in Processes and Services?</i>		
	Graphical processes	8	5
	Code generation	6	1
	Industry standards	2	3
	All Aspects	0	1

Table 2. Service-oriented systems start to fulfill their potential by utilizing processes

The rows display the number of vendors who supply the user with ways of designing and implementing their individual processes into the software. This process goes beyond a mere customization of a packaged software solution. “Graphical processes” enable a dialogue between the implementation partner (the “consultant”) and the future user (the “business expert”).

With the help of graphical workflow engines consultant and business expert can discuss the detailed steps of a business process (with its events and ramifications). This can help to form a common understanding of how the software should finally

work. Examples for these kinds of ERP extensions are *event-driven supply chains* (Scheer and Habermann, 2000) or *workflow modeling tools*. The second row displays the number of vendors who can use these graphical models to actually generate ERP source code from them. Industry standards (third row) refer to the availability of pre-defined processes which are implemented into the ERP system, e.g. a typical pricing model for retail. The last row contains the vendors who offer all of the three options.

The columns on the other hand indicate the correlation of process modeling (rows) with the underlying technical architecture. The term “Service-oriented architectures (SOA)” refers to those vendors that apply the paradigm of SOA (Liebhart, 2007) within their system architecture. We do not differentiate further between views or technical implementations. SOA-capable vendors on the other hand represent systems that can be operated in a SOA-environment but do not follow the conceptual approach internally.

The table reads as follows: 8 vendors whose systems follow a fully service-oriented approach are also able to provide graphical process modeling tools. 6 of these have the possibility to generate code from the graphical models. In the following section we are going to discuss the implications of the table together with the qualitative remarks of the company representatives.

Process Orientation: Graphical Design Support

The first requirement for *continuous process support* (Liebhart, 2007) can be, at least on the visual level, fulfilled by some of the vendors (cf. table 2.1). According to Delen et al. (2005) “the synergistic combination of descriptive graphical models created using enterprise modeling methods (...) can deliver substantial results.” 50 % of the questioned software companies offer appropriate modeling possibilities, whether through connection of existing tools or by means of self-developed display methods. However, *it will remain at the stage of visualization (of business processes) for the next few years*. The next step, a coupling of process and application level in the framework of a process-driven code generation, is currently rarely implemented. Only 25 % of the vendors currently enable code generation from modeling. The offers range from workflow rules to whole class diagrams. *The lack of support for automatic process transformation will not be enhanced*. Complicated internal dependencies within an ERP system prevent building the needed program structure for supporting this feature. The software companies see no practical benefits in code generation, a procedure, which in their opinion is simply impossible because of the internal dependence of an ERP system, as the following quote from a provider shows: “*ERP systems are too complex to make business process modeling worthwhile.*” (Frick, 2008) Furthermore, there is little support concerning a standardized view of processes. Only 25 % of the vendors currently support process standards. *Due to the need to provide fast and simple solutions for the customers it will be experience-based processes that are utilized in the future.*

Service Orientation: The Concept of “Service” in ERP Systems

Services have established themselves as an important or even central building block in the system conception. 53 % of the questioned vendors stated that they have integrated services into their system architecture, whether as integral service-oriented architecture (SOA) (28 %) or just as a SOA capability (25 %). Primarily, their benefit is gained from the possibility of offering functionalities externally. The reasons for this lie partly in differing definitions of SOA, which are internally seen as propagated by large producers such as SAP, IBM or Microsoft (Liebhart, 2007) and therein make a standard architectural basis difficult. On the other hand, such a consistent new conception means a re-programming or even new programming of many system components. *The possibility of avoiding this expenditure and offering the required service by means of a service level agreement will be used more often in the coming years*. Although it may sound strange, an interview partner expressed it as follows: “*We can’t do SOA, we are SOA.*”

Flexibility of Processes and Services: Basis for Agile Enterprises

The already existing potential in Service-Oriented Architectures (SOA) in conjunction with standardized process mapping (e.g. BPMN and BPEL) has, because of a lack of support from process modeling standards, not yet been exploited. A service orientation has already been implemented by 17 companies. In addition 13 of 17 vendors who use services in their system (internally and externally) do also have a graphical process representation. However, an orchestration of the services over and above the planning level is only possible to a very limited degree. Code generation is almost exclusively available for SOA based systems (7 of 8 vendors) so the infrastructure for combining processes with underlying services exists. Nevertheless the code which is currently produced is limited to specific code fragments (class diagrams, workflow rules, etc.).

The use of standards in process modeling is independent of the underlying architecture. Two vendors with a SOA and three with a SOA capability use industry standards. This means that the idea of a system which supports the ability to adapt to changed business processes will remain the exception in the coming years. The underlying architecture necessary to achieve such freedom and power of design would have to be component-oriented and also service-oriented up to current standards (Sprott, 2000), so that the functionalities connected with the processes can, without any problem, be rearranged according to the restructuring carried out in the model. This will also help to meet increasing requirements regarding improved agility (Osterhout et al., 2006; Overby et al., 2006).

Based on these findings it is safe to assume that *the graphical representation of processes will be more likely in combination with service-oriented vendors*. The same conclusion is feasible for code generators that will be used within service-based scenarios. *The architectural support for these tools on the other hand will be limited to a few vendors*. The majority of vendors are not ready or able to rethink and rebuild their systems accordingly. When it comes to process standards service-oriented systems are more likely to include them. But without a common sense of well conceptualized and reusable process scenarios there will not be many systems in the future making use of standards.

CONCLUSIONS AND LIMITATIONS

Based on the results of our empirical study of the German speaking ERP market we discussed the aspects of process orientation, service orientation and flexibility (agility) concerning future ERP software suites. We collected a large amount of data and decided to focus this paper on vendors whose systems are service-oriented. These vendors have, to some extent, already met the corresponding *technological and organizational requirements* for a flexible system that can cope with future technological and business-related challenges. However, in some areas there is still a clear need for development.

Process orientation is partly implemented in terms of a visual representation, it has not, however, come into its own yet as a standard organizational tool. Particularly in continuous process design and in the implementation of process standards there are still deficits requiring intensive further development. Modeling should not remain on the simple visual level but should, together with a service-oriented application system, allow for a reorganization of functions above the planning level. There are already corresponding approaches, although they are only used by a small proportion of the questioned companies. Additionally, there are standardized processes for cross-company process modeling for which implementation is lacking.

In the *service-oriented areas*, the necessary measures for a continuous application provision are to a large extent already implemented. Nevertheless, there are various aspects which still require further attention. SOA is still not clearly defined by all the companies questioned. However, the service idea is at least known of as a rough concept by all those questioned. Based on services, legacy systems can more easily be re-used, new modes of operations can be offered and acquisitions can be more easily integrated into the existing system. Nevertheless, a disciplined service administration is needed to ensure clarity, security etc., especially for large scale use. New technologies can even accelerate this process, as the expansion of Web services in the context of SOA has shown.

Flexibility of ERP systems is wanted by the customers, advertised by the vendors and rarely implemented in reality. The topic has been scarcely treated in the scientific literature (only 3 of the 21 papers in our literature review deal with agility in ERP systems). Hence, we see a clear need for further research on this particular aspect of ERP systems especially as a considerable amount of vendors already realized first developments towards agile and flexible systems. Nevertheless, it seems as if some time will pass before the topic really takes off. One vendor phrased it as follows: *“As far the market goes, it’s: evolution not revolution!”*

The paper presents selected aspects of a detailed analysis of the future requirements of ERP software in the German-speaking market based on an empirical study. We were confirmed in our belief that this topic still needs further research by the editors of the EJIS special issue on packaged software who stated: *“In summary, we believe there is a need to theorize about packaged software and its place within the field of information system.”* (Light and Sawyer, 2007) Combining qualitative with quantitative research aspects, we intended to shed light on the research question of how future packaged ERP systems are going to look like. Our research has several limitations. Firstly, 18 of the questioned vendors are present in Europe respectively operate worldwide. The discussion itself however is focused on the German-speaking area and it is questionable that the results can be applied to other countries e.g. due to cultural implications (Davison, 2002; Leidner and Kayworth, 2006; Soh, Sia, Fong and Tang, 2000). Secondly – although the return rates were very favorable – this study is subject to the usual constraints regarding statistical representativeness. 32 interviews with vendors can only reflect a small proportion of the complete universe of German-speaking ERP users and vendors.

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