What Are the Factors Affecting ERP System Integration?
Observations from a Large Manufacturing Enterprise

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Abstract: The first wave of Enterprise Resource Planning (ERP) systems integrated the core internal business processes and provided operational benefits for companies. The second wave of ERPs introduced additional challenges due to the need for ERPs to interact also with various other systems beyond organizational boundaries, highlighting integration as a critical activity during the ERP system development. This paper takes a Grounded Theory approach to investigate ERP system integration. A model of four groups of factors affecting on ERP system integration was created. Challenged by the domain, organizational landscape, ERP development network partners and system characteristics, ERP system integration is a continuous and cooperative effort during the ERP development, conducted by the dynamic ERP development network. It struggles through forced-marriage relationships, political games and organizational changes and aims at an integrated business engine that makes the business more competitive. The model creates a base for further research to investigate how integration issues are solved in ERP development networks.

1 INTRODUCTION

"If you investigate IT and are searching for an easy integration between systems, there is no such thing. Or, if there is, I'm very interested in hearing more about it." –Enterprise architect, adopting organization

Companies have adopted ERP systems to automate and integrate their core business processes in order to achieve operational benefits and to improve the business performance (Beheshti, 2006). Implementing an ERP system is a challenging and costly project. It is constant balancing between customization of the package and re-engineering the business processes to fit the package (Law et al., 2010). Moreover, ERP projects are complex socio-technical endeavours that involve both social interactions between many stakeholders and technical aspects in development or customization of the ERP system (Albuquerque and Simon, 2007). ERP systems tend to change the organizational culture and way how people do their work (Liang and Xue, 2004). Despite the fact that ERP vendors including SAP, Microsoft and Oracle have been building additional capabilities to their products, we repeatedly observe the failures of ERP projects (IDG Consumer and SMB, 2013). The increased body of knowledge and more advanced products in the market have not prevented ERP projects from challenges.

Even though ERP systems are usually adopted to replace numerous legacy systems, an ERP system does not eliminate the need of other information systems (Lehmann and Gallupe, 2005; Xu, 2011). During the last two decades, the boundaries between systems have become fuzzier as systems cross the organizational borders to collaborate with business partners besides the integration of internal business functions (Hsu, 2013). Integrating an ERP system with non-ERP systems is not considered easy (Doedt and Steffen, 2011; Momoh et al., 2010). Because of the extended role of an ERP system as the backbone enterprise business suite that connects with customers and business partners (Hvolby and Trienekens, 2010), integration becomes an important consideration during the ERP system development.

In our previous study, we analysed the existing literature on ERP system integration and concluded that there is a lack of studies with systematic research approaches and ERP-specific integration

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strategies have not been widely studied, especially from the perspective of different groups of organizations involved in the project (Kähkönen and Smolander, 2013). Furthermore, integration is not well understood as a concept (Chowanetz et al., 2012; Gulledge, 2006). Recognizing this we attempt to fill the gap and contribute to the knowledge on ERP system integration. We apply a qualitative method and use the Grounded Theory methodology (Corbin and Strauss, 1990) to observe and understand the practice of ERP system integration in a global manufacturing enterprise. When making the inquiry into the practice, we concentrated on the following research question: *what are the factors affecting ERP system integration?*

The next section provides the background for this study by describing the concepts *ERP system integration* and *ERP development network*. In Section 3, the research approach is presented. A model of factors affecting ERP system integration is developed in Section 4. The model is compared with the existing literature and future research is discussed in Section 5. Section 6 concludes this paper.

2 BACKGROUND

2.1 ERP System Integration

Integration is a general term that has various dimensions and meanings in the domain of information systems. According to Linthicum (2004), integration has technical, business process and strategic perspectives and it includes data exchange between systems, standardization of business processes and also cooperation and coordination between human actors (Linthicum, 2004). Integration can happen inside a single organization or it can cross organization boundaries, which can be considered external integration (Barki and Pinsonneault, 2005). Gulledge (2006) clarified the concept of integration related to enterprise systems by dividing integration into "big I", in which business processes are integrated by a single software application such as ERP, and "little I", in which enterprise systems are linked together by different approaches, such as database-to-database and application server integration (Gulledge, 2006).

When examining integration from the perspective of an ERP system, it can be concluded that integration consists of diverse activities. Integration of business functions is the goal of an ERP implementation as the ERP system enables data flow between business processes (Hsu, 2013). However, numerous other information systems, such as Decision Support Systems (DSS) and Manufacturing Execution Systems (MES) are still needed, and application level integration of ERP system and these systems is often necessary (Shafiei et al., 2012; Tao et al., 2004). The functionality of an ERP is often enhanced by bolt-on applications, such as CRMs (Customer Resource Management), and WMSs (Warehouse Management System) (Watts et al., 2008). Because the purpose of a contemporary ERP is to provide the backbone for business collaboration, external integration with business partners' systems is unavoidable (Møller, 2005). Another form of ERP system integration is to provide interfaces for customers and clients to access the system on mobile. This type of integration is called portal-oriented application integration (POAI) where an interface is built to display the desired information needed by the intended user group (Linthicum, 2004). In this paper we understand ERP system integration as *an activity that builds interfaces and manages interconnections between the ERP and other internal and external systems during the ERP development, where the dimensions of technology, standardization and business processes must be dealt as a collaborative effort with proper strategies by the ERP development network.*

2.2 ERP Development Network

Many groups of stakeholders are involved in ERP projects (Skok and Legge, 2002). Besides the adopting organization, the ERP vendor can have the key role in the project by providing support and tools for development (Somers and Nelson, 2004). Consultants are often hired to ERP projects to solve different problems that occur during the implementation (Metrejean and Stocks, 2011). The ERP community has been defined as a group consisting of an ERP vendor, consultant and implementing organization and it is suggested that understanding the relationships and interactions within this group would be a key milestone in the ERP research (Sammon and Adam, 2002). Koch (2007) uses the term "ERP network" in his work but mainly focuses on the complexity of organizational structures of ERP vendors.

However, it is often the case that this network of stakeholders involved in ERP development is even more complex if all the involved organizations are taken into account. The "flagship" organization, such as SAP or Microsoft can have a major role in

the ERP development when a packaged ERP is adopted. The network also includes supply chain partners, suppliers of supporting software (databases, operating systems and tools), as well as vendors of existing systems that are integrated with the ERP system. Multiple levels from the key organizations are involved, including the upper management, business process owners, mid-level managers, the IT-department, business representatives and end-users. Furthermore, the network is dynamic, which means that it constantly changes its shape during the ERP development. In this regard, we define the ERP Development Network (EDN) as *a dynamic group of stakeholders from different levels of all the involved organizations that are needed for ERP-related problem solving during the ERP system development.*

3 RESEARCH APPROACH

Qualitative research methods are essential also in information systems development (ISD) and software development, because of the central role of human behaviour in them and due to the fact that they introduce, besides technological challenges, also numerous organizational and management issues (Seaman, 1999). Grounded Theory (GT), originally developed by Glaser and Straus in 1967, was chosen as the research method for this study due the fact that ERP projects are complex and they include cooperation and collaboration of various stakeholders. As an inductive research method that is based on rich real-world research data, GT is suitable for approaching complex organizational phenomena (Charmaz, 2006). ERP development is a socio-technical endeavour making the role of network of stakeholders and human interactions evident (Albuquerque and Simon, 2007). Respectively, ERP system integration is not purely a technological challenge but includes also collaboration and knowledge sharing among various stakeholders (Welker et al., 2008).

Our specific focus on the integration challenges in ERP development networks required in-depth knowledge of different stakeholders involved in the ERP project. Therefore, we needed to approach the subject with an iterative inquiry into the EDN and with investigation of the challenges presented from different viewpoints. Without having a predefined theoretical model in mind, we investigated the EDN from the viewpoint of one stakeholder to another, iteratively collecting and analysing the data, which GT supported well. This far GT has not been widely utilised to investigate the integration in ERP projects. However, we deemed it especially suitable when investigating broad phenomena, such as ERP system integration, in depth.

GT is a qualitative research method that allows to develop theory iteratively based on data that is systematically collected and analysed (Strauss and Corbin, 2008). Data is usually collected by interviewing or observing one or several cases, but other sources of evidence like written documentation or other archive material can be used as well (Urquhart et al., 2010). GT is considered to be useful for creating context-based and process-oriented descriptions of organizational phenomena and it provides, in its Strauss and Corbin version, relatively clear guidelines for the data analysis (Corbin and Strauss, 1990). The main benefit of GT is that it allows a researcher to trace back to the original sources of data in order to observe how the theory has been developed and how different instances of data have emerged into concepts and relationships between them (Strauss and Corbin, 2008).

The data analysis in Strauss and Corbin's version of GT consists of three coding procedures: open, axial, and selective coding. In open coding, the transcribed data is first labelled with codes that capture the meaning of the current piece of data. The most important procedure in open coding is constant comparison between the pieces of data in order to find similarities and differences. In axial coding, the connections between categories are formed. Basically, this is the interpretation of codes, categories, and properties developed in open coding with the goal of refining the constructs and making them more abstract and theoretical (Urquhart et al., 2010). In selective coding, the goal is to choose a core category and interpret its relationships to other categories and explain it as a theory.

As data is collected and analysed iteratively, the main question is when to stop the process. As a theory emerges, more focus can be needed on some particular aspects of it. At the same time, categories, dimensions, and properties become more refined as more data collected. The situation when a researcher finds out that any new set of data will not bring significant new codes, categories and/or relationships is called theoretical saturation (Strauss and Corbin, 2008).

3.1 Case Description

The adopting organization (from now on referred as AO) is a large and global manufacturing enterprise with an annual turnover over 8 billion euros. AO

decided to build a fully-customized ERP system for sales and logistics in order to replace several legacy systems and also to overcome the year 2000 problem without having to make the necessary updates to all the existing systems. The implementation started in the middle of 1990s and during that time, the existing ERP packages did not have the desired functionality to support business processes of the domain and control the complex supply chain in AO's specific business field. The ERP project went through major challenges, including redesigning the insufficient system architecture and a merger of companies. Eventually, the project greatly exceeded the intended budged. However, the system is currently in a global use and it was widely considered as successful in the interviews. It is still under a constant development in 2014. The supplier of the system has remained the same from the beginning and has a long-term relationship with AO. Major parts of the development have been recently outsourced to Asia by the supplier to reduce development costs. Benchmarking against ERP products in the market is constantly being done, but for the time being, AO has decided to keep the system to handle its core business processes.

ERP system integration has been a challenging endeavour during the early phases of the project, requiring a vast amount of resources, expertise and strict processes, and also being the major consideration of the current development. The ERP system is integrated with a packaged ERP system from SAP that is used for administrative processes such as financial controlling and human resources. Moreover, according to AO's global ERP strategy the system is taken into use in any new facility in order to achieve synergy benefits. This requires integrating the system with operative systems in facilities. In order to let customers and partners to access the relevant information, a web interface to the system has been built. Creating an infrastructure to support mobile use to access the system with mobile devices has also been under consideration. Integration with supply chain partners and their systems, including systems of warehouse and transportation operators as well as customs systems has also been made. To ease the supply chain collaboration, e-business standardization with competitors and business partners within the same domain has been considered.

When interviewees were asked about their thoughts how the challenging project was managed to be completed, it was pointed out that the timing was right, there were not much economic pressure that kept the faith of upper management for the project. However, the interviewees estimated that if a similar project would have been carried out few years later, it had never been completed.

3.2 Data Collection and Analysis

The data was collected by theme-based interviews that were conducted during February and May 2013. Instead of determining a large number of fixed questions addressing specific areas of interest, the questions for the interviews were open-ended, focusing on the interviewee's experiences in the ERP project. The more detailed questions were asked based on responses of interviewees. For example, major challenges and successes experienced in ERP development were asked. This way, we were able to get a rich set of data for further investigation.

The data collection started with discussions with our key contact person from the upper management in AO. The goals of the research project were briefly presented to him in order to identify the right persons to interview. In general, the snowballing technique (Strauss and Corbin, 2008) in which the next interviewee is a referral from the previous one was used for selecting the interviewees. Rather than interviewing random persons, we navigated through the ERP development network from one interviewee to another in order to get different viewpoints to the same issues.

In total we interviewed 17 industrial experts representing different roles in the EDN. The interviewees had different positions, ranging from

Table 1: Roles and organizations of the interviewees.

	Role	Organization
AO1	Business-IT negotiator	Adopting organization
AO2	IT manager of business area	Adopting organization
AO3	Programme manager	Adopting organization
AO4	Enterprise architect	Adopting organization
AO5	Representative of sales	Adopting organization
AO6	IT support manager	Adopting organization
AO7	Representative of logistics	Adopting organization
AO8	Project manager	Adopting organization
S1	Software manager	Supplier
S2	Service owner	Supplier
S3	Continuous service manager	Supplier
S4	Infrastructure manager	Supplier
S5	Project manager	Supplier
S6	Lean software developer	Supplier
S7	Service manager	Supplier
C1	Middleware manager	Consulting company
C2	Technical consultant	Consulting company

upper management to mid-level management and developers, and included people from AO, the supplier of the ERP system and a consulting company. Due to the long duration of the ERP system development, the roles and responsibilities of the interviewees have been constantly changing. Some of the interviewees have been intensively involved during the early implementation of the system whereas others are currently working with the system.

The duration of interviews ranged from 26 to 73 minutes, the average being 45 minutes. The list of interviewees' roles and their organizations are listed in Table 1.

3.2.1 Open Coding

After conducting the interviews, they were transcribed to text format and analysed by using ATLAS.ti as the coding tool. The first step in GT is to open code the data by conceptually labelling the data based on its interpreted meaning. *Customer-supplier relationship, packaged ERP suitability* and *evaluating the system architecture* are examples of open codes. The total number of different codes created was 192. We classified the open codes into categories. A category gives the context for the code and provides the data with more concrete meaning. For example *evolution* if appearing without the category, is ambiguous but providing the code with a category *ERP development network* will clarify the meaning. The *code ERP development network: evolution* associates the evolution to the EDN. This means that when identifying the name of the code, the context for the corresponding piece of data is also identified. The total of 10 categories were created in open coding. These categories and their relations are further described in the next section.

3.2.2 Axial Coding

In axial coding, the relationships between categories are identified and new categories may be formed based on them. Open and axial coding are not necessarily sequential steps in the analysis process, but are often done concurrently.

The category *ERP development network (EDN)* includes all the organizations related to ERP system development, including *Adopting organization* (the company that takes the ERP system into use), *Supplier* (takes care of the actual implementation of the system) and *Consultants* (external experts involved in development). Besides these three groups of organizations, the EDN consists of *supply chain partners, database* and *infrastructure vendors* among other organizations. In addition, *relationships*, *conflicts*, *cooperation*, *cultural issues* and *knowledge transfer* were put into this category. AO operates in *Domain*, which determines the *business processes* to be automated by the ERP system. External changes and incidents such as the year 2000 problem or the economic crisis can take place on the domain. *ERP system development* includes all the activities of development, including *specifying the system*, *testing*, *change management* and *roll-out*. *Integration* contains all the activities related to integration, for example, *providing interfaces*, *master data management*, *integration with internal systems* and *integration with the supply chain*. Integration is realized during the ERP system development. *ERP system* is the ultimate artifact that results from the development process. It has a certain *scope* and *architecture* and it evolves through *technological changes*. Additional categories were created for *Challenges* and *Success factors* and codes of these categories can relate to any of the aforementioned categories.

We interpreted that there were indications of theoretical saturation in the analysis of last interviews. The data did not produce new codes and already observed phenomena and patterns repeated.

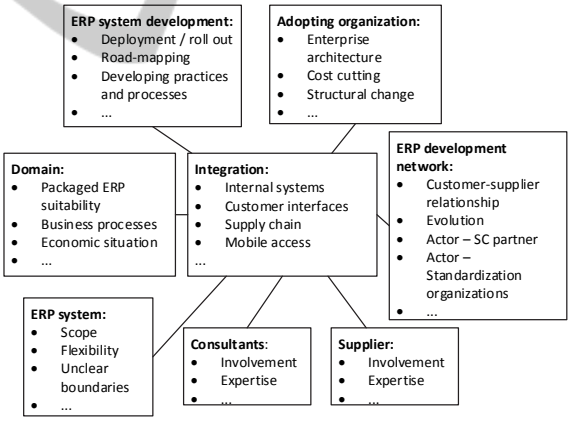

Figure 1: Categories with some of their codes after selective coding.

3.2.3 Selective Coding

Finally, in selective coding, the core category is selected and the whole data is then looked from the perspective of this category. Other categories support the core category in explaining the emerging theory. We chose *Integration* as the core category, because it emerged from the data as an important matter, having been a major challenge during the project phase of the ERP system development as well as being one of the current challenges. Figure 1

shows the main category and related categories (two of the categories, Challenges and Success factors have been excluded from this figure) and some of the codes of these categories.

From the categories, four classes of factors that affect ERP system integration were identified. These levels are *Organizational landscape* (renaming the category Adopting organization), *EDN partners* (combining categories EDN, Supplier and Consultants), *ERP system* and *Domain* (using the categories with the same same). The individual codes from these categories that were identified as factors affecting ERP system integration are presented in the next section.

4 FACTORS AFFECTING ERP SYSTEM INTEGRATION

4.1 Organizational Landscape

The EDN forms around AO, which adopts the ERP system. *Organizational landscape*, consisting of *Enterprise architecture (EA)*, *ERP strategy*, *Supporting practices* and *Integrative systems' characteristics* form the base for ERP system integration. *Structural change* and *Political agendas* can introduce additional integration challenges. The following chapters describe these factors in more detail.

Enterprise Architecture: Because of the global organization and demanding supply chain, the EA of AO is rather complex. By having a single and integrated system used by different business units with different needs, specifying new functionality for the system is challenging. In order to manage the EA, as new features are introduced into the ERP system, an internal architecture check is done first to see if there is a duplicate feature in the IT architecture and if the new functionality could be achieved through integration.

ERP Strategy: AO has a global ERP strategy, in which they aim to reach synergy benefits by implementing the system globally in every new facility. AO is constantly road-mapping the ERP system to develop the strategy. A representative of AO commented the challenges of road-mapping:

"You never reach the ideal world, you end up in having lots of stuff [different systems] here and there, maybe all the possible ERP vendors in some way. Then you have this company-level roadmap and it constantly evolves." –AO1

It was also pointed out that the current ERP strategy needs often to be explained to new managers:

"Our manager has changed a couple times over the past years, and every time at the three-month mark the new manager wonders why we have two ERPs instead of one." –AO5

Furthermore, it appeared that the ERP strategy has been changing, which has caused a need for additional integrations:

"The scope has changed somewhat, as far as logistics goes we've moved away from the system and we've replaced it with external ERP systems, and integrated those with the system." –AO3

Supporting Practices: Developed through trial and error, AO has created well-established practices and processes to support ERP development. These practices appeared to have a significant role in roll-outs, when integrating the ERP system with facility systems:

"I think that ERP and its network are not just the system, but also the supporting processes and service processes that we have been building." –AO6

"Auditors haven't produced any findings for years regarding our process control. […] We've been told by our auditor that they have never seen processes controlled this well anywhere." –AO5

Deployments of the system to facilities have been challenging projects that have required active participation of different members of EDN, including the supplier, managers, facility managers, end-users and business representatives. Moreover, decent practices and processes for integration have been necessary. The first roll-out did not succeed because of serious performance issues due to the lack of systematic testing practices and because the initial testing environment did not match the real environment. Integration testing was seen as one area where strict processes are necessary:

"Then we arranged a pretty massive testing. We tested with the facilities' real business cases that [the system] works the way it's supposed to and is compatible with the system of the facility and other integrated systems, because [the system] had to be integrated with each facility system." –AO2

"And the more successful the testing sessions are between the facility system and the ERP, the better everything will start off. In that sense the testing of the facility integration is absolutely the key"–AO5

Integrative Systems' Characteristics: Because the system replaced several existing legacy systems, the parallel run of the ERP system and a legacy system could take from several months to one year of time. Because of the heterogeneity of the facility

systems, the system integration approach is different in each location due to varying functionality of the facility system in question. Different templates for roll-outs have been made to deploy the system. The interviewees commented on the deployments:

"It was a big thing to first integrate it to each facility system, and in [the system's] case we even had to modify it a little bit in each facility because of their differences, and then all that testing and launching and such, it required a lot of work." –AO2

"In many cases it will require big changes to [the system], depending on the facility. Some facilities don't require many changes […] The ease of the roll-out may vary greatly between facilities." –S2

"We have big differences between facilities, depending on how well the integration was carried out, and how well the interface is managed." –AO5

Structural Change: The organizational structure of AO appeared to be constantly changing during the development of the ERP system. A big merger of two companies took place when the system was not yet taken into use. The merger did not only introduce competing systems but also changed the power structures inside AO:

"But then came the merger into the picture and then started the fight whose systems to be utilized in where. And unfortunately, the upper management gave too much freedom for the units to determine, which systems to use. This caused at least one year of uncertainty of how to move forward." –AO7

Political Agendas: Because of the structural changes in AO, different functional areas became under a changed leadership. This led to decisions to take some of the functionality away from the ERP system to be implemented in other systems, which required additional integrations with the ERP system. As a result, the original scope of the system changed. This was mentioned as one of the major challenges in the current state of the system and it has also increased the costs:

"So the strategy has been changed allowing units to have more decision power on which direction to take […] I would have maybe... thought harder on detaching our logistics systems from it. Because one of the strengths of the ERP system was that it was so comprehensive, everything was included. All the logistical functions could be done within it. So to then go and detach them from the system." –AO3

"They [logistics] started making separate islands, they wanted to "freeze" the system to a certain point and started to include all kinds of additional systems there. It has been ongoing for ten years now and we have ended up to serious problems and the costs have increased in that area. [Consultants] have evaluated the systems and made this great finding that it's a spaghetti and a new transportation management system needs to be built there…" –AO1

One interviewee also criticized the replacing the functionality of the ERP system with additional integrations:

"Now and then you underestimate things like the demands of system integration. […] The relevant data produced by logistics systems should also be imported to the ERP system. That is the area where we probably have the biggest gaps at the moment. We do not have sufficient transparency in the sales and supply chain system, this being the ERP system, with regard to logistical processes." –AO5

4.2 EDN Partners

ERP development is a cooperative effort of the EDN in which AO forms relationships with other members of the EDN. These relationships appear to change during the ERP development. For example, AO ended up in a conflict with a database vendor, which eventually led to the change of the provider of ERP database. *Customer-supplier relationship*, *Supplier's expertise*, *Software vendors*, *Consultants' involvement*, *Supply chain (SC) partners* and *Standardization partners* appeared to have an impact on ERP system integration.

Customer-supplier Relationship: AO has had a long-term relationship with the supplier of the system. Both AO and the supplier had a positive viewpoint on their relationship:

"I have to give credit to the supplier as well, they had worked with us before. And they knew our business. They understood our needs, and they knew how to look for the right solutions." –AO3

"We've had the benefit of very skilled representatives from the supplier side, with a long history with [the system] and system integration. This is worth its weight in gold, and more." –AO5

"I think [the relationship] is some kind of a partnership. We are in a close cooperation daily, we are making things together. It is not a traditional customer-supplier…" –S6

However, it was pointed out that neither of the partners has always been satisfied with this relationship. AO has even considered of buying the source code of the system from the supplier, but according to interviewee "*it did not turn out to be a realistic option*". One interviewee comments the

relationship:

"We have understood for a long time that we are in a kind of a forced marriage" –A05

The customer-supplier relationship appeared to have a major importance in ERP system integration. Deploying the system to new facilities has been carried out by close cooperation between AO and supplier. However, it seems that AO is locked to the supplier, because it may not be possible to replace the well-established cooperation and knowledge base built during many years of collaboration.

Supplier's Expertise: It turned out that the supplier has had the key role in ERP system integration. Because of the long-term relationship, the supplier has built many of the current systems used facilities and has the required knowledge on these systems when integrating systems. Furthermore, the supplier's knowledge on AO's business has proven to be a major facilitator in cooperation.

Software Vendors: It appeared that database vendors affected the decisions on integration technologies in the early phases of the ERP project. The supplier was relying on the solution of a large database vendor as the main technology for the ERP system. AO was also relying on the supplier's expertise in this matter and the project ended up in difficulties because of a non-scalable system architecture. Consultants from a small middleware company were not able to convince AO to choose their technology until later when the architectural problems occurred.

Consultants' Involvement: Consultants were involved in the beginning of the system implementation to redesign the system architecture by replacing the original 2-tier architecture with a middleware solution based on transaction processing monitors. This made the system architecture more scalable for a broader user base and enabled the integration of business functions. Consultants' relationship with the supplier appeared to be crucial when redesigning the system architecture:

"Practically, they [the supplier] didn't have a clue of how to make it work, and when we looked at it, it seemed that the way of implementing the system and the use of object model was completely wrong." –C2

A middleware consultant also mentioned that the cooperation with the supplier was challenging in the beginning, but after the initial challenges, an improved system architecture was realized.

Supply Chain (SC) Partners: Due to a need to collaborate with the supply chain, SC partners have been introducing external systems to be integrated with the ERP system. It was pointed out that a sudden need to integrate a system can occur:

"And later came – it was not originally specified as a requirement of the system – this transportation cost management system came there." –AO7

Connecting the system with SC partners' systems was occasionally seen challenging:

"ERP has connections to various logistics providers, since the system also handles logistical functions. So third party companies are involved, freight forwarders, harbor operators, warehousing and such. But they are not giving us any sort of definitions, the system simply has connections to these third parties. This has sometimes been challenging." –S2

Standardization Partners: AO has participated in e-business standardization efforts within the domain in order to develop standardization with other companies. Standardization partners appear to be another EDN group that has an impact on ERP system integration: – AO develops standards in cooperation with these partners to ease the business integration in SC.

4.3 ERP System Characteristics

At the system level, the *Amount of customization* and *System architecture* were identified as important factors affecting ERP system integration.

Amount of Customization: The interviewees commented the benefits of the customized system by highlighting the control of development, being free of licensing costs and the advanced functionality provided through customization:

"[The system] is a tailored system for us and the input for development comes 100% from us" –AO4

"With SAP or another such solution, there's always other parties driving development, you don't have to come up with everything you need, ideas from other sources get productized as well. That's something we're completely missing." –AO5

"They couldn't have had a better system what they got when they made a glove to a hand […] I have never seen such advanced functionality anywhere, you can just drag a shipping container and drop it to a ship" –S4

However, development of an extremely customized system introduced some of the specific challenges, such as the performance issues due to non-scalable system architecture. Moreover, the benefits of a customized ERP do not come for granted. The development is expensive and there are no other parties driving the development as it is the case with packaged ERP systems:

"We have a big burden in driving development. We need to come up with everything that we want in the system. There is no baseline of a ready-made package."–AO5

In the interviews, the discussion often ended up comparing the amount of customization and business process change in ERP development. The interviewees generally saw that having a fully customized system is not very common due the fact that ERP systems are usually implemented with packaged products, either by using a single vendor strategy or a best-of-breed approach by combining software packages from multiple vendors. By having a customized ERP system, AO can have a total control over the system and its integration capabilities. AO is not affected, for example, by the version updates made by the ERP flagship organization, such as SAP. A middleware consultant commented on updating a packaged ERP in another organization:

"Based to all that how difficult it was to make version updates in SAP, from the spectator's perspective I can only estimate that there is a hell of a lot of home-made ABAP-code [in the system]." – C2

Also, the supplier commented the situation, in which additional layers for integration had to be made whereas as in AO the integration logic could be built directly to the system itself:

"We made for [the competitor] these integration portions where they integrate existing ERP systems, but because their functionality was not sufficient, we made additional layers which had intelligence for processing the supplied goods, it was processed into a form that the ERP systems could handle it. At [AO] we didn't have to make these additional layers because we could build the intelligence into the actual resource planning system." –S1

System Architecture: The system architecture had to be flexible enough to allow the integration with external systems. One interviewee saw that integrating ERP with external systems has been relatively painless:

"One benefit of the system is that is a has many things that allows the external partners to operate in it" –AO7

However, it also appeared that replacing certain functionality in the system has not always been straightforward, because of the architectural design of the system.

"It would have been better to create the system in such a way from the start that different aspects had been more like separate modules. So that you could have taken them and combined them more." – AO3

4.4 Domain

Domain was identified to have an indirect impact on integration by defining the suitability of packaged ERPs, defining the environment where AO operates, including *Business processes* and *Economic situation*.

Business Processes: During the time when AO made the decisions about the system, business process support of available ERP products in the market was not comprehensive. This was seen as the major driver that led to the decision to make a fully customized ERP. The business processes were said to be *"challenging"* and *"difficult to change to fit the packaged ERP"*. The business processes affected the amount of customization of the system which in turn have been affecting ERP system integration.

Economic Situation: Economic situation was pointed out to be another issue affecting ERP system integration by constantly introducing changes to the organizational structure of AO. These changes have sometimes altered the business processes that the ERP system must support and further caused rearrangements to the system:

"[The system] has enabled many things that we have been doing over the years to increase our competitiveness and supported the organizational changes. We have been able to rearrange the services by fluently combining different machine lines and production pipelines according to how we want to arrange our business." –AO6

Recently, AO has been constantly cutting the development costs, which has postponed the development of lower-priority features, such as the mobile access to the system. A representative of the supplier pointed out that "selling" new features, like the mobile access to the system has been challenging because of the cost cutting of AO.

4.5 Summary of Results

Figure 2 presents a model of factors affecting ERP system integration. ERP system integration is a collaborative effort of AO and EDN partners. ERP strategy and enterprise architecture manage the ERP system integration by determining when to integrate the ERP system with other systems. Supporting practices and involvement of all the relevant stakeholders need to be present when integrating the ERP system internally. Different integration approaches must be created based on the

characteristics of integrative systems. Additional challenges can be caused by structural changes in AO and political agendas of managers that may introduce competitive systems to be integrated with.

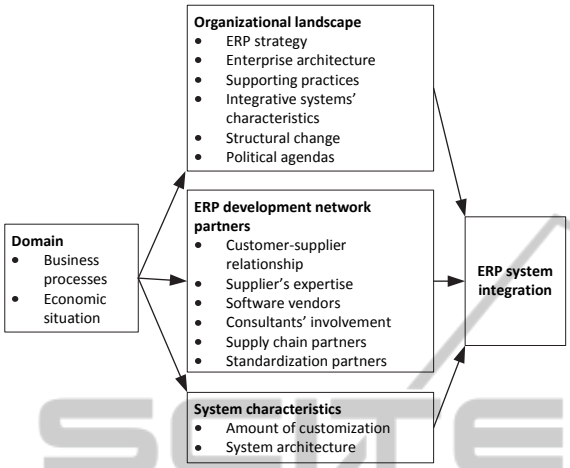

Figure 2: Factors affecting ERP system integration.

Supplier is the most important EDN partner in solving ERP system integration issues. Supplier's expertise and relationship to AO create a base for successful ERP system integration. Other EDN partners that can have impact on integration are software vendors (that affect the decisions on integration technologies), consultants (that can enter the project to solve integration problems), supply chain partners (that can suddenly introduce additional systems to be integrated with) and standardization partners (who are involved in development of standards to facilitate the supply chain collaboration).

ERP system characteristics at the system level, including the amount of customization and system architecture can either facilitate or hinder the integration. It seems that by having a full control on the system characteristics, modifying the system is possible and integration can be less troublesome. However, the system architecture may introduce challenges when parts of the ERP system functionality are replaced with other external integrative systems.

Domain on which AO operates has indirect impact on integration by determining the business processes and economic situation of AO. It also determines the standardization environment and business environment including the business partners to be collaborated with. The amount of customization of the ERP system is determined by the extent to which business processes of AO are supported by the ERP products on the market.

5 DISCUSSION

Our findings contribute to the field of ERP and IS integration by highlighting the socio-technical nature of ERP system integration and especially the role of different organizations affecting it. In our literature review (Kähkönen and Smolander, 2013) we pointed out that ERP system integration is often studied with non-systematic research methods, and integration between ERP and a specific target system is usually considered by means of technical solutions. The role of EDN is not often emphasized in the studies of ERP system integration. We believe that considering EDN becomes especially relevant when managing the complex architecture consisting of ERP and multitude of other systems and their integration. Moreover, it has been suggested that methods for enterprise systems integration have not been aligned with the advances on integration technologies (Xu, 2011). A literature review on IS integration research pointed out that we do not know much about moderating factors on IS integration (Chowanetz et al., 2012). Our study addresses this gap in this field.

Studies addressing affecting factors on ERP implementation and studies on ERP success factors are partly related to our findings. For instance, a socio-technical model for ERP implementation has been proposed (Somers et al., 2000). In this model, ERP implementation process is affected by the external environment and the organization itself. This model does not discuss about EDN, which may be explained by the early publication time of the study. ERP success factors have been studied comprehensively (e.g. Momoh et al., 2010; Ngai et al., 2008). Even though critical success factors are often organizational, they generally lack the EDN perspective. Our findings suggest that EDN relationships, such as customer-supplier and also supplier-consultant relationship, have a key role when solving integration issues during ERP development. The relationship between the client and the vendor has been identified as a success factor in ERP implementation (Ngai et al., 2008). Our study pointed out its relevance also to ERP system integration.

Lam (2005) studied enterprise application integration (EAI) success factors and concluded that they are partly similar to general ERP success factors – successful EAI needs to consider the factors on the levels of business, organization, technology and project. Chowanetz et al. (2012) extended this list with environmental factors surrounding the organization. Hoverer, neither of these classifications is addressing the role of EDN.

Besides the role of supplier, our evidence suggests the important roles of consultants and business partners in ERP system integration.

As the integration requirements of ERPs have increased and ERP has been extended towards SCM, the relationship between ERP and e-business have been increasingly studied. Thus, factors affecting e-business adoption can be partly related to our findings. For instance, there is quantitative evidence on organizational factors, such as company's scope and skills affecting e-business adoption from the adopting organization point-of-view (Nurmilaakso, 2008). Smolander and Rossi (2008) observed that political and organizational forces affect the development process of cross-organizational e-business initiatives. Xue et al. (2005) and Chen (2003) discuss the affecting factors on e-business standardization and identified stakeholders, such as IT product vendors and systems integrators, and also organizational factors, including company size, industry type and IT-infrastructure as factors affecting the adoption of e-business standards. Our study highlighted the relationship between ERP and e-business and is aligned with these findings, but we see standardization as one (but just one!) important part of ERP system integration.

5.1 Future Research

By identifying the factors affecting ERP system integration, our study creates a baseline for future research on strategies and approaches to effectively solve the integration issues in different EDNs. Because they are not widely studied, EDNs need to be investigated further, especially from the integration point-of-view. A comparison between the EDNs of packaged and customized ERPs and their integration strategies could be an interesting topic to study further. The EDN of a company utilizing a packaged ERP is most likely very different due to a number of external consultants and the presence of a flagship ERP company, such as SAP. Moreover, it would be interesting to investigate how the amount of customization affects integration. Quantitative studies are also needed to investigate the factors affecting ERP system integration in a larger scope.

5.2 Limitations of the Study

This study has some limitations. As in all qualitative studies, the findings of this study cannot be easily generalized. The findings are related only to the specific case and all generalizations are theoretical (Lee and Baskerville, 2003), i.e. they generalize specific observations to theoretical concepts. With these concepts we can explain the events in the studied organization and we also strongly believe that these affecting factors on ERP system integration are similar in other contexts as well. Understanding the factors can help managers to pay more attention to integration and interoperability of ERP systems and evaluate the flexibility of ERP packages and to further develop approaches to solve integration issues in ERP projects.

6 CONCLUSIONS

We have proposed an empirically grounded model of factors that had an effect on ERP system integration in a large manufacturing enterprise. We found four classes of factors affecting ERP system integration: *Domain*, *Organizational landscape*, *ERP development network partners*, and *ERP system characteristics*.

The Domain has an indirect impact on integration through economic situation and business processes by affecting all the other classes of factors. In the Organizational landscape, ERP strategy and enterprise architecture have a role in managing the integration of the ERP system with other systems. Structural changes can introduce political agendas within the organization by making the ERP system integration more challenging. ERP system characteristics can determine the ease of technical integration. With a fully customized ERP system, the company has a total control over the interfaces of the system, which seems to make the integration less painful, bypassing some general integration challenges of packaged ERPs.

What has not been discussed earlier in detail is that ERP system integration is affected by many stakeholders including software vendors and suppliers, consultants, supply chain partners and standardization organizations – ERP development network partners. We found that the relationships in the ERP development network can be tightly coupled and this can have a significant effect on ERP system integration. In order to be realized, ERP system integration demands cooperative practices. A long term customer-supplier relationship and supplier's expertise as well as collaboration between supplier and consultants turned out to be key enablers of integration.

The developed model of factors affecting ERP system integration reflects the nature of ERP development as socio-technical endeavour. The

current literature often ignores the role of the EDN by focusing on the adopting organization only. This study established a base for further research on ERP system integration to investigate strategies and approaches to effectively solve the integration issues in different EDNs.

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