ERP Integration
A Systematic Mapping Study

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Abstract: Companies have been adopting Enterprise Resource Planning (ERP) systems for decades in order to integrate business functions to increase their competitiveness. The original goal of ERP was to provide an all-in-one integrated suite for the enterprise. However, in a modern business environment, ERPs are integrated externally with customers, suppliers and business partners and internally with continuously changing system landscape of the enterprise. In this paper we present a systematic mapping study that investigates how ERP integration-related issues have been studied by the academia between 1998 and 2012. Studies about technological issues are mostly dealing with systems inside a company whereas studies on methodological issues focus on the integration of the supply chain management and e-business. However, these studies are often either carried out without a rigorous research method or they are based on single cases only. Quantitative methods have been mainly used to investigate quality attributes of ERPs. It is still unclear, how integration issues are effectively solved by a network of stakeholders in an ERP project. This requires more research in the future.

1 INTRODUCTION

ERP systems are integrated computer information systems that aim to integrate the core business processes in a company, previously automated by monolithic legacy applications (Alshawi et al., 2004; Yusuf et al., 2004). They are designed to automate the flow of information, material and financial resources of these processes to a single database, which can be accessed to get real-time enterprise data whenever needed (Somers and Nelson, 2003; Su and Yang, 2010). The rationale for adopting an ERP system is that the enterprise can enhance its business performance, financial predictability, and decision making by business process automation with timely access to management information (Yusuf et al., 2004). ERP can also increase the productivity as well as improve the quality of customer service and knowledge management (Berchet and Habchi, 2005). Adopting an ERP system means that a company usually chooses an ERP product from a certain vendor (e.g. SAP, Oracle or Microsoft) and either re-engineers its business processes to match those offered by the ERP product, or customizes the ERP product to match the existing processes (Somers and Nelson, 2003; Themistocleous and Corbitt, 2006).

The origin of ERP systems can be traced back prior to 1960s when inventory control systems were introduced (Metaxiotis et al., 2003). MPR (Material Requirements Planning) systems emerged in 1970s to convert production plans into raw material requirements and in late 1980s, mainframe-based MPR2 systems were to optimize the production process of the plant (Cardoso et al., 2004; Hwang and Grant, 2011). Later, more functional areas including accounting and finance could be served by one unified system called ERP (Cardoso et al., 2004).

Originally designed to integrate only the internal business functions, it was soon realized that ERPs could not meet all integration requirements of the changing business environment. It became necessary to integrate operations across national borders and coordinate business processes with partners in strategic alliances (Barki and Pinsonneault, 2002). Business collaboration has become a key strategy for companies and it needs cooperation among organizations, integration of business processes and enterprise systems (Wang et al., 2005). In a modern

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business environment, a single organization is a part of the network of delivering and supporting organizations – a part of the supply chain (Su and Yang, 2010). Even though it is challenging to accomplish, organizational integration is needed to interconnect customers, distributors and suppliers via integrated supply chains (Barki and Pinsonneault, 2002). Implementing an ERP system is seen as the first step in the process of enterprise-wide supply chain integration. (Downing, 2010; Yusuf et al., 2004). There is a need to manage the integration among different businesses and systems (Eckartz et al., 2009).

Currently, an ERP system is just one of the many information systems used in organizations (Oman, 2011).The scope of ERP has advanced to *Extended ERP* or *ERPII,* in which the traditional ERP is integrated with other operational systems such as SCM (Supply Chain Management) and CRM (Customer Relationship Management) (Vathanophas, 2007). During the years, different technological solutions, including EAI (Enterprise Application Integration) and SOA (Service Oriented Architecture) have been introduced to solve the integration issues between these systems (Margaria et al., 2010; Wang and Zhang, 2005). A modern ERP is often accessed by mobile devices from different locations (Frank and Kumar, 2012; Jankowska and Kurbel, 2005). It also provides access for customers via web interfaces (Vathanophas, 2007).

Even though significant amount or research has been conducted on ERP systems during the last 15 years, we can still read from the news about ERP disasters: for example US Air Force spent over one billion dollars to an ERP project and cancelled the unsuccessful project after 8 years (CXO Media Inc., 2013a). Also, IBM was recently sued because of disastrous mismatch between an ERP product with a manufacturing company (CXO Media Inc., 2013b).

As modern ERP implementations are becoming more complex and challenging, we believe that integration has a key role in ERP projects. Therefore this study takes the first step in a research project that aims to investigate integration issues in modern ERP projects. This paper maps systematically the existing literature and investigates how ERP integration has been studied in the academia in order to provide a solid baseline for ERP integration research.

The next section provides the definition for the concept *integration* and discusses other literature reviews performed on ERPs. Section 3 explains how the process of this mapping study was carried out. Results are presented in section 4. Section 5 discusses about the future directions of ERP integration research and section 6 provides the conclusions.

2 BACKGROUND

2.1 Definition of Integration

Integration is an ambiguous term that has many interpretations in different domains. For example, in strategy, it means *"coordination of activities and management of dependencies between them*" (Glouberman and Mintzberg, 2001). In production and logistics, it is *"coordinated management of information, material flows, plant operations and logistics through a common sets of principles, strategies, policies and performance metrics"* (Barki and Pinsonneault, 2002). The dictionary also provides multiple definitions for integration, for example "*the act of combining or adding parts to make a unified whole*" (Farlex Inc., 2013). In the domain of information technology, integration is often associated with different perspectives. For example, Barki and Pinsonneault (2002) list the following perspectives:

- *Technical* perspective sees at least two interconnected systems exchanging data
- *Business Process* perspective views standardized business processes among organizations coupled through information technologies
- *Strategic* perspective views integration as coordination and cooperation between human actors

Application integration and or*ganizational integration* are often referred with internal and external perspectives. Application integration is a strategic approach to bind information systems together (Linthicum, 2004). According to Linthicum (2004), application integration can be both internal and external (business-to-business, B2B). Moreover, integrating information systems inside a single company is often referred as Enterprise Application Integration (EAI). Organizational integration is "*the extent to which all processes and technologies of the entire value chain of an organization constitute a unified whole"* which can be happening internally within an organization or externally across different organizations (Barki and Pinsonneault, 2002). Also, it is stated that internal integration deals with interrelationships and trade-offs within a firm while

external integration refers to coordination with customers and/or suppliers (Welker et al., 2008). The evolution of the Internet and web technologies have changed the focus of integration, to consider also external stakeholders, to connect customers and suppliers through CRM and SCM to the ERP system (Búrca et al., 2005; Turner and Chung, 2005).

Instead of being just a technical activity, *Information sharing* and *cooperation* are tasks that are closely related especially to external integration, where business partners integrate their systems (Barki and Pinsonneault, 2002). We also see integration as an activity which aims at blending elements of systems inside and outside the company to a unified whole, not only by means of technical solutions but also by information sharing and collaboration between human actors.

2.2 Existing Literature Reviews on ERPs

Since the end of 1990s, ERP systems have been a major interest of researchers. Seven systematic literature reviews to map all the conducted research on ERP systems have been done (Addo-Tenkorang and Helo, 2011; Botta-Genoulaz et al., 2005; Esteves and Pastor, 2001; Esteves and Bohorquez, 2007; Moon, 2007; Schlichter and Kraemmergaard, 2010; Shehab et al., 2004).

These literature reviews address the integration issues only partly. Shehab et al. (2004) did not point out categories related to integration issues in their study. Botta-Genoulaz et al. (2005) used the category "ERP for supply chain management," which views an ERP as a platform for other applications, including CRM and SCM. The authors found five articles that deal with integration of ERP and other systems. Esteves and Bohorquez (2007) identified 21 integration-related articles and categorized these articles as "Evolution." Moon (2007) identified 37 articles dealing with extending the functionality of ERPs whereas Addo-Tenkorang and Helo, (2011) found 15 articles related to this category. Schlichter and Krammergaard (2010) identified studies related to "ERP tool" and "ERP and supply chain management," but the authors only pointed out few examples related to these categories.

Rather than examining all the ERP related research we aim at finding out the ERP integration issues from the literature in order to provide a comprehensive view to this topic. We wanted to investigate how internal and external information systems are being integrated with ERPs and by what means integration issues have been studied. Only Schlichter and Krammergaard (2010) identified the research approaches of the studies, but they did not highlight what approaches have been used to investigate integration issues.

For this study, we have set the following research questions: 1) *How have the number of publications related to ERP integration been evolved between 1998 and 2012?* 2) *What aspects of integration have been investigated?* 3) *What research methods have been used in these studies?* and 4) *What topics need to be investigated further?*

3 RESEARCH METHOD

A systematic literature review (SLR) is a secondary study which aims to gather and evaluate all the evidence on a selected research topic (De Almeida Biolchini et al., 2007; Kitchenham et al., 2009). It aims at identifying gaps in current research to point out the potential areas of further research and it can also provide background to position new research activities (Kitchenham and Charters, 2007).

Systematic mapping study (SMS, sometimes called as scoping review) is a study complementary to SLR (Kitchenham and Charters, 2007; Petersen et al., 2008). Kitchenham and Charters (2007) highlight qualitative differences between SLR and SMS. Petersen et al. (2007) provide more comprehensive comparison by stating that there are similarities and differences in goals and process as well as in breadth and depth of these studies. Unlike SLR, SMS does not aim at establishing the state of evidence and identifying the best practices based on empirical evidence. Mapping studies do not study articles in detail but aim at classification and thematic analysis. The goal of both types of studies is to identify the research gaps with the aim to influence the future direction of primary research. An SMS aims to classify and structure a certain field of interest, often by analysing the categories and frequencies of publications (Petersen et al., 2008). An SMS analyses the literature to find out what kind of studies related to research question have been done, what is their publication forum and what kind of outcomes have been produced (Bailey et al., 2007). The process for SMS in software engineering has been defined by Petersen et al. (2008). Figure 1 presents this process.

First, the research questions are defined for the SMS. Search strings are selected and they are used to search articles from scientific databases to identify the primary studies, by manually browsing and handling the results of the search. Screening

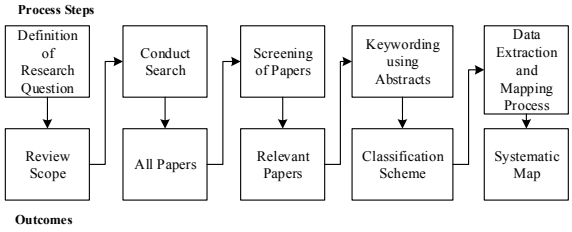

Figure 1: A process of systematic mapping study.

of papers for inclusion and exclusion is used to filter out the papers that do not answer the research questions. In keywording of abstracts, the context and contribution of research is identified. This can be done by identifying a set of keywords and combining them to form a high-level understanding of research area. Based on keywording, the population of related papers can be classified and categorized. Finally, the data is extracted from studies and presented in form of a systematic map that visualizes the results with graphs and tables or other graphical representations (Petersen et al., 2008).

In our study, keywords and databases were selected after defining the research questions. Searches were made by using the advanced search functionality offered by the databases. A set of related articles was identified from the search results by using inclusion and exclusion criteria. Categorization was made iteratively by handling the set of related articles that were not excluded. Finally, the results were presented, a systematic map was produced and the meaning of results was interpreted.

3.1 Selecting Keywords and Databases

First, a pilot search from different databases was made to estimate how feasible the chosen area of interest is for performing a systematic mapping study. It appeared that the number of search results varied from 20 to 260 depending on the database by using keywords *"ERP" AND "integration"*. We decided that this number of articles is possible for closer investigation.

Rather than choosing specific journals or conferences, we selected six databases for review: ACM, CiteSeer, IEEEXplore, Sciverse, SpringerLink and EBSCO. These databases target a wide range of the most important conferences and journals in computer science, software engineering, and information systems. Moreover, they all offer an advanced search functionality that allows searching from different parts of the article, like from titles, abstracts, and keywords.

We decided to search the terms *"ERP" AND "integration"* from the metadata (titles, keywords and abstracts) of articles. The time period was set from 1998 to 2012. From ACM, CiteSeer and EBSCO we had to perform two searches, because the search engines allowed only searching from titles or from abstracts instead of from all the metadata. Filtering was used in searching to crop the unrelated topics in Sciverse and EBSCO. Table 1 shows the results from actual search.

Table 1: Results from actual search.

Source	Search criteria and filtering	Accepted / Total
ACM	1) ERP and integration from abstracts, published in 1998-2012 2) ERP and integration from titles, published in 1998-2012	5/21 1/1
CiteSeer	1) ERP and integration from abstracts, published in 1998-2012 2) ERP and integration from titles, published in 1998-2012	25/66 5/7
IEEEXplore	ERP and integration from metadata, published in 1998-2013	141/239
Sciverse	ERP and integration from titles, abstracts and keywords limiting to Computers in Industry, European Journal of Operational Research, Expert Systems with Applications, Information & Management, International Journal of Production Economics	18/26
SpringerLink	ERP and integration from titles and abstracts since 1.1.1998, no book chapters	12/42
EBSCO	1) ERP and integration from abstracts, source type: academic journals, published in 1998-2012, filtering out evoked potentials from thesaurus terms 2) ERP and integration from titles, source type: academic journals	88/261 15/58
TOTAL		**310/721**

3.2 Handling the Related Articles

In total of 721 search results were first reviewed by reading the title, keywords and abstract. This was done to decide if the article meets the criteria. At this point, articles focusing on completely different

topics such as Event Related Potentials, or articles written in other language than English were dropped out. We also removed duplicate articles. In total 310 articles were identified as potentially interesting, and they were reviewed in more detail.

3.2.1 Exclusion Criteria

During the further analysis of the remaining 310 articles, filtering was performed to drop out unrelated articles. An article was excluded if it was not related to integration issues. For example, many articles mentioned the used keywords in the abstract, but focused on other issues than the integration with other systems. The term "Integration" usually appears in a definition of ERP, which is often presented in the abstract to introduce the research area. Also, if it occurred that the article just briefly mentioned ERP and mainly focused on some other subject, the article was left out. This filtering reduced the total number of articles from 310 to 140. In addition, for this report, due to the limited space of a conference article, we chose to focus only on journal articles, to reduce the number of articles to be reported. This reduced the number from 140 to 56. The full data is available in http://enact.lut.fi/erp_sms.

3.2.2 Categorization of Articles

The categorization was made by iteratively analysing the 56 selected journal articles. The data recorded from the related articles is shown in Table 2.

Table 2: Data collected from articles.

Article Data	Categorization Data
Publication Name *Publication Type* (journal, conference or other) *Publication Forum* (if available) *Publication Year* (1998-2012) *Keywords* (if available) *Author's Home Country*	*Scope of Integration* (internal, external or internal & external) *Sub Category* (technological issues, methodological issues, quality issues, or extension to ERP) *Research Method* (systems dynamics, literature study, focus group, survey, delphi study, constructive research, case study, multiple case study)

From each publication, publication name, publication type, name of the publication forum, year and country were recorded. The categorization was made by dividing articles to classes based on their scope of integration: *Internal*, *External* or both *Internal and External*. "Internal" deals with the integration of applications, systems and devices inside a company with no involvement of business partners, or with no relation to business partners. "External" means that ERP integrates with information systems outside the organization or that the integration aims at collaboration of business partners or external stakeholders. If the article discussed about both aspects, it was categorized under "Internal & External." In cases where the specific target of integration (e. g. Advanced Planning and Scheduling (APS) or the supply chain management system) was mentioned, it was also recorded. Furthermore, the related sub-categories were identified. The sub-categories were created inductively, by labeling conceptually the most essential topic of interest of the article. The list of sub-categories included *Technological Issues*, *Methodological Issues*, *Quality Issues,* and *Extending ERP*.

The research method used in the article was recorded. It was not always clearly defined in the article. In these cases the method was set either to "literature study" in cases where article just presented some ideas by relying on literature or "constructive research" in cases where the article proposed a construct based on the literature.

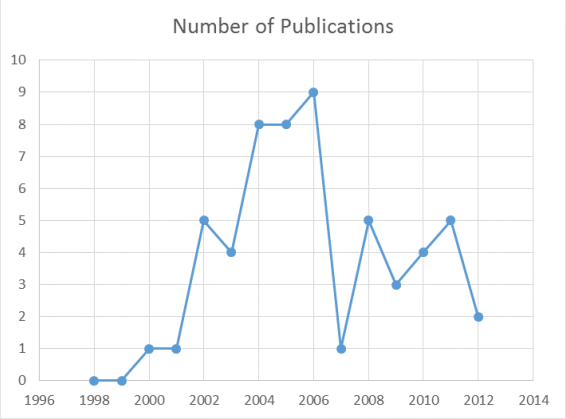

Figure 2: The number of journal publications on ERP integration.

4 RESULTS

Figure 2 shows the number of ERP integration related journal publications yearly. The year 2006 had the biggest number of publications. Since there are no published articles in years 1998 and 1999, it

seems that the time period used as the search constraint is suitable.

About half (28) of the publications address *methodological issues*. These articles discuss about processes and approaches of how integration was carried out in a certain case. They also discuss about critical success factors, challenges, management and information sharing in ERP integration. Some of these articles also proposed a conceptual research framework. The second biggest subset (12 articles) deals with *technological issues*. These articles propose a technological approach to integration typically by presenting an architectural solution or by discussing about certain technologies used in integration. 7 publications discuss about *extending ERP* by identifying additional functionality that could be provided by the ERP system, or by proposing a new architecture for the ERP system.

Quality issues was selected as a sub-category if the article addressed measureable characteristics of ERP systems or benefits provided by the ERP system related to integration. 9 articles addressed this sub-category.

Table 4 lists the applied research methods used in these articles. It is notable that most of the articles are case studies, use constructive approach or are based on literature only. In addition, a common qualitative approach such as ethnography is

Table 3: A systematic map of ERP integration.

	Internal	**External**	**Internal & External**	**ERP Characteristics**
Technological Issues	(Huang, 2002) CR (Wiers, 2002) CS (Wang et al., 2005) CR (Ou-Yang and Hon, 2006) CR (Hu and Wang, 2008) CR (Wei et al., 2008) CR (Oman, 2011) CR	(Siau and Messersmith, 2002) LS (Margaria et al., 2010) CS (Shafiei et al., 2012) CR	(Tao et al., 2004) CR (Wang and Zhang, 2005) CR	
Methodological Issues	*Processes and Approaches:* (Soliman et al., 2001) GT (Alshawi et al., 2004) CS (Gayialis and Tatsiopoulos, 2004) CS (Lam, 2005) CS (Stefanou and Revanoglou, 2006) CS (Xu et al., 2006) CR (Metaxiotis, 2009) LS (Lee et al., 2010) CS *Challenges:* (Worley et al., 2002) CR (Yusuf et al., 2004) CS (Zhu, 2006) S (Momoh et al., 2010) LS	*Processes and Approaches:* (Tarn et al., 2002) LS (Ash and Burn, 2003) CS (Búrca et al., 2005) CS (Themistocleous and Corbitt, 2006) CS (Koh et al., 2006) CS (Toloie–Eshlaghi et al., 2011) LS *Information sharing:* (Kelle and Akbulut, 2005) LS *Challenges:* (Akkermans et al., 2003) DS (Themistocleous, 2004) CS (Bose et al., 2008) CS	*Processes and Approaches:* (Lee et al., 2003) LS (Vathanophas, 2007) FG (Akyuz and Rehan, 2009) LS (Hvolby and Trienekens, 2010) LS (Cagliano et al., 2006) S *Information sharing:* (Welker et al., 2008) MCS	
Quality Issues	*Benefits:* (Kang et al., 2008) S (Uwizeyemungu and Raymond, 2012) MCS (Ranganathan and Brown, 2006) S	*Benefits:* (Zheng et al., 2000) CS (Ghani et al., 2009) CS (Chung et al., 2011) LS	*Benefits:* (Hwang and Grant, 2011) S *Characteristics of ERP:* (Turner and Chung, 2005) CR (Baki and Çakar, 2005) S	
ERP Extension				*New Functionality to ERP:* (Cardoso et al., 2004) LS (Rom and Rohde, 2006) S (Koslowski and Strüker, 2011) SD *New Architecture for ERP:* (Metaxiotis et al., 2003) CR (Frank, 2004) CR (Ip et al., 2004) CR (Lea et al., 2005) CR

completely missing from this population of journal articles and grounded theory is applied only in one article.

Table 4: Applied research methods.

Applied Research Method	Number of Publications
Systems Dynamics (SD)	1
Literature Study (LS)	11
Focus Group (FG)	1
Survey (S)	7
Delphi Study (DS)	1
Constructive Research (CR)	16
Case Study (CS), Multiple-case study (MCS)	16, 2
Grounded Theory (GT)	1

The systematic map of ERP integration is presented in table 3. The scope of integration, related sub-category and applied research methods of the articles are presented in the map. For research methods, abbreviations from table 4 are used. The next chapters walk through the main findings from the found articles and interprets the systematic map of ERP integration.

4.1 Technological Issues

A fair number of articles deal with technical issues of integration. This is not surprising, as integration is often seen as a technical matter. Articles addressing technological issues aim at building flexible solutions and architectures for integrating ERP with other systems. Specific technologies such as SOA and EAI are often used to aid the integration effort (Margaria et al., 2010; Wang and Zhang, 2005).

Systems targeted by these implementation frameworks include other information management systems such as APS (Advanced Planning and Scheduling), DSS (Design Support Systems) or Product Data Management (PDM) (Hu and Wang, 2008; Ou-Yang and Hon, 2006; Wei et al., 2008). The process of integrating ERP with APS is presented, problems encountered, best practices in integration as well as a functional architecture is presented (Wiers, 2002). Also, an architecture to integrate the DSS over SCMs and ERPs of multiple organizations is proposed (Shafiei et al., 2012). In manufacturing companies, there is often a need to integrate ERP with robots on the execution level through a MES (Manufacturing Execution System). An approach to develop a distributed MES that integrates ERP with operational systems at the lower level is proposed (Huang, 2002). A process and technology for ERP and MES integration is presented (Oman, 2011).

Sometimes ERP integration targets both manufacturing and planning systems. An approach where data exchange is made internally and externally between ERP, APS and MES is proposed (Tao et al., 2004). Enabling technologies for ERP and E-commerce technologies are briefly discussed (Siau and Messersmith, 2002). Integration can also target legacy systems and other systems of business partners (Margaria et al., 2010; Wang and Zhang, 2005). Also, an approach for integrating distributed relational database systems with different enterprise systems is described (Wang et al., 2005).

The articles related to technological issues are often made with no systematic research approach. Instead, they are mostly relying on literature or they are based on specific cases. Because of this, they may not be fully applicable to other organizations. In addition, the studies related to implementation do not generally cover the systems accessed by external stakeholders, such as SCM and e-commerce systems. Moreover, mobile and web interfaces which are important in modern ERPs are not discussed in these articles at all.

4.2 Methodological Issues

Several studies address the integration challenges caused by ERP systems that are generally seen as difficulties in the integration with other applications. There are challenges when interconnecting specific ERP modules with other subsystems internally (Zhu, 2006). Also, implementing the interfaces between systems and connecting ERP with non-ERP systems can sometimes be a complex effort (Bose et al., 2008; Momoh et al., 2010). Retrieving data from legacy systems by building temporal interfaces can be challenging (Yusuf et al., 2004). It has also been identified that ERP systems sometimes prohibit the building of additional systems that communicate with it (Worley et al., 2002). It is argued that ERP systems are not designed to cross organizational boundaries, and additional technologies, such as EAI are needed to cross-organizational integration (Themistocleous, 2004). Because of the non-modular and closed system architecture, insufficient for an extended enterprise functionality, the current ERP solutions cannot support SCM integration efficiently (Akkermans et al., 2003).

Many studies report processes and approaches to integrate ERP with different systems. The critical success factors when integrating ERP with computer-aided design and manufacturing

(CAD/CAM) systems has been evaluated (Soliman et al., 2001). A process of building a decision support system by integrating carefully selected functions from SCM, GIS (Geographic Information System) and ERP is presented (Gayialis and Tatsiopoulos, 2004). In a case study of an ERP project in healthcare, integration with various different internal systems such as non-ERP applications, web applications and mobile devices was needed (Stefanou and Revanoglou, 2006). Two literature-based studies discuss the integration of ERPs and Knowledge Management (KM) systems (Metaxiotis, 2009; Xu et al., 2006). An integration methodology for PDM and ERP integration by digital manufacturing is proposed (Lee et al., 2010).

EAI is sometimes used to integrate ERP with other systems and ERP modules. A case study of an EAI project where ERP was integrated with several other internal systems is made (Lam, 2005). It is also suggested that processes can be easily integrated when combining ERP with EAI (Themistocleous and Corbitt, 2006). An approach to integrate ERP modules from different vendors by using EAI to minimize the need of customization of ERP packages is made (Alshawi et al., 2004). A high-level comparison between ERP and EAI as means for enterprise integration is proposed (Lee et al., 2003).

ERP is strongly related to Supply Chain Management and e-business. Relationships of ERP and SCM have been studied (Cagliano et al., 2006; Toloie–Eshlaghi et al., 2011). The integration methods and strategies of ERP and SCM are discussed (Koh et al., 2006; Tarn et al., 2002). An approach for SMEs to extend their ERP system across the supply chain is also presented (Búrca et al., 2005). Requirements for an electronic supply chain are studied and it is pointed out that ERP should be first integrated with other internal applications before forming an e-supply chain (Akyuz and Rehan, 2009). ERP is also seen as a backend system for e-business and an inter-organizational ERP process model has been constructed (Vathanophas, 2007). Existing e-business frameworks and their relationships to enterprise applications such as ERP and CRM is made and a prediction of their future state and challenges is proposed (Hvolby and Trienekens, 2010). A framework for E-business change is proposed by stating that there are other than technological matters, such as cultural and change management issues that affect the integration in E-business projects (Ash and Burn, 2003).

Two studies address information sharing and cooperation. Internal and external information sharing as an integrative practice to enable better collaboration in supply chain planning is examined (Welker et al., 2008). Also, a framework of cooperation for supply chain partners is provided by analyzing both enablers and obstacles in ERP systems that facilitate supply chain information sharing and cooperation (Kelle and Akbulut, 2005).

The studies addressing methodological issues mainly focus on external integration of SCM and e-business. Information sharing and collaboration practices are not studied broadly. In addition, tools used to aid integration efforts have not been investigated widely. Many studies are based on a single case study only. It could be useful to know more about general challenges and success factors that can be adopted in other situations as well. Therefore, besides qualitative studies, there is a need for industry-wide quantitative studies. Moreover, the use of tools to aid integration efforts is unrecognized by these studies.

4.3 Quality Issues

A number of studies that investigate certain quality attributes of ERP systems or evaluate the relationships between ERP benefits and integration have been conducted from different viewpoints. A framework is proposed to evaluate the potential of ERP to e-business by considering flexibility, modularity and integration of an ERP system (Turner and Chung, 2005).

A linkage between ERP and SCM is studied. Chung et al. (2011) suggest a framework to evaluate ERPs capabilities to support SCM initiatives. Also, benefits of integrating ERP with SCM is discussed (Ghani et al., 2009; Zheng et al., 2000).

The effect of integration on performance is examined. Kang et al. (2008) investigate how non-IS integration (people, standardization and centralization) affects performance. A multi-level view of integration and its influence on ERP performance is studied (Hwang and Grant, 2011). Also, the benefits of ERPs with a greater physical scope have been investigated (Ranganathan and Brown, 2006).

The ERP package selection criteria is studied with a conclusion that the system's fit with partners' systems, cross-module integration and compatibility between other systems are the top criteria when selecting ERP systems (Baki and Çakar, 2005).

This category contains the most quantitative studies conducted on ERP integration issues in the

population. Integration is generally considered as beneficial to enterprises. These studies also suggest the role of ERP as a backbone of an extended business system. The non-IS perspective of integration proposed by Kang et al. (2008) could be studied also with qualitative methods, such as grounded theory and case studies.

4.4 Extending ERP

This category of articles discusses the need for additional functionality for ERP systems and completely new approaches for ERP system architecture.

The similarities and differences of ERP and workflow management systems are identified and it is noted that ERP vendors have been starting to add workflow capabilities on their products (Cardoso et al., 2004). The relationships between ERP and Strategic Enterprise Management (SEM) systems are investigated and their integration is proposed (Rom and Rohde, 2006). A knowledge-based system for production-scheduling as an ERP module is proposed (Metaxiotis et al., 2003). It has been suggested that an on-demand ERP could provide a sustainability benchmarking service and also other services based on the ERP data (Koslowski and Strüker, 2011).

An ERP system architecture, based on re-configurable characteristics of material objects and financial objects, and having the advantage of workflow re-configurability and re-usability is proposed (Ip et al., 2004). An architecture for integrating distributed ERP systems with e-commerce systems is presented (Frank, 2004). Also, a prototype based on a multi-agent ERP to achieve enterprise wide integration is suggested (Lea et al., 2005).

These articles address diverse topics, but they all identify the need of extending the functionality of ERPs. New architectures for ERP systems are proposed because of the need for more flexible ERP system architecture where other systems can easily be integrated. ERP as an on-demand service is addressed by one article only (Koslowski and Strüker, 2011). The future studies could investigate how the requirement for on-demand ERP integration affects integration.

5 DISCUSSION

When comparing the results of this study with the previous literature reviews of ERP systems, some evolution in ERP integration research can be identified.

Esteves and Pastor (2001) found out a set of articles dealing with connecting ERPs with other systems and identified that these articles were mainly technology-oriented by focusing on development of interfaces with other systems, web technologies and integration of CRM modules. In their updated literature review, the authors highlighted the need the need of more research on ERP and SCM integration and saw mobile technologies, on-demand and open source ERPs as future trends (Esteves and Bohorquez, 2007). If comparing our findings with these observations, it can be seen that methodological issues have been increasingly targeted, even more than technical issues. Moreover, there are studies that address ERP and SCM integration approaches. However, our study did not find examples of using mobile technologies in integration. Also, how open source and on-demand ERPs affect integration issues remains unclear.

Botta-genoultaz et al. (2005) identified only few articles dealing with the relationship and integration between ERP and SCM. Our study pointed out the lack of technological solutions regarding this integration, but instead methodological issues have been investigated to some extent.

Moon (2007) identified a set of articles dealing with ERP extension and observed a further expansion of ERP's scope as a future trend. According to authors, companies are considering extensions to their ERP systems towards e-business, SCM, CRM, MES, supplier relationship management, and business intelligence systems. The authors also found some articles explaining enabling technologies and how to expand the functionalities of ERP. Our study brings out a more detailed viewpoint of how integration issues with these systems have been studied.

Addo-Tenkorang and Helo (2011) also identified the extended nature of ERP and proposed that future ERPs are based on more advanced technologies, such as SOA, web services, Web 2.0 and they state that future ERPs will be delivered in SaaS (Software as a Service) model. There is no doubt that ERP products will be enhanced with more advanced technologies. However, we believe that instead of technical issues, methods, tools, and coordination to manage the integration in future ERP systems will become more relevant than technological matters.

5.1 Limitations of Study

This study has some limitations. First, because the study focused only on journal articles, conference articles and their contribution to this area have been left out. We have, however, collected and analyzed also all conferences articles that met the query criteria. The full data table is available in http://enact.lut.fi/erp_sms. Second, because of the general nature of the term "integration", some studies may have been filtered out, if authors have used some other terms, such as "interconnecting systems." Integration is a commonly used term which is often not well-defined. Third, the set of related articles may not be fully complete. Some databases such as Google Scholar were left out because of the limitations of their search functionality. However, we believe that the selected databases and their query results provide a very representative view of previous research.

5.2 Future Research

As ERP systems are becoming more complex, there is also a more urgent need to solve the integration issues in ERP projects. The concept of an ERP community has been defined as a tactical group consisting of an ERP vendor, an ERP consultant and the implementing organization (Sammon and Adam, 2002). We believe that this community is more complex, consisting of multiple stakeholders, including vendors of existing and interfacing systems, customers, business partners and also other project-specific groups. There is a need to study ERP projects from the ERP stakeholder network perspective to investigate how integration issues are effectively solved in this network; what kind of tools, methods, and processes are used to aid the integration and how are the people collaborating. By examining these networks it is possible to uncover new research knowledge of ERP integration, its issues and their solutions. Both qualitative and quantitative research is needed, first to find out the emerging issues and then to validate the presumptions. This area of research is also very suitable for design science (Peffers et al., 2007) and action research (Iivari and Venable, 2009) methodologies, currently not systematically applied by the studies in the population.

6 CONCLUSIONS

ERP is adopted by many enterprises today. A modern ERP system not only integrates the core internal functions of one company but also integrates to the business network and is accessed by multiple stakeholders, including customers and business partners.

This paper mapped the existing literature of ERP integration by searching articles from scientific literature databases. We searched journal articles related to ERP integration issues. A total of 56 articles were analyzed further. The articles were categorized based on their scope of integration (internal, external or both) and also by using four sub-categories: technological issues, methodological Issues, quality issues and extending ERP.

Although it is often difficult, ERP integration is necessary due to ERP's role as a backbone of the enterprise business system. According to our analysis, the research that aims at solving technological issues is often conducted with no rigorous and well-defined research method. Moreover, the observed research on technology deals mostly with internal manufacturing and decision making systems, and lacks the focus on SCM and e-commerce that are accessed by external parties. The device aspect with mobility and Internet has not been widely considered either. The methodological issues that have been investigated focus mostly on e-business and SCM integration, but mainly with single cases only. The use of tools and collaboration practices are quite unrecognized by the current studies. The most comprehensive research on ERP integration has been done on quality issues by examining the ERP characteristics and benefits of integration.

Even though ERP products have improved over the years, there still seems to be significant issues with ERP projects. A fair amount of research has been conducted on ERP systems, so this makes us wonder why – with better products and a huge knowledge base – these projects still fail frequently. One reason for this could be the more complex environment and unrecognized area of research – the ERP stakeholder network. The future research should consider various stakeholders in the ERP development network and study how integration issues are solved within this network.

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