ERP System Implementation in Small and Medium-Sized Enterprises

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Abstract

This thesis presents a study of Enterprise Resource Planning (ERP) system implementation in small and medium-sized enterprises (SMEs). Compared to large enterprises, SMEs represent fundamentally different environments, with a number of characteristics typifying the SME context. Because of these distinguishing differences, the findings from studies of ERP implementation in large enterprises cannot be fully applied to SMEs. The purpose of this research project is to explore the influences of the SME context on the ERP system implementation, addressing the following overall research question: *How does the SME context affect ERP system implementation?* The implementation term in this thesis refers to the entire ERP life-cycle, denoting the complete implementation process.

A qualitative exploratory research approach is applied to answer the research question. The research is conducted through a combination of literature review and case study research. The empirical part comprises a multiple case study of ERP implementation in four SMEs. All four case organizations are privately owned SMEs in the Czech Republic.

The research strategy applied is to investigate influences of the contextual factors on various activities across the ERP life-cycle. A list of characteristics, which typify the SME context and could potentially influence on ERP implementation, is synthesized from relevant literature. The SME characteristics are grouped into three contextual dimensions: organizational, environmental, and technological. Then, the influences of the SME characteristics on various activities across the ERP life-cycle are explored. To organize the findings, a six stage model of the ERP-life cycle is adopted. A detailed cross-case analysis is conducted, identifying similar and contrasting findings between the cases.

The research results are presented in five articles published in international conference proceedings and journals. The purpose of this thesis summary is to integrate and discuss the results presented in the publications in a coherent way.

The thesis contributes to four research areas. First, the study contributes to the research stream on contextual influences on ERP system implementation, with particular focus on the influence of the SME context. The ownership type and limited resources were identified as the most influential characteristics of the SME context. Furthermore, an early stage of organizational growth and obsolete legacy systems influenced several issues.

Second, by exploring ERP outcomes the study contributes to the area of ERP implementation evaluation and the impact of ERP systems on organizations. In total, 26 ERP outcomes were identified. The findings were compared with the measurement tool by Gable et al. (2003), indicating potential refinement of their framework. The new outcomes identified in this study may be integrated into the framework to reflect the unique conditions of SMEs.

Third, the study contributes to the research on ERP system customization. The findings provide evidence of a high level of ERP system customization applied by the case SMEs. By investigating the reasons for ERP system customization, the thesis contributes to better understanding of this subject in SMEs. Seven reasons for ERP system customization were identified, of which ownership type and stage of organizational growth of the SMEs are reasons which have not been covered in extant research.

Finally, by analyzing the characteristics of the case SMEs, the study also contributes to the more general research on IS in SMEs. The findings indicate a need for a more nuanced view on what should be considered 'general' SME characteristics. While SMEs are often characterized in terms of low level of IS knowledge, simple business processes and operations limited to local markets, this was not supported by this study. In addition to what is reported in former literature, the stage of organizational growth has been identified as an important contextual factor in SMEs.

In general, the findings demonstrate that the SME context influences ERP system implementation and thus should be taken into consideration in future research and practice. For SME managers, the study findings can be useful for increasing their understanding of the concerns related to ERP system implementation. In particular, SMEs need to improve their strategic planning of IS utilization. Furthermore, the findings indicate that SMEs should emphasize a thorough business process analysis, and increase their attention to outcome evaluation of the ERP system. Also, the vendors need to consider the SME context when implementing an ERP system in this type of organizations. The study documents that ERP system customization may be favoured by SMEs, but the reasons for ERP system customization need to be better understood. The role of owner-managers, unique business processes, and stage of organizational growth are important aspects concerning ERP system implementation in SMEs.

This study relates the identified influences to the different phases and activities in the ERP life-cycle. It thus provides a more complete picture of the ERP implementation

process, compared to earlier studies usually focusing only on one particular phase. Further research may follow the research direction proposed in this thesis. In particular, the applied strategy of investigating influences of SME characteristics on activities within the ERP life-cycle may serve as a useful perspective for further studies on ERP system implementation in SMEs.

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1 Introduction

This PhD thesis focuses on Enterprise Resource Planning (ERP) system implementation in small and medium-sized enterprises (SMEs). The purpose of the thesis is to investigate the influences of the SME context on ERP system implementation and contribute to a better understanding of this topic. The motivation for this research project has both a scientific and a practical background, as explained in the following.

Since there exist various definitions of ERP system in the literature, and some researchers use the terms ERP system and enterprise systems interchangeably (e.g., Davenport, 1998; Gable et al., 2003), the perception employed by this study needs to be introduced at this point. This thesis, in line with Markus and Tanis (2000), perceives enterprise systems as a more generic term, hence considering ERP systems as a subset of this generic group of systems. The thesis follows the definition portrayed by several ERP studies, defining an ERP system as: *"a comprehensive, packaged software solution seeking to integrate the complete range of a business's processes and functions in order to present a holistic view of the business from a single information and IT architecture"* (Klaus et al., 2000, p. 141).

Furthermore, to delineate the scope of this research, a definition of an SME needs to be introduced. This thesis adopts the EU definition of SME as an enterprise with fewer that 250 employees and annual turnover less than 50 million euro (European Commission, 2005). SMEs play an essential role in any economy in the world and embody the economic backbone (Tan et al., 2010). By providing jobs and contributing to the socio-economic development, small businesses represent an important segment of economies (Wolcott et al., 2008). In the European economy, SMEs are a major source of employment, entrepreneurial skills and innovation (European Commission, 2005). In 2007, SMEs constituted 98,8 % of the almost 19 million enterprises in the 27 EU countries' non-financial business economy (Eurostat, 2008). SMEs represent fundamentally different environments, with a number of characteristics distinguishing them from large enterprises (Doukidis et al., 1996). Examples of these distinctive characteristics include market orientation, culture, structure, and ownership type (Ghobadian and Gallear, 1997; Wong and Aspinwall, 2004).

Enterprises worldwide have adopted ERP systems in order to leverage business performance (Beheshti and Beheshti, 2010), and ERP systems have become one of the most widespread IT solutions in organizations (Al-Mashari et al., 2003). In recent

years, with ERP vendors moving their attention towards the SME market, SMEs are now frequently adopting ERP systems (Snider et al., 2009). However, even though midrange and less complex ERP systems have been designed especially for SMEs (Koh and Simpson, 2007), ERP system implementation remains a challenge for many SMEs (Malhotra and Temponi, 2010; Olson and Staley, 2012).

With regard to the issue of IT/IS adoption, SMEs have been found to be constrained by limited resources, limited IS knowledge, and lack of IT expertise (Cragg and King, 1993; Levy and Powell, 2000; Thong, 2001). Because of these constraints an investment in IT innovation is a critical issue for SMEs. Wrong IT investment decisions can have a huge impact on the enterprise's business results. This applies particularly to an ERP system due to its complex implementation process and high resource requirements. Due to their limited resources, SMEs might have greater difficulties in overcoming an ERP implementation failure compared to large enterprises (Muscatello et al., 2003; Poba-Nzaou and Raymond, 2011).

The perceptions on the term 'implementation' vary in the literature. From a technological diffusion perspective, IT implementation can be defined as: "*an organizational effort directed toward diffusing appropriate information technology within a user community*" (Cooper and Zmud, 1990, p. 124). ERP studies have employed various stage models, representing the ERP life-cycle, in order to investigate the ERP system implementation. However, the term implementation has been used both to denote the complete process, and a limited part of the ERP life-cycle (e.g., phase three in the framework by Esteves and Pastor, 1999). The implementation term in this thesis is used to refer to the entire ERP life-cycle.

Recognizing the importance and significance of ERP systems, a substantial body of knowledge has been accumulated by the ERP research field (Esteves and Bohorquez, 2007; Moon, 2007; Schlichter and Kraemmergaard, 2010). However, most of the ERP literature is based on findings from large enterprises (Muscatello et al., 2003; Loh and Koh, 2004). Because of the fundamental differences between large enterprises and SMEs, the findings from studies of ERP implementation in large enterprises cannot be fully applied to SMEs (Mabert et al., 2003; Buonanno et al., 2005; Laukkanen et al., 2007). Although a number of researchers have focused on the issue of ERP in SMEs, based on our thorough literature review (Haddara and Zach, 2011), we have identified a need for more research to gather sufficient knowledge about this phenomenon. In particular, extant research provides only scarce findings about the effect of the SME characteristics on ERP system implementation. Yet, it is important to recognize the

distinguishing characteristics of SMEs and consider how these influence the ERP implementation issues faced by SMEs (Gable and Stewart, 1999).

Given the motivation presented, this thesis aims to explore ERP system implementation in SMEs and shed light on the issues affecting this endeavor. In particular, the research aims to identify how specific characteristics of SMEs affect the implementation of ERP systems. Accordingly, the thesis addresses the following overall research question:

- *How does the SME context affect ERP system implementation?*

In addition to this main research question, the study investigates a number of sub-questions. These address various aspects of the phenomenon under study and are presented later.

The empirical basis for the thesis is a multiple case study of ERP implementations in four SMEs in the Czech Republic. The results from this research are presented and discussed in five research publications (see Appendix C). The purpose of this thesis summary is to integrate the publications and present the research findings in a coherent way.

The rest of the thesis is organized as follows. Chapter 2 introduces different research perspectives on the concept of ERP system implementation and presents the perspective applied in this thesis. In chapter 3 the applied research approach is described, including research design, data collection, and overview of the cases studied. Chapter 4 provides an overview of the five research publications, summarizing the individual papers and their findings. The research contributions are presented in chapter 5. Chapter 6 summarizes the research outcomes, indicates research limitations and reflects on the implications for further research and practice.

2 Related research

This chapter provides an overview of literature related to the research presented in this thesis. As outlined in the introduction, the phenomenon of interest is ERP system implementation in the context of SMEs. There exists a substantial body of scientific literature related to the area of ERP systems, as well as literature about the general relationship between IS and organizations. This review does not intend to cover all existing literature within these two domains, but rather concentrates on the issues relevant for the present research.

In section 2.1, I start with defining the SME context. The purpose of the section is to elicit the characteristics which typify the SME context, and could potentially influence on ERP implementation. Based on a review of relevant research I present a summary of SME characteristics, which represent the SME context studied in my research. The section is organized as follows. I start with a brief discussion of context in IS research (2.1.1). Then I present a review of literature on contextual influences in SMEs (2.1.2). The review covers general literature exploring the influence of the SME context on organizational initiatives, research on the contextual influences on adoption of IT/IS in SMEs, as well as contextual influences on ERP implementation in SMEs. Finally, a summary of SME characteristics is discussed in detail (2.1.3).

In section 2.2, I present and discuss different perspectives on ERP system implementation. The purpose of the section is to provide an overview and understanding of the state-of-the-art in ERP implementation literature, with particular focus on the issues relevant for my research. I organize the section according to the two theoretical approaches of ERP implementation research, i.e. variance research (2.2.1) and process research (2.2.2).

In section 2.3, I position my study in relation to the presented literature. I introduce the research perspective applied and present a research framework.

2.1 Defining the SME context

2.1.1 Context in IS research

The importance of context has been emphasized in the IS literature (e.g., Avgerou, 2001): *"It could be argued that all information systems studies are contextual, as they address issues of technology implementation and use within organizational rather than in a laboratory setting. Thus, by the nature of the object of its study, information*

systems research considers a changing entity within its environment." (Avgerou, 2001, p. 44).

However, conceptualizations of the term context differ among studies. With regard to the boundaries of contextualist studies, three levels of context may be identified (Avgerou, 2001):

- Organization
- Organization's environment
- National and international environment

Early IS research focused largely on intra-organizational IT innovation, and the contextual factors were thus usually considered within the boundaries of an organization (e.g., Ein-Dor and Segev, 1978; Raymond, 1990). A number of IS studies have extended the focus beyond the single organization and included aspects of the organization's environment into consideration, highlighting the existence of competitive pressures on organizations. Increasingly, national and international aspects have also been introduced in research on IT innovations (Avgerou, 2001). The study presented in this thesis regards context mainly in terms of the first two bullet points listed above, while some aspects of national environment are also discussed.

Several frameworks and models have been employed to capture the contextual influences on IS. A number of studies have adapted the technology-organization-environment (TOE) framework by Tornatzky and Fleischer (1990) to explain IT innovation (e.g., Chau and Tam, 1997; Zhu and Kraemer, 2005; Zhu et al., 2006), including studies on ERP system adoption and implementation (e.g., Kouki et al., 2006; Pan and Jang, 2008; Kouki and Pellerin, 2010).

The TOE framework defines three elements of a firm's context influencing the process of adoption and implementation of technological innovation: organizational context, technological context, and environmental context. These three contextual dimensions are discussed in the following and the TOE framework is illustrated in Figure 2.1.

- Characteristics of the *organizational context* typically include firm size, centralization and formalization, complexity of managerial structure, quality of human resources, the amount of slack resources, decision making, and internal communication.

- The *environmental context* represents the arena in which a firm conducts its business, such as industry, competitors, access to recourses supplied by others, and governmental regulations.
- Characteristics of the *technological context* are defined in terms of all internal and external technologies relevant to the firm. The technological context is considered separately from the rest of the context in order to focus attention on influences of the technology on the adoption and implementation process (Tornatzky and Fleischer, 1990).

Important for the focus of this study, the TOE framework has been tested and validated by studies on IT adoption and assimilation in SMEs (e.g., Thong, 1999; Iacovou et al., 1995; Kuan and Chau, 2001; Scupola, 2003; Raymond et al., 2005). Also several studies investigating ERP adoption in SMEs have employed the framework (e.g., Ramdani and Kawalek, 2007; Raymond and Uwizeyemungu, 2007; Ramdani et al., 2009; Poba-Nzaou and Raymond, 2011). These studies successfully utilized the framework to organize selected contextual factors, and found it to be a relevant framework that can be used to study SMEs' adoption of enterprise systems (Ramdani and Kawalek, 2007).

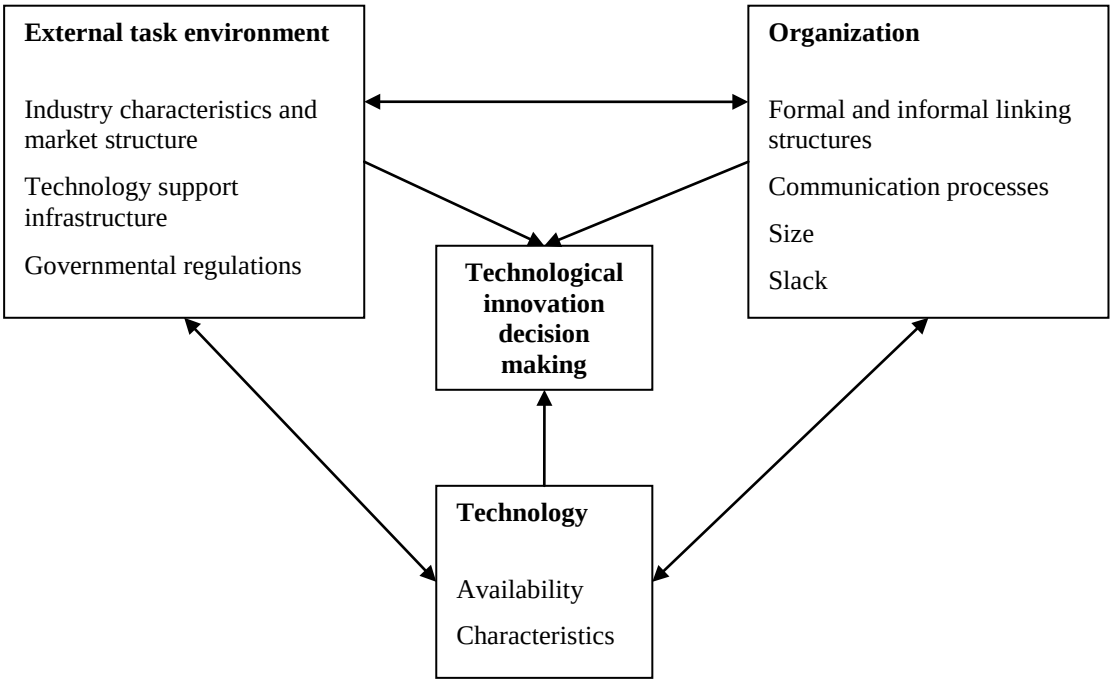

Figure 2.1. The TOE framework (adopted from Tornatzky and Fleischer, 1990)

Based on the successful use of the TOE framework in former research, I have adopted the framework in my research. I organize the SME characteristics according to the three contextual dimensions of the TOE framework. The following section presents a review of literature to identify characteristics which typify the SME context, and that could potentially influence ERP implementation.

2.1.2 Contextual influences in SMEs

This section introduces an overview of relevant literature on contextual influences in SMEs. The review particularly focuses on studies conducted in the field of IS and ERP, as these are of the highest relevance for the thesis. Since the characteristics of the SME context originate from reference disciplines within organizational research (e.g., management, organizational design, and organizational behavior), I perceived it valuable to review this broader literature as well. Thus, in addition to the literature on IS and ERP in SMEs, I reviewed studies investigating the influence of SME characteristics on various organizational initiatives. In this, rather than aiming for a comprehensive review, I focused on identifying frequently cited studies used as references for illustrating distinguishing characteristics of the SME context.

Two studies were identified to be particularly relevant, as they provide a comprehensive overview of inherent characteristics distinguishing SMEs from large enterprises. The studies explore the SME context with relation to Total Quality Management (TQM) (Ghobadian and Gallear, 1997) and Knowledge Management (KM) (Wong and Aspinwall, 2004).

The study by Ghobadian and Gallear (1997) explored the differences between large enterprises and SMEs, and analyzed the relationship between the SME characteristics and TQM practices. Based on a literature review, the authors compiled an extensive list of issues distinguishing SMEs from large enterprises, grouped into six areas: *structure, procedures, behavior, processes, people, and contacts*. The influence of these issues on TQM implementation practices was investigated through four exploratory case studies, resulting in a framework for successful implementation of TQM in SMEs.

In the study characterizing KM in a small business environment, Wong and Aspinwall (2004) looked at specific SME characteristics and the key problems and issues associated with KM. Inspired by Ghobadian and Gallear (1997), based on a literature review the authors proposed a list of SME characteristics which can have an influence on the implementation of KM. The characteristics were classified into six groups:

ownership and management; structure; culture and behavior; systems, processes and procedures; human resources; customs and market. This conceptual paper concludes that recognition of these elements is crucial in order to provide a compatible KM approach for SMEs.

Several studies have investigated various factors affecting IT/IS adoption in SMEs (e.g., Thong and Yap, 1995; Thong, 1999; Sharma, 2009), such as CEO characteristics, employees' IS knowledge, information intensity, and competition. The studies have identified several barriers to IT adoption in SMEs, including resource constraints (Blili and Raymond, 1993; Cragg and King, 1993; Levy and Powell, 2000; Thong, 2001), limited internal IT/IS expertise (Blili and Raymond, 1993; Cragg and King, 1993; Cragg and Zinatelli, 1995; Iacovou et al., 1995; Fink, 1998; Levy and Powell, 2000; Thong, 2001), and limited IS knowledge (Cragg and King, 1993; Cragg and Zinatelli, 1995; Levy and Powell, 2000).

Among the aforementioned studies on IT/IS adoption, the study by Blili and Raymond (1993) stands out in terms of its coverage of SME characteristics and its emphasis on the importance of SME environment specificity. The authors investigated the threats and opportunities of SMEs during IT adoption, and developed a schematic summary of the unique SME characteristics with respect to strategic information systems. The SME specificity features were classified into five areas: *environmental specificity, organizational specificity, decisional specificity, psycho-sociological specificity, and information systems specificity*. The study provides a framework for analyzing the threats and opportunities formed by IT in SMEs.

In a similar vein, several studies investigated the influence of various factors on ERP system adoption in SMEs, such as business size (Raymond and Uwizeyemungu, 2007; Ramdani et al., 2009; Chang and Hung, 2010), CEO characteristics (Shiau et al., 2009; Chang and Hung, 2010), industry type (Ramdani et al., 2009; Chang and Hung, 2010), competitive pressure (Ramdani et al., 2009; Chang and Hung, 2010), employees' competence of IS (Chang and Hung, 2010), and availability of resources (Raymond et al., 2006; Raymond and Uwizeyemungu, 2007; Seethamraju and Seethamraju, 2008). These studies provide valuable findings about the influence of particular factors on the adoption of an ERP system. However, few studies have examined the influence of the unique SME characteristics distinguishing them from large enterprises. Moreover, most of the studies focus on adoption of the ERP system, limiting the scope to a single phase of the ERP life-cycle.

An exception to this is an article by Gable and Stewart (1999), focusing on implementation issues in SMEs adopting SAP R/3. They distinguish between four dimensions of SME specificity (*organizational, decisional, psycho-sociological, and information systems specificity*) and discussed the application of these in the context of ERP systems implementation. However, their paper only presents a tentative model describing interacting variables, with no empirical data. Unfortunately, no follow-up empirical study has been published.

2.1.3 Overview of SME characteristics

Based on the literature review, Table 2.1 lists the identified SME characteristics that could potentially influence on ERP implementation. The overview is largely based on four summative studies which I found particularly relevant for the purpose of the thesis (i.e., Blili and Raymond, 1993; Ghobadian and Gallear, 1997, Gable and Stewart, 1999; Wong and Aspinwall, 2004). The SME characteristics are grouped according to the three contextual dimensions of the TOE framework: *organizational characteristics, environmental characteristics, and IS characteristics*. Selected key references are included for each characteristic.

Table 2.1. SME characteristics

SME characteristics	Selected references
Organizational characteristics	
Resources • Modest financial resources • Limited human capital • Limited resources for employees' training	Blili and Raymond 1993, Ghobadian and Gallear 1997, Gable and Stewart 1999, Bernroider and Koch 2000, Levy and Powell 2000, Thong 2001, Wong and Aspinwall 2004, Raymond and Uwizeyemungu 2007
Ownership, management, and decision making • Owner is the CEO • Time constraints of owner-managers • Top management highly visible and active • Few layers of management • Centralized decision-making • Short-term decision-making cycle • Intuitive decision process	Blili and Raymond 1993, Ghobadian and Gallear 1997, Gable and Stewart 1999, Wong and Aspinwall 2004
Structure • Simpler, flatter, and less complex structure • Flexible structure and information flows • Single-sited • Organic structure • Limited and unclear division of activities • Low degree of employees' specialization	Blili and Raymond 1993, Ghobadian and Gallear 1997, Gable and Stewart 1999, Wong and Aspinwall 2004
Culture • Unified culture • Few interest groups • Common corporate mindset • Low resistance to change	Ghobadian and Gallear 1997, Wong and Aspinwall 2004

• Organic and fluid culture • Influenced by owner-managers	
Processes and procedures • Smaller and less complicated processes • More flexible and adaptable processes • Informal rules and procedures • Low degree of standardization and formalization	Ghobadian and Gallear 1997, Wong and Aspinwall 2004
Environmental characteristics	
Market, customers • Mostly local and regional market • Normally dependent on a small customer base • Affected by powerful partners in their supply chain	Blili and Raymond 1993, Ghobadian and Gallear 1997, Wong and Aspinwall 2004, Seethamraju and Seethamraju 2008
Uncertainty • High level of environmental uncertainty • Uncertain and unstable environment	Blili and Raymond 1993, Gable and Stewart 1999, Seethamraju and Seethamraju 2008
Information Systems characteristics	
IS knowledge • Limited knowledge of IS • Modest managerial expertise • Limited management attention to IS • Lack of strategic planning of IS	Blili and Raymond 1993, Cragg and Zinatelli 1995, Levy and Powell 2000, Levy et al. 2001, Shiau et al. 2009, Chang and Hung 2010
IT technical expertise • Limited IT/IS in-house technical expertise • Emphasis on packaged applications • Greater reliance on third party	Raymond 1985, Blili and Raymond 1993, Cragg and Zinatelli 1995, Iacovou et al. 1995, Fink 1998, Gable and Stewart 1999, Levy and Powell 2000, Thong 2001, Shiau et al. 2009, Chang and Hung 2010
IS function, IS complexity • IS function in its earlier stages • Subordinated to the accounting function	Blili and Raymond 1993, Gable and Stewart 1999

In the following I present each of the SME characteristics in more detail, based on the literature referenced in Table 2.1. It should be noted that some of the literature on IT/IS in SMEs is relatively old and not specifically related to ERP systems. Hence, one of the aims of this study is also to investigate whether the assumptions about SME characteristics in extant research also hold for contemporary ERP system implementations.

Organizational characteristics

Resources. SMEs have been found to be constrained in terms of their financial as well as human resources. They usually do not dispose of a capacity to develop and manage their own IS and thus they are likely to rely on third parties such as vendors and consultants. This might lead to limited control over the information resources and may thus increase the level of risk. In addition, because of the resource constraints SMEs have been reported to invest less in employees' training, as opposed to large enterprises which usually have resources to develop customized training and educational programs.

The research on selection of ERP systems shows that affordable cost and short implementation time are among the most important selection criteria in SMEs. With limited resources available, the enterprises were less disposed to the adoption of an ERP system, and financial constraints were identified as the main cause of non-adoption of ERP systems among SMEs.

Ownership, management, and decision making. The CEOs of SMEs are usually owners who have the ultimate power of control and commonly oversee every aspect of the business. Often they are the only ones with responsibility for and access to the information needed to identify opportunities for using IT for strategic or competitive purposes. The owner-managers usually do not have enough time to reflect on strategic issues, as they are busy with day to day operations and their attention is more on core business operations.

Decision-making is SMEs has been reported as generally centralized with fewer layers of management and decision makers. The centralized decision-making implies that the CEO can either be the main obstruction or the main catalyst for change. Furthermore, the decision-making cycle is usually short-term. In addition, the decision process in SMEs has been found to be more intuitive and based on experience, as a limited number of formal information and decision models are employed.

Structure. Compared to large enterprises, SMEs have been in general reported having a simpler, flatter, and less complex structure. A simpler structure facilitates a change initiative across the organization. As a result of a flat structure in SMEs, the working environment is more flexible, and the communication process is likely to be less complex and easier to manage. Moreover, SMEs have been found to often operate on a single site. In addition, SMEs are also likely to have an organic structure. Workers in small firms often perform a variety of tasks, implying a low degree of specialization in the employees' jobs.

Culture. Culture in SMEs has been reported as unified, with few interest groups. Employees have usually been characterized as having a corporate mindset emphasizing the company as a single entity. The unified culture may provide SMEs with a strong foundation for change, as employees easily understand what the company is trying to achieve. In addition, compared to large enterprises, culture in SMEs has been characterized as more organic and fluid. In the same time, as a result of the strong dominance of owner-managers in SMEs, culture is easily shaped and influenced by their personality and outlook.

Processes and procedures. The operations and processes in SMEs are usually characterized as smaller in scale and less complicated than those in large enterprises. Moreover, the processes in SMEs are also often more flexible and adaptable to changes taking place around them. Therefore, SMEs are likely to be more adaptable to implementing new initiatives, as they are less likely to be "locked-in" to their existing processes. One implication of the need to react quickly is that that most of the activities in SMEs are governed by informal rules and procedures, with low degree of standardization and formalization.

On the other hand, several ERP studies reported importance of SME idiosyncratic processes and a need for preserving these (e.g., Bernroider and Koch, 2001; Vilpola and Kouri, 2005; Quiescenti et al., 2006; Snider et al., 2009). Business processes in SMEs were also reported to have a low degree of standardization and formalization.

Environmental characteristics

Market and customers. The market encompassed by SMEs has mostly been reported as local, having limited international range. In general, SMEs are characterized as dependent on a small customer base with frequent and close contacts with customers. Major customers or suppliers, who are typically powerful in their supply chain, may force SMEs to adopt a system compatible with their extant solution and thus influence ERP system implementations in these organizations.

Uncertainty. SMEs are typically characterized by a high level of environmental uncertainty. The uncertain and unstable environment influences any long term investments in information technologies. Uncertainty relating to the technological environment and the competition is likely to significantly affect IS implementation in SMEs.

Information Systems characteristics

IS knowledge. SMEs have been reported having limited IS knowledge, as there is usually not sufficient managerial expertise available to plan, organize, and direct the use of information resources. Traditionally, most CEOs in SMEs focus on management issues and pay less attention to technology. The lack of IS knowledge may lead to insufficient attention by management to IS and in turn to a lack of strategic planning of IS implementation and use.

In a similar vein, a recent study assessing ERP adoption in SMEs concluded that lack of IS knowledge may inhibit SMEs from adopting ERP systems (Shiau et al., 2009).

The findings showed that the more IS knowledge CEOs have, the more they are inclined to adopt ERP systems. Also the results by Chang and Hung (2010) indicated a positive influence of the CEO's IS knowledge as well as employees' IS knowledge on ERP system adoption.

IT technical expertise. SMEs are also often reported being constrained by limited internal IT/IS technical expertise. Many SMEs possess insufficient level of in-house IT/IS expertise necessary for successful IS adoption, and are thus more likely to purchase a packaged software instead of developing a system in-house.

This argument has been supported by a recent study of ERP system adoption in SMEs (Chang and Hung, 2010), which reported lack of IT/IS professionals and a shortage of developing resources. Also, Shiau et al. (2009) indicated that SMEs do not have the technical IT expertise to evaluate information systems. On the other hand, the studies by Olsen and Sætre (2007b, 2007a) propose in-house development of ERP systems as the best alternative for SMEs, stating that nowadays SMEs may have sufficient IT competence. Similar, a study by Olson and Staley (2012) reported in-house development of an ERP system as an option considered by the case SME, as the company had experience in software engineering.

IS function, IS complexity. The IS function in most SMEs is typically perceived to be in its early stage of evolution. However, more recent studies indicate a need for nuancing this view. For example, a study evaluating readiness of SMEs for ERP adoption recognized that most of the studied SMEs used quite complex IS solutions (Raymond et al., 2006).

Stage of growth

In addition to the SME characteristics identified from the literature review, I discuss *stage of organizational growth* as an organizational characteristic which may distinguish SMEs from large enterprises, and which has not been sufficiently covered by the reviewed literature. In SMEs, often being in an early stage of organizational growth, the change dynamics are often relatively greater than in large enterprises. This does not imply that large enterprises do not grow, but the argument made is that the character of SMEs' businesses is often more dynamic, with changes occurring more frequently and faster compared to large enterprises.

A large volume of scientific literature is dedicated to mapping organizational growth patterns, and various perspectives have surfaced over time. One of the predominant perspectives is the *organizational life-cycle*, describing organizations as passing

through a series of stages (Churchill and Lewis, 1983). This perspective continues to be widely used in academic and practitioner literature (Phelps et al., 2007). Several models of organizational *stage of growth* have been developed (e.g., Churchill and Lewis, 1983; Hanks et al., 1993; Greiner, 1998). Their purpose is to explain the dynamism of organizational growth processes, but they differ in the number of proposed stages (McMahon, 1998). The models are often focusing on SMEs, as the growth aspect is of high importance in these organizations (Dobbs and Hamilton, 2007).

The model by Churchill and Lewis (1983) derives a life-cycle with five stages of small business growth (existence, survival, success, take-off, and resource maturity). Each phase is characterized by the following features: organizational size, diversity, complexity, management style, organizational structure, extent of formal systems, major strategic goals, and the owner's involvement in the business.

While the stage approach has received criticism due to its limitations in terms of explanatory power, underpinning assumptions about linear sequential growth, and limited supporting evidence (Dobbs and Hamilton, 2007; Phelps et al., 2007), this perspective is useful in framing the general processes of organizational evolution and continuous change over time (Hite and Hesterly, 2001), and for understanding the organizational aspects of what should change in a business (Street and Meister, 2004). The organizational life-cycle perspective has also been applied in IS research, and refined models of IS planning and IS strategy change have been presented in the IS literature (e.g., Doukidis, 1996; Levy et al., 2001).

A distinction should be made between stage of growth and another contextual characteristic, organizational maturity. Organizational maturity is defined as "*the degree to which organizational processes are systematized and formalized through rules, procedures, and management practices*" (Raymond, 1990, p. 7). Among the numerous models developed for assessing the maturity level, the Process and Enterprise Maturity Model by Hammer (2007) is well recognized. A common dimension of organizational maturity is the level of formalization (Raymond, 1990). Hence, organizational maturity is related to the level of maturity of organizational processes, in this study captured in the "processes and procedures" characteristic. These two characteristics of organizational context are often interrelated, as organizational growth may impose changes and improvements in business processes. Higher organizational growth stages are also often characterized by increased level of process formalization. But this does not always hold true. Hypothetically, an

organization with stable size/growth can develop from immature to mature in its business processes, and vice versa, a company can grow without increasing its level of maturity.

2.2 ERP implementation research

Numerous studies addressing various topics and issues of the ERP phenomenon have been conducted over the years (Botta-Genoulaz et al., 2005; Moon, 2007; Esteves and Bohorquez, 2007; Schlichter and Kraemmergaard, 2010; Grabski et al., 2011). A recent literature review by Schlichter and Kraemmergaard (2010) distinguished between the following eight research topics covering the range of aspects published within the ERP field: implementation, optimization of ERP, management and ERP issues, the ERP tool, ERP and supply chain management, studying ERP, ERP and education, and the ERP market and industry. According to the results of their literature review, 80 percent of the reviewed articles fall into the first four research topics. The implementation aspect was reported as a predominant subject counting for 30 percent of the studies.

Naturally, ERP research builds on more general IS research. A large body of knowledge has been accumulated in the IS research field over time, and various taxonomies to classify different types of IS research have been proposed. A classic example is the typology introduced by Orlikowski and Baroudi (1991), classifying IS research as positivist, interpretive and critical research based on ontological and epistemological assumptions. Another common perspective for classifying IS research is the distinction between variance and process theories, based on Mohr (1982). This perspective was first introduced in IS by Markus and Robey (1988) and has since then received considerable recognition. Variance theories are concerned with: *"predicting levels of outcomes from levels of contemporaneous predictor variables"* (Markus and Robey, 1988, p. 589), while process theories are concerned with: *"explaining how outcomes develop over time"* (Markus and Robey, 1988, p. 589).

A substantial part of IS research has focused on the notion of IS implementation, and numerous theories and models of IS implementation have surfaced over the years, varying in research approaches and methods of investigation applied. Due to a multitude of such contributions, IS implementation theory has been characterized as quite diverse (Marble, 2000). Also the conceptualizations of implementation itself differ in literature. My intention here is not to provide a thorough overview of the theories and conceptualizations applied, for this I rather refer to former meta-analysis

studies of IT/IS implementation research (e.g., Tornatzky and Klein, 1982; Kwon and Zmud, 1987; Alavi and Joachimsthaler, 1992; Marble, 2000; Premkumar, 2003). This thesis adopts the definition of IT implementation as: *"an organizational effort directed toward diffusing appropriate information technology within a user community"* (Cooper and Zmud, 1990, p. 124).

A general trend has been a move towards more focus in IS implementation research (Marble, 2000), with studies focusing on individual factors significant in the implementation, special types of systems, or specific types of organizations. Due to the uniqueness of SMEs, a number of studies have focused on IS implementation in this context. A good overview of this research stream is provided by Premkumar (2003).

ERP implementation has received great attention in the research literature, and several perspectives to study this phenomenon have been developed. These are introduced in the rest of this section. In line with Robey et al. (2002), I organize the ERP implementation literature according to the two theoretical approaches introduced above: variance and process research. Each sub-section discusses a particular topic in a general way, followed by a focus on research in SMEs.

2.2.1 Variance research on ERP implementation

The focus of ERP studies within the variance research stream includes three particular aspects: contextual factors, critical success factors, and ERP effects.

Contextual influences on ERP implementation

Studies investigating the influences of various contextual factors on ERP system implementation can be categorized in the variance research stream. As discussed in section 2.1.2, this research focuses on investigating influences of various factors on the adoption of an ERP system, thus restricting the scope to a limited part of the ERP life-cycle. Moreover, few studies have examined the influence of the unique SME characteristics.

Various theoretical perspectives to investigate influences of contextual factors on ERP system implementation have been applied. One of the common approaches employed is the concept of fit, originated from contingency theory (Lawrence and Lorsch, 1967; Donaldson, 2001). The fundamental perspective of contingency theory is that organizational effectiveness is achieved by fitting organizational characteristics to contingencies, when a contingency is defined as *"any variable that moderates the effect of an organizational characteristic on organizational performance"* (Donaldson

2001, p.7). The contingency theory has been widely utilized in IS research (e.g., Khazanchi, 2005; Khalifa and Shen, 2008; Raymond and Bergeton, 2008), and the concept of fit has also been applied in ERP research (e.g., Hong and Kim, 2002; Morton and Hu, 2008; Ifinedo and Nahar, 2009). The concept of fit within the ERP context can be defined as *"the congruence between the original artifacts of ERP and its organizational context"* (Hong and Kim 2002, p.27). The contingency theory was considered as a potential theoretical lens in the beginning of this research project (Zach, 2009). However, I found this perspective too static and narrow in scope, ignoring the richness and complexity of ERP implementation, and hence did not follow this path further.

Critical success factors

The studies on ERP critical success factors (CSFs) represent the predominant research stream adopting a variance approach. The term CSF was coined by Rockart (1979), defined as *"the limited number of areas in which results, if they are satisfactory, will ensure successful competitive performance for the organization"* (Rockart, 1979, p.85). In terms of ERP research, CSFs are factors that should be present or fulfilled in order to guarantee ERP implementation success (Robey et al., 2002; Nandhakumar, 2005).

Numerous studies have investigated CSFs of ERP system implementation (e.g., Holland and Light, 1999; Nah et al., 2001; Somers and Nelson, 2001; Akkermans and van Helden, 2002; Al-Mashari et al., 2003). The findings vary to some extent, but the commonly articulated ERP CSFs are top management support, project team competence, project management, clear goals and vision, project champion, user involvement, use of consultant, business process reengineering, and minimal system customization.

CSFs have also been investigated by studies in SMEs (e.g., Loh and Koh, 2004; Reuther and Chattopadhyay, 2004; Sun et al., 2005; Snider et al., 2009; Doom et al., 2010; Kale et al., 2010; Malhotraa and Temponi, 2010; Upadhyay and Dan, 2010). The studies discovered that most of the general ERP CSFs apply to SMEs (e.g., Doom et al., 2010), while some studies also found CSFs unique for SMEs (e.g., Snider et al., 2009). For further discussion I refer to the literature review conducted in article 1 (see Appendix C).

Here I briefly discuss one particular CSF, namely minimal ERP system customization. A number of studies identified minimal ERP customization as one of the CSFs for

ERP system implementation (Nah et al., 2001; Somers and Nelson, 2001), including research in SMEs (Upadhyay et al., 2011). In contrast, some studies have documented failed ERP projects applying customization (Kholeif et al., 2007; Hawari and Heeks, 2010). In particular, research on ERP system implementation in SMEs indicates that SMEs may rather choose to adapt ERP systems to the business processes (Snider et al., 2009; Poba-Nzaou and Raymond, 2011), since system flexibility is important for these organizations (van Everdingen et al., 2000; Bernroider and Koch, 2001). This issue exemplifies that the CSFs from large enterprises may not apply to SMEs. The issue of ERP system customization has been further discussed in article 4 (see Appendix C).

ERP effects

Variance research also includes studies of ERP effects, focusing on the outcomes of ERP implementation (Robey et al., 2002). This issue has received substantial attention and the ERP literature includes numerous studies investigating ERP system outcomes. Over the years, various approaches to ex-post evaluation of ERP system outcomes have been developed. These include studies employing ERP success assessment tools (Tan and Pan, 2002; Gable et al., 2003; Ifinedo, 2006a), ERP benefit frameworks (Shang and Seddon, 2000; Shang and Seddon, 2002; Staehr, 2007; Williams and Schubert, 2010), and ERP balanced scorecard frameworks (Chand et al., 2005; Velcu, 2007; Uwizeyemungu and Raymond, 2009).

A significant contribution in this area is the model for Enterprise Systems[1] Success (ESS) measurement developed by Gable et al. (2003). This model is selected as a framework for investigating ERP outcomes in this study (see article 3 in Appendix C). I present the ESS model in more detail in the following.

The ESS model builds on the models by DeLone and McLean (1992) and Myers et al. (1997), with the success dimensions and measures revised to meet the ERP characteristics. The model involves 27 measures of ERP success grouped into four dimensions: information quality, system quality, individual impact, and organizational impact. *Information quality* is a measure of the quality of the information the ERP system produces. *System quality* includes measures of the ERP system performance from a technical and design perspective. *Individual impact* measures the extent to which the ERP system has influenced the capabilities and effectiveness of workers. The *Organizational impact* dimension captures the extent to which the ERP system

[1] The terms enterprise system and ERP were used interchangeably in this model.

has promoted improvements in organizational results and capabilities (Gable et al., 2008).

The model is presented in Figure 2.2. It is purely a measurement tool for assessing the ERP success, and it does not propose any causality effects between the dimensions (Gable et al., 2003). The model gained considerable recognition and has been further employed in several studies (e.g., Sedera et al., 2003; Sedera and Gable, 2004; Sehgal and Stewart, 2004; Ifinedo, 2006a; Gable et al., 2008). Petter et al. (2008) in their thorough literature review found the ESS model to be the most comprehensive tool for IS success measurement. They state one of its strengths to be that it avoids overlap between the constructs and measures.

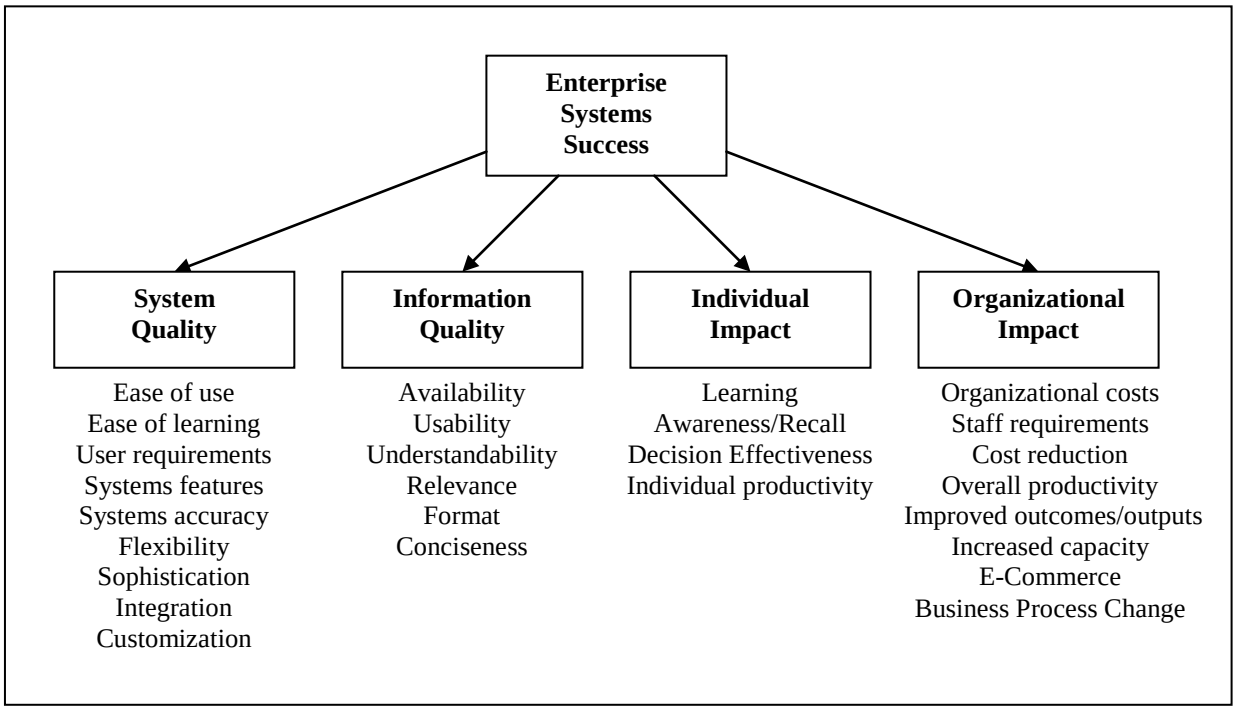

Figure 2.2. The ESS model (adapted from Sedera et al., 2004)

A limited number of studies have focused on ERP system outcomes in SMEs. Esteves (2009) conducted a survey to investigate ERP benefits realization in SMEs, applying the ERP benefit framework by Shang and Seddon (2000). The study determines a link between the benefits and the point in time when the various benefits are expected to materialize, resulting in a benefit realization road-map for ERP usage in SMEs.

Another study reporting ERP outcome assessment in SMEs was conducted by Federici (2007, 2009). The author aimed at a post-introduction assessment of ERP outcomes in SMEs. Interestingly, the study also investigated factors influencing the outcomes. A list of the five most cited benefits that were promised to large companies by ERP adoptions was adopted. The results of a survey of 50 SMEs showed that the most

common benefits were procedure simplification, easier information retrieval, improved performance management, and production efficiency improvements. The most influential factors observed were depth of organizational change and type of chosen ERP producer.

Recently, Kale et al. (2010) investigated performance evaluation of ERP implementation in Indian SMEs. Nineteen ERP benefits were studied through a survey of 130 SMEs. The findings indicated that SMEs benefited mainly by reduced need for support, improved customer services, and improved communication.

Although these studies used data from SMEs, they did not examine in detail the specificity of the SME environment. Moreover, by basing the studies on existing frameworks or lists of ERP outcomes, the studies do not exploit the potential to identify and explore new outcomes which might be specific for SMEs.

2.2.2 Process research on ERP implementation

In contrast to variance research, process research seeks to explain how changes emerge over time. This perspective builds on the more general IS implementation research pursuing the process view (Markus and Robey, 1988; Newman and Robey, 1992). In this theoretical perspective, IS implementation is typically considered as a sequence of stages. As an example, Kwon and Zmud (1987) developed a six stage model of the implementation process, building on diffusion of innovation (DOI) theory (Rogers, 2003). The model has later been refined by Cooper and Zmud (1990), consisting of the following six phases: initiation, adoption, adaptation, acceptance, routinization, and infusion.

In ERP research, various stage models representing the ERP life-cycle have been developed. These usually differ in the number of stages they encompass, distinguishing between three (Parr and Shanks, 2000), four (Markus and Tanis, 2000), five (Ross and Vitale, 2000; Chang et al., 2008), and six phases (Esteves and Pastor, 1999).

The framework by Markus and Tanis (2000) has been employed by a number of ERP studies (e.g., Kumar et al., 2002). The model consists of four phases, characterized by key players, typical activities, characteristic problems, appropriate performance metrics, and range of possible outcomes. The phases are: project chartering, the project, shakedown, and the onward and upward phase.

- *Project chartering* includes the activities before the official start of the project. These include the organizational decision about an investment in a new IS solution, mapping of existing business processes, analysis of potential benefits and limitations, specification of functionality needed, and system selection.
- *The project* phase encompasses all activities between the system selection and "going- live". It comprises activities such as project team building, business process modeling and reengineering, system customization and configuration, end user training, data conversion, testing and debugging, and rollout.
- *Shakedown* is defined as the period between "going-live" and the time when operations get into routine use. During this phase the system performance is tuned, bugs are fixed, and additional training is conducted if needed. The end users are getting familiar with the system and operations are becoming "normal."
- The *onward and upward* phase is defined as the period since "normal" operations to when the system is replaced by an upgraded version or a different system. Typical activities involved are additional user skill building, continuous business improvement, and benefits and success assessment.

In contrast, Esteves and Pastor (1999) developed a six stage ERP life-cycle framework. The authors mapped the research issues that can be analyzed within an ERP life-cycle process, and categorize them into the following phases: adoption decision, acquisition, implementation, use and maintenance, evolution, and retirement (see Figure 2.3). Each of the phases involves several issues and activities typical for a particular phase. These are briefly discussed in the following.

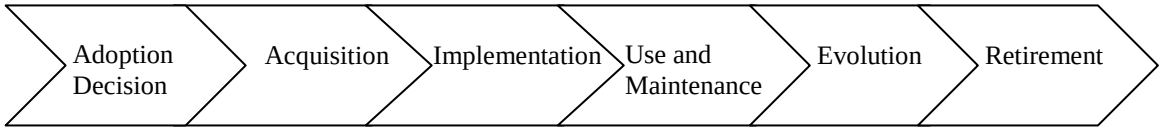

Figure 2.3. ERP life-cycle framework (adapted from Esteves and Pastor, 1999)

- During the *adoption decision phase* organizations recognize their need for a new ERP system. This phase comprises activities such as definition of system requirements, its goals and benefits, and an analysis of the intended ERP system impact.
- The *acquisition phase* includes selection of the product that best fits the selection criteria. Also, an implementation partner is selected based on factors such as price,

vendor location, maintenance services, etc. This phase may also include appointing a selection team, analysis of the return on investment (ROI), and reference visits.

- The *implementation phase* in the framework consists of activities such as ERP system customization, business process management, and user training. In the beginning of the phase an implementation team is usually appointed. Also, the actual technical installation when an ERP system "goes-live", is carried out during this phase. This task is usually carried out by a vendor or consulting company, and can be done via various implementation methodologies.

  Here I need to point out that the terminology used by the Esteves and Pastor differs from the terminology used in this thesis. As emphasized in the introduction, I use the implementation term to refer to the full ERP life-cycle. The Esteves and Pastor model exemplifies how the term 'implementation' can be used to denote a limited part of the implementation process (phase three in the framework).

- The *use and maintenance phase* includes activities such as system utilization, user acceptance and satisfaction, and benefits realization. After "going-live", the system also needs to be maintained, malfunctions need to be corrected, and special optimization requests need to be met.

- The *evolution phase* involves extensions of the ERP system through integration of additional applications (e.g., CRM, Business Intelligence, etc.), and identification of possible new benefits.

- Finally, in the *retirement phase* the ERP system is substituted by a new ERP system or other IS approach.

Table 2.2 provides an overview of possible issues and activities experienced during the various phases of the ERP life-cycle. Naturally, not all the stated activities need to take place in a single project, and additional activities may also appear. Moreover, not all ERP projects will necessarily progress through the same life cycle stages (Robey et al., 2002).

Table 2.2. ERP life-cycle activities (adapted from Esteves and Pastor, 1999)

Adoption decision	**Acquisition**	**Implementation**	**Use and maintenance**	**Evolution**	**Retirement**
Needs recognition - motivation (adoption drivers)	ERP system selection	Implementation team composition	Use of the system	Integration of more capabilities into the ERP	ERP system abandonment
System requirements specification	Implementation partner selection	System customization	Maintenance	New benefits	Substitution of the ERP system
Goals and benefits definition	Selection criteria	Business process management	Debugging		
ERP system impact analysis	Reference visits	Users training	Upgrades		
	Selection team composition	Technical installation	User acceptance and satisfaction		
	Selection decision	Implementation methodology	ERP outcomes (benefits realization)		
	ROI analysis	Data conversion			

2.3 The research perspective applied in this study

Despite the prevalence of variance studies in IS literature, limitations of this research stream have been expressed (Newman and Robey, 1992; Robey et al., 2002). The variance studies have been criticized for their lack of understanding of implementation process features (Newman and Zhao, 2008), and thus being too simplistic (Newman and Robey, 1992). Already Kwon and Zmud (1987) called for integration of the two approaches by exploring *"the impact of multiple contextual factors on multiple implementation stages"* (Kwon and Zmud, 1987, p.125). Thus, their model of the implementation process can be seen as a combination of the variance and process approach, as they argue that the influences of the different factors can be expected to vary across the different stages (Munkvold, 1998).

Some ERP studies have also applied a combination of the variance and process approach. While exploring CSFs of ERP implementation, Somers and Nelson (2001) related the identified CSFs of ERP implementation to the phases of the process model by Cooper and Zmud (1990). In a similar vein, Nah et al. (2001) classified the CSFs according to the Markus and Tanis (2000) ERP life-cycle model. The phases of the Markus and Tanis model were also used to link with critical elements for a successful ERP implementation in SMEs (Loh and Koh, 2004). Esteves (2009) classified the ERP benefits found along three ERP usage phases (stabilise, synthesise, and synergise).

Some researchers have argued that variance and process theories should not be combined (Seddon, 1997; Markus and Robey, 1998), resulting from the assumption that variance theories are positivist and process theories are interpretive (Burton-Jones et al., 2004). Burton-Jones et al. (2004) question this assumption and claim that: *"there is no necessary relationship between one's choice of theoretical approach and one's choice of positivist or interpretive assumptions"* (Burton-Jones et al., 2004, p. 22). The authors furthermore state that employing a "pure" variance or "pure" process approach drastically limits the flexibility to explore certain phenomena, and they encourage employment of combined theoretical approaches. A combination of the variance and process approaches can provide a more comprehensive explanation of IS implementation issues, as the approaches can complement each other (Burton-Jones et al., 2004).

In the light of the aforementioned, this thesis employs a combination of both variance and process theoretical approaches to study the influence of the SME context on ERP system implementation. The variance approach is embodied by the SME characteristics, representing the contextual factors studied. The stage model of the ERP life-cycle embodies the process approach, representing various stages of the implementation process. Hence, the aim is to investigate influences of SME characteristics on various ERP life-cycle phases and their activities (see Figure 2.4).

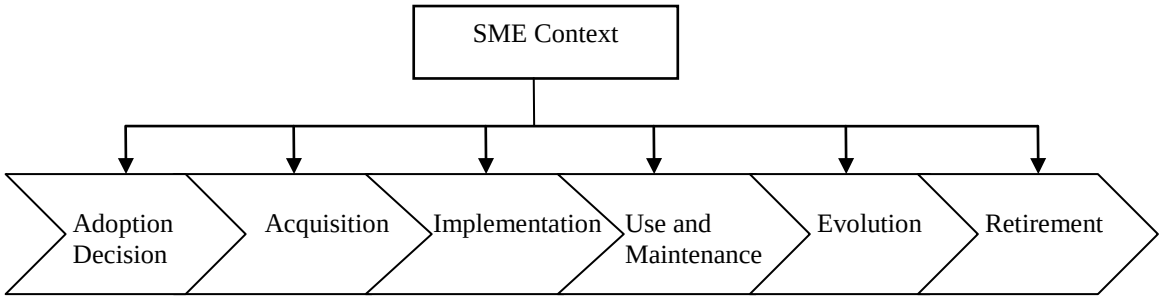

Figure 2.4. Research framework

The SME context studied in this thesis is formed by the SME characteristics introduced in section 2.1. Thus, the terms SME characteristics and SME context are used interchangeably in the thesis. Figure 2.5 summarizes the identified dimensions of the SME context. The SME characteristics are organized according to the three contextual dimensions of the TOE framework (presented in Figure 2.1): organizational, environmental, and information systems characteristics.

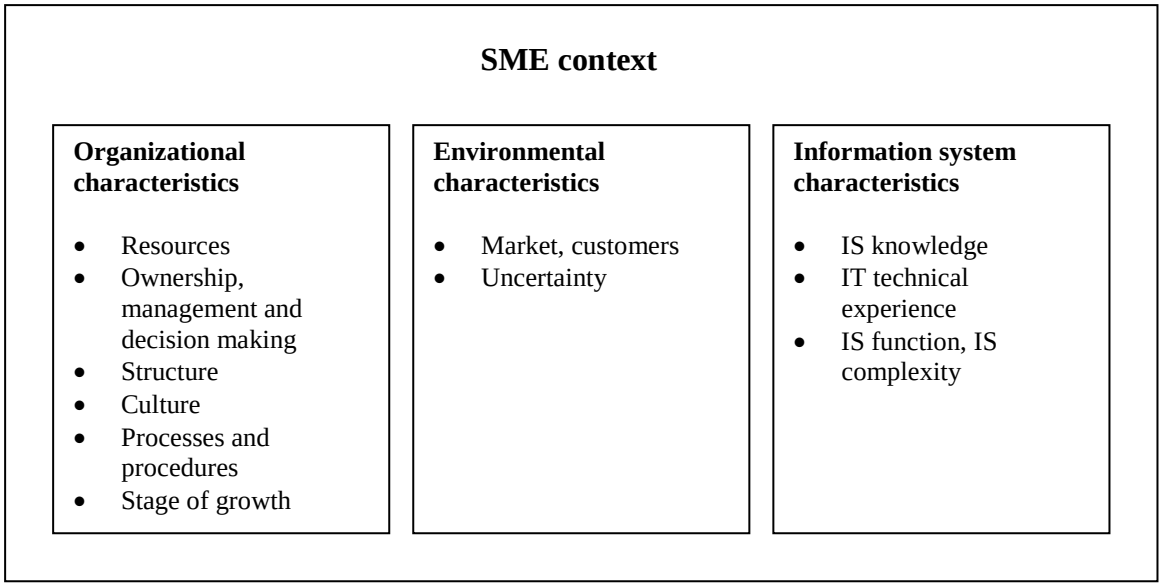

Figure 2.5. Characteristics of the SME context

The study investigates influences of the SME context on various stages of the ERP life-cycle. The Markus and Tanis model was utilized in the beginning of my research project, and was applied in article 2. However, this study showed that it was difficult to distinguish between the two last phases of the model: project shakedown, and onward and upward phase. We found it hard to determine when the operations had become "normal." Therefore, for the rest of the project, I decided to adopt the ERP life-cycle framework by Esteves and Pastor (1999).

The main reason why I have adopted this framework is that it applies a more granular approach compared to other models. It provides more detailed understanding of the ERP life-cycle and thus a better classification of the implementation activities. In particular, the framework clearly distinguishes between system adoption and acquisition, as these are two diverse phases which are usually merged in other models. The framework is used in order to systematically organize the activities of the ERP life-cycle.

3 Research approach

This PhD research project applied a qualitative exploratory research approach. The research has been conducted through a combination of literature review and case study research. The empirical part comprises a multiple case study of four SMEs. The unit of analysis for the case studies is the ERP system implementation in an SME.

A case study is defined *as "an empirical inquiry that investigates a contemporary phenomenon in depth and within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident"* (Yin, 2009, p.18). With regard to the purpose of the research to identify new insights within the context of ERP system implementation in SMEs, case study served as an appropriate research approach.

The research applied a multiple case study design (Yin, 2009). A multiple case design may be preferred over a single case design, as analytic conclusions independently arising from two (or more) cases will be more powerful than those coming from a single case alone (Yin, 2009). Moreover, multiple cases strengthen the precision and validity of the findings (Miles and Huberman, 1994).

Case studies have been widely utilized in ERP research (Schlichter and Kraemmergaard, 2010), and the multiple case study approach has been applied in a number of recent ERP studies (e.g., Rothenberger et al., 2009; Snider et al., 2009; Poba-Nzaou and Raymond, 2011).

The main reason for choosing a multiple case study in this research was to enable a cross-case comparison and thus to enable identifying findings common for all cases as well as findings specific for particular contexts. The selected research approach formed the basis for the research design, case selection, data collection and data analysis. These aspects are further presented in the following sections.

3.1 Research design

Research design can be defined as *"a logical plan for getting from here to there, where 'here' may be defined as the initial set of questions to be answered, and 'there' is some set of conclusions (answers) about these questions. Between 'here' and 'there' may be found a number of major steps, including the collection and analysis of relevant data."* (Yin, 2009, p.26).

The research design in this study comprised several activities. An overview of the research activities is depicted in Figure 3.1. The letters indicate data collection in the

four case organizations (the case organizations and their selection procedure will be further discussed in the following sections). The numbers in the figure represent the research articles, indicating the time span for the development of each of these.

First, a literature review was conducted. While literature review was an ongoing activity throughout the PhD project, Figure 3.1 refers to the main part of the literature review which resulted in the first article. The literature review employed a systematic methodology, with explicit procedures for searching the articles (for more detail see publication 1). In total, 77 articles were included in the review. The articles were classified according to the phases covered in the ERP life-cycle framework by Esteves and Pastor (1999). The analysis also concentrated on various research themes, theories and research methods employed by the articles reviewed. The literature review revealed gaps in former research within the domain of interest and identified potential research opportunities. This research phase served to further refine the problem definition.

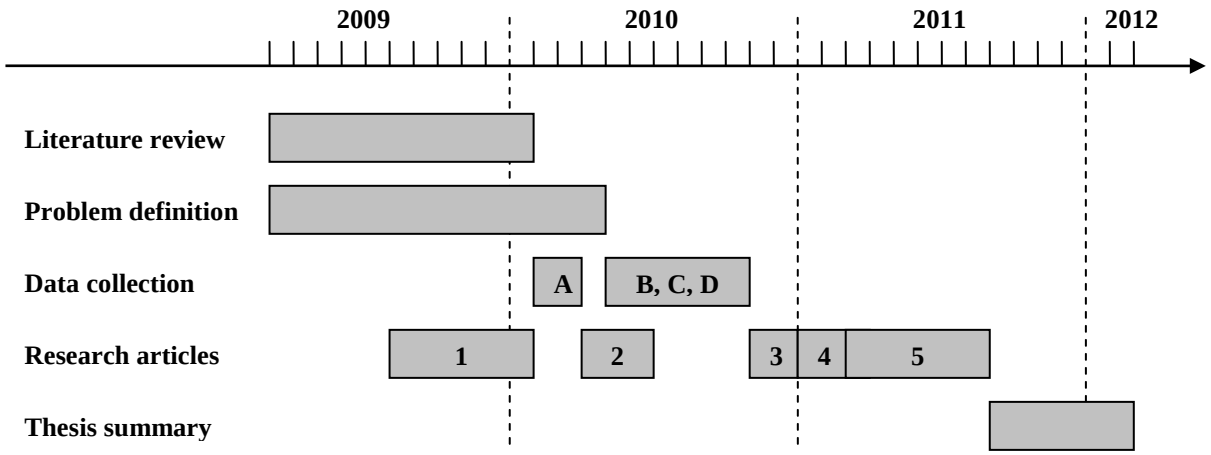

Figure 3.1. Overview of research activities

The empirical part of the research is comprised of a multiple case study. First, an exploratory study of the first case organization was conducted, resulting in article 2. This study documented the relevance of the research focus and the findings indicated potentially important issues for further investigation. The first case study also helped to plan further research steps including subsequent data collection in the other three organizations. The multiple case study enabled a cross-case analysis in order to investigate differences and similarities between the four cases, resulting in articles 3, 4 and 5.

3.1.1 Case selection

With regard to the focus of this research, the primary criterion for selecting the cases was that the organization needed to be an SME (following the EU definition introduced in chapter 1) having implemented an ERP system. At the outset of the research project two potential countries were considered for the data collection, the Czech Republic and Norway. The Czech Republic is the country of my origin, while Norway is the country where I perform the PhD studies. After a thorough consideration the Czech Republic was selected for the data collection. There are several reasons for this choice.

One of the main issues considered was a potential language barrier in Norwegian companies. The interviews would need to be conducted in English, and concerns were raised about the willingness and proficiency of the informants to perform interviews in English. This also implied a potential risk of losing the richness of the data, as well as ability to capture the context in desired detail.

Another advantage of the Czech context was that I possessed better knowledge about the Czech market and society. More importantly, I had personal contacts in several Czech companies, which proved to be highly beneficial for gaining access to the organizations. All the familiar companies were privately owned enterprises. As the adoption of ERP systems is believed to be higher in private sector than in public sector organizations (Ifinedo, 2006b), I perceived it natural to focus on the private sector.

The selection process in this research project was based on a mixture of criterion, opportunistic, theory based, stratified purposeful, and snowball sampling strategies (Miles and Huberman, 1994). The selection of all case SMEs followed the opportunistic sampling strategy. Their selection was not made at the beginning of the project, but rather emerged gradually in response to various issues emerging from the data. In addition, the individual cases were selected based on different strategies as explained in the following.

Access to the first case organization was an important selection criterion (Yin, 2009). Due to a personal contact I gained convenient access to the company. This was a manufacturing company, and the findings from the first case showed how the production strategy can be a significant factor affecting ERP implementation. To enable comparison between the cases, the selection of the three subsequent cases followed the stratified purposeful sampling strategy (Miles and Huberman, 1994).

As the second case another manufacturing company was selected. Its selection also followed the snowball sampling strategy, as it was identified as a potential case based on the interviews in the first company. Since the first two cases were manufacturing companies, the intention was to include a company representing a significantly different business type. Therefore, a non-manufacturing organization was included in the study as the third case. Finally, in contrast to the first company operating under the make-to-order (MTO) production strategy, as the fourth case I selected a manufacturing organization operating under a make-to-stock (MTS) production strategy. This can be classified as a theoretical sampling strategy (Miles and Huberman, 1994, Corbin and Strauss, 2008).

In general, the selection of the cases was also restricted by limitations in terms of time and resources available for the PhD project. The number of cases was limited to four. This is argued to be an adequate number of cases for generating theory with sufficient empirical grounding (Eisenhardt, 1989). More details about the cases are provided in the following section.

3.1.2 Case overview

All four case organizations are privately owned SMEs from the Czech Republic. In order to ensure anonymity, the organizations are labeled as CompA, CompB, CompC, and CompD.

Table 3.1 lists key characteristics of the companies and the ERP implementation projects in the four cases. The case companies represent different phases in the ERP-life cycle, varying from 11 months (CompA) up to 5,5 years (CompD) of experience with the ERP system at the time of data collection. According to the life-cycle stages modelled by Esteves and Pastor (1999) (presented in Figure 2.3), three of the companies (CompA, CompB, and CompC) were in the “use and maintenance” phase, while CompD was in the “evolution” phase, as they had extended the ERP system with a Business Intelligence module in 2010. The following section provides a brief presentation of the individual cases.

CompA, founded in 1994, is a manufacturing SME engaged in production of fiber optic components. The company operates on a single site, situated in a smaller city in the Czech Republic, and consists of six product divisions, comprising also a technological center providing development and design of new products and production technologies.

Table 3.1. Characteristics of the case companies and ERP implementation projects

	CompA	**CompB**	**CompC**	**CompD**
Industry	Fiber optic components	Electronic components	Cosmetics	Agriculture machinery
Business type	Manufacturer	Distributor/ Manufacturer	E-shop	Manufacturer
# of employees	220	100	50	200
Time of "going-live"	April 2009	October 2006	August 2007	January 2005
Experience since "going-live"	11 months	3,5 years	3 years	5,5 years
ERP system	Helios Green	ABRA G4	ABRA G3	ALTEC Aplikace
Implemented modules	Finance, Commerce, Logistics, Production Control	Finance, Commerce, Logistics, Production Control, Asset Management, Human Resources	Finance, Commerce, Logistics, Asset Management, Human Resources, CRM (limited)	Finance, Commerce, Logistics, Production Control, Asset Management, Human Resources, Material Requirements Planning, Production Planning, Business Intelligence (extension in 2010)
Legacy information systems	4 separate DOS-based systems (accounting, production control, payroll system, attendance system)	2 separate DOS-based systems (accounting, production control)	DOS-based accounting system	2 separate DOS-based systems (accounting, production control)
Implementation partner	Certified agent	Vendor	Certified agent	Vendor
Implementation team	10 internal employees	4 internal employees + consultant	2 internal employees	6 internal employees

In 2007, CompA decided to invest in a new ERP system to replace the obsolete legacy systems. The CEO appointed a team responsible for the system selection. After a thorough selection process, the ERP system Helios Green was selected in 2008. This ERP system was developed by one of the leading software houses in the Czech market, LCS International, founded in 1990 and acquired by Assecco Solutions in 2007. CompA selected a small local IT firm operating as a certified agent of the ERP vendor as implementation partner. The firm offers a complete service covering all aspects of an ERP system implementation, including a follow-up support.

However, right after the system selection the implementation project was discontinued by top management. The reason was the market uncertainty resulting from the financial crisis in 2008. The project was restarted 4 months later in a reduced version, only one and a half month before the planned start of the system. Because the financial manager refused to change the accounting system during the fiscal year, the company decided to meet the initial deadline and start the new ERP system from the beginning

of the year. As a consequence of the time constraints, an accounting module was launched in the beginning of January 2009 and the rest of the system was launched by mid-April.

The cooperation with the implementation partner went well and, except for a slight delay, the implementation project has been perceived as successful. CompA uses the ERP system extensively and continues to develop it further. For example, a new production division of optoelectronic components started three months after the ERP system "going-live". This required substantial modifications of the ERP system and development of a new module for production rendering. Interestingly, the company gained access to the system development software and develops the ERP system internally.

CompB, founded in 1991, is a distributor and manufacturer of electronic components for demanding applications in the areas of aerospace, military, transport, and telecommunications. The company operates on two sites within a smaller city in the Czech Republic. In October 2006, the company implemented the ERP system ABRA G4. It is the highest version of the ERP system developed by ABRA Software, one of the largest Czech ERP vendors, operating on the market since 1991. The ERP system was implemented by the vendor, while a local consultant was also involved in the project. CompB is the only case using an external consultant. However, in the other cases the implementation partners also provided consulting services to the companies.

The implementation project took more time than was planned because of the high level of ERP system customization required by the company. In addition, the CEO required all historical data to be transformed from the legacy system, which also complicated the project. All modules were implemented at once, except for a financial module which was implemented with more than one year delay. This was caused by a skeptical stance of the financial manager, as he wanted to keep the old accounting system. The implementation project, despite some problems in the beginning of the system usage, is perceived as successful. The system is further developed through cooperation with the consultant, and the company plans to extend the system further to the manufacturing area.

CompC, founded in 2001, is engaged in selling perfumes and cosmetics through the internet. The company is privately owned by two owners, who are also the company CEOs. CompC operates on a single site situated in a smaller city in the Czech Republic. In the end of 2006 the company decided to renew their IS solution, which

was restricted to the accounting function. The ERP system requirements were specific in the emphasis on maximal automation of processes, possibility of extensive program modifications, and system openness for add-on extensions.

In August 2007, the company implemented ABRA G3, a smaller version of the ERP system from the same vendor as in CompB. The ERP system implementation has been carried out by a small local IT firm, selected as the implementation partner. This firm operates as a certified agent of ABRA Software, and offers a complete range of services for the EPR system implementation.

All selected modules were implemented at once. The implementation team consisted of two internal employees, while the CEOs were also actively involved in the whole implementation process. CompC is characterized by significant expansion during the last decade. The growth of the company causes new requirements which have radical influence on the system extension. The scope of the system in terms of user licenses has increased almost ten times during three years since 2007. The implementation project in CompC is reported to be successful, and the ERP system is considered essential for the firm's business activities.

CompD, founded in 1992, produces and distributes agriculture machinery. The company operates on a single site, situated in a smaller city in the Czech Republic. As the company expanded over time the legacy IS solution became insufficient and a need arose for a more sophisticated system for managing the company.

In January 2005, the company implemented ALTEC Aplikace, an ERP system developed by a smaller Czech ERP vendor, ALTEC, founded in 1991. In contrast to the two previous vendors, ALTEC does not have its headquarters located in Prague, but in a smaller city in the same region as CompD. The implementation project has been carried out by the vendor. All modules were implemented at once but with considerable further development over time, as some modules were immature and did not offer the required functionality. CompD collaborated intensively with the vendor on further development of the system and even became a testing partner of the ERP system. In 2010, the ERP system was extended by a business intelligence module offered by the vendor.

3.2 Data collection

Two qualitative data collection techniques have been used in this research:

- Interviews
- Document analysis

3.2.1 Interviews

The primary source of data has been personal interviews. In total, 34 interviews were conducted across the four organizations. The data collection was carried out during the period from February to October 2010 (as illustrated in Figure 3.1). Apart from two telephone interviews with the vendors in CompA and CompD, all interviews were conducted face-to-face at the companies' locations, usually in meeting rooms. The interview process followed the guidelines by Myers and Newman (2007) for conducting qualitative interviews.

In order to collect different perspectives on the ERP system implementation, the interviews have been conducted with multiple stakeholders across the four organizations. Key informants were selected according to their perceived ability to report on the studied phenomenon. The emphasis was put on collecting data from informants involved in the ERP implementation projects, while also end users were included in the interviews. The respondents represented different positions within each organization. In addition, vendors or consultants involved in the ERP implementation were also interviewed. This approach enabled to collect various viewpoints from different roles within the ERP implementation projects. The interviews lasted from about 20 to 100 minutes, with an average of about one hour. Table 3.2 provides details about the informants' positions and length of the interviews.

The interviews were semi-structured, using an interview guide with open-ended questions. An initial interview guide was developed based on the literature review, and was used for data collection in CompA. The interview guide was slightly updated based on what was learnt from the first case analysis, and used for further data collection in the other three companies. The interview guide covered two main areas. The first area included information about the organization, business activities, and the ERP system implementation project in general (mostly discussed with project leaders and their assistants). The second area covered questions regarding various issues of the ERP system implementation through the entire ERP life-cycle (Esteves and Pastor, 1999), including issues such as ERP implementation motivation, selection process, implementation team activities, critical success factors, user training, ERP system usage, ERP outcomes, maintenance, system development, etc. The informants were asked to express their personal opinions and viewpoints about the particular issues. An example of the interview guide is included in Appendix A, providing an overview of the discussed issues and questions raised.

Table 3.2. Overview of interviews in the four cases

Case	Number of interviews	Work position of informants	Duration of interview (in minutes)
CompA	14	CEO	20
		End user (sales department)	32
		Financial manager	46
		Implementation partner's CEO (telephone interview)	21
		IS administrator (programmer)	87
		IT manager	77
		Key user for production	65
		Key user for production planning	56
		Key user for sales	72
		Key user for warehouse	39
		Project leader (quality manager)	78
		Project leader and project leader assistant	85
		Project leader assistant (key user for purchasing)	68
		Technology manager	63
CompB	7	Consultant	87
		End user (technology department)	53
		Financial manager	48
		IT/IS administrator	76
		Project leader assistant (technology manager)	58
		Project leader assistant (technology manager)	88
		Sales manager	32
CompC	4	End user (warehouse)	32
		Implementation partner's CEO	83
		Project leader (sales manager)	65
		Wholesale manager	54
CompD	9	Economic manager	58
		End user (sales department)	70
		IT/IS administrator	34
		Payroll clerk	21
		Production manager	48
		Project leader (purchasing manager)	95
		Technology manager	59
		Vendor's consultant (telephone interview)	15
		Warehouse manager	27

The selection of the issues covered in the interview guide was grounded in the ERP literature, as these have been identified by previous research as important aspects in relation to ERP system implementation. Various contextual factors have been reported by a number of studies to influence the ERP implementation (e.g, Raymond et al., 2006; Raymond and Uwizeyemungu, 2007; Seethamraju and Seethamraju, 2008; Ramdani et al., 2009; Shiau et al., 2009; Chang and Hung, 2010). The contextual influences were investigated in relation to various phases of the ERP life-cycle. The time perspective plays an important role in ERP implementation, as different phases of the ERP life-cycle are characterized by different activities, key players, and problems typical for each particular phase (Markus and Tanis, 2000).

The interview guide comprised open-ended questions and my intention was to allow for open discussion with the informants about the focused issues. The SME characteristics identified from literature (Table 2.1) were considered during the interviews, but these were not introduced up front as I did not want to influence the informants' answers by any given framework. Instead, these were only used as a basis for potential prompting questions. This approach also applied for all other issues covered in the interviews.

ERP system implementations are substantial investments, expected to yield positive outcomes. Determination of ERP success and its evaluation remains an ongoing concern in both practice and research (e.g., Esteves, 2009; Federici, 2009; Uwizeyemungu and Raymond, 2009; Kale et al., 2010; Williams and Schubert, 2010). Therefore, the interview guide covered questions regarding perceptions of success, acceptance, usage, ERP implementation evaluation, and ERP outcomes. The four dimensions of the ESS model by Gable et al. (2003) were used as a basis for prompting questions. The role of CSFs is essential in ERP system implementation projects. Numerous studies reported on these crucial factors in both large enterprises (e.g., Holland and Light, 1999; Nah et al., 2001; Somers and Nelson, 2001; Al-Mashari et al., 2003), as well as in SMEs (e.g., Loh and Koh, 2004; Reuther and Chattopadhyay, 2004; Sun et al., 2005; Snider et al., 2009; Doom et al., 2010; Kale et al., 2010; Malhotraa and Temponi, 2010; Upadhyay and Dan, 2010). The CSFs identified in former studies were used as a basis for prompting questions.

Apart from one interview with the CEO of CompA, all interviews have been recorded. Every informant was asked about his/her agreement with recording in the beginning of the interview and I did not experience any aversion or reluctance to the recording practice. In addition, I took notes in the interview guide, indicating important or interesting issues mentioned during the interviews.

E-mail and telephone communication were also used for clarification of some issues. In particular, subsequent data collection was conducted regarding the ERP system customization in the companies. Additional information about the applied level of ERP system customization and its reasons was collected through a follow-up e-mail to one representative per case, considered to be the most competent informant for the customization topic (project leader in CompA, consultant in CompB, certified agent in CompC, and vendor in CompD).

Additional information was also collected about ERP system outcomes. A survey based on the instrument developed by Gable et al. (2003) was sent to all interviewed

informants. The aim was to collect additional information to enable a comparison with former studies applying the same instrument. However, due to low response rate and incompleteness of the received responses, this data could not be further utilized.

3.2.2 Document analysis

The data collection has been further supplemented by document analysis. Two types of documents have been collected: documents including general information about the case organizations (company web pages, company presentations, and brochures), and documents about the implementation projects (project documentation provided by the organizations, web pages of the vendors and implementation partners, and reference studies developed by vendors). The documents were carefully studied and relevant information was extracted. The purpose was mainly to provide additional information about the case organizations and implementation projects studied.

3.3 Data analysis

The analysis process went through several steps as the research progressed, reflecting the focus of the particular research publications. For all four articles, the first step conducted has been a within-case analysis (Eisenhardt, 1989). For the three articles based on multiple case studies, this was followed by a cross-case analysis. These two steps are described in the following.

3.3.1 Within-case analysis

The main purpose of the within-case analysis was to gain a comprehensive understanding of the individual cases. The analysis focused on revealing information about the organizational setting and the implementation project in general. The main material analyzed here involved the interview audio files, notes in the interview guides, and various documents collected.

For the first case (article 2), the data analysis was managed without use of any analytical software. The analysis aimed to integrate information from various informants regarding the issues covered in the interview guide, as well as new issues emerging from the data. During the analysis process a substantial number of notes were made in MS Word. Based on the analyzed data several overview tables were developed to get a better understanding of the data. In addition, important quotes regarding each of the studied issues were transcribed.

3.3.2 Cross-case analysis

After data collection in the other three companies the data got more complex and complicated for analysis. Therefore, NVivo 9 software has been used to manage the data through a coding process. Here, the data from all four cases were treated together. The main reason was to enable a cross-case analysis.

The analysis strategy differed slightly according to the purpose of the individual articles. For articles 3 and 4, relevant parts covering issues related to ERP outcomes and ERP customization were transcribed and translated into English. The transcribed material was then analyzed through a coding process. The coding followed the focus of the articles. For article 3, the codes represented particular ERP system outcomes mentioned by the interviewees. While the four dimensions of the ESS model (Gable et al., 2003) were used as an underlying framework, the analysis also focused on identifying additional outcomes emerging from the interview data. For article 4, the data analysis concentrated on identifying reasons for ERP system customization. The reasons for ERP customization identified in former literature were used as underlying constructs during the analysis. For both articles, the analyzed text was also coded to indicate contextual influences on the issues studied .

For the purpose of article 5 a more complete overview of the data was needed. The entire recordings were therefore transcribed in full in the original language (Czech). The data analysis concentrated on identifying influences of the SME characteristics, thus the codes represented particular SME characteristics emerging from the data. While a list of SME characteristics identified from former literature was applied as a basis, the analysis was open for identifying additional characteristics specific for SMEs. The data were further analyzed according to the ERP life-cycle framework, with the identified factors being assigned to the particular phases.

In general, with regard to the nature of the coding applied, it can be characterized as selective coding (Corbin and Strauss, 2008). In Appendix B, I provide an example of the coding process.

The cross-case analysis concentrated on investigating similarities and differences between the cases, focusing on the following dimensions:

- **Contextual dimensions** (i.e., industry, business type, number of employees, experience since “going-live”, time since “going-live”, ERP system, implemented modules, legacy IS, implementation partner, and implementation team). Comparison of the cases according to the contextual dimensions served as a basis

for further analysis, relating the findings to similarities and differences in these dimensions. The results of the comparison were presented in a number of tables, as an example see Table 3.1.

- **Particular focus of the analysis** (e.g., ERP outcomes, ERP customization, customization reasons, etc.). As explained above, the analysis process reflected the focus of the individual articles. The studied aspects were compared across the cases. The results were usually presented in tables, as an example see Table 3 in article 3, or Table 3 in article 4.
- **Influences of the SME context**. The influences of the SME context were also compared across the cases. The findings were further analyzed in relation to comparison results based on the two previous dimensions. Table 5.1 provides an overview of the cross-case analysis with focus on the influences of the SME context.

The findings from the cross-case analysis were then compared with findings from former research. This comparison identified similarities as well as differences in the findings, indicating the contributions of the study. These are further discussed in chapter 5. A diagrammatical representation of the research design is illustrated in Figure 3.2.

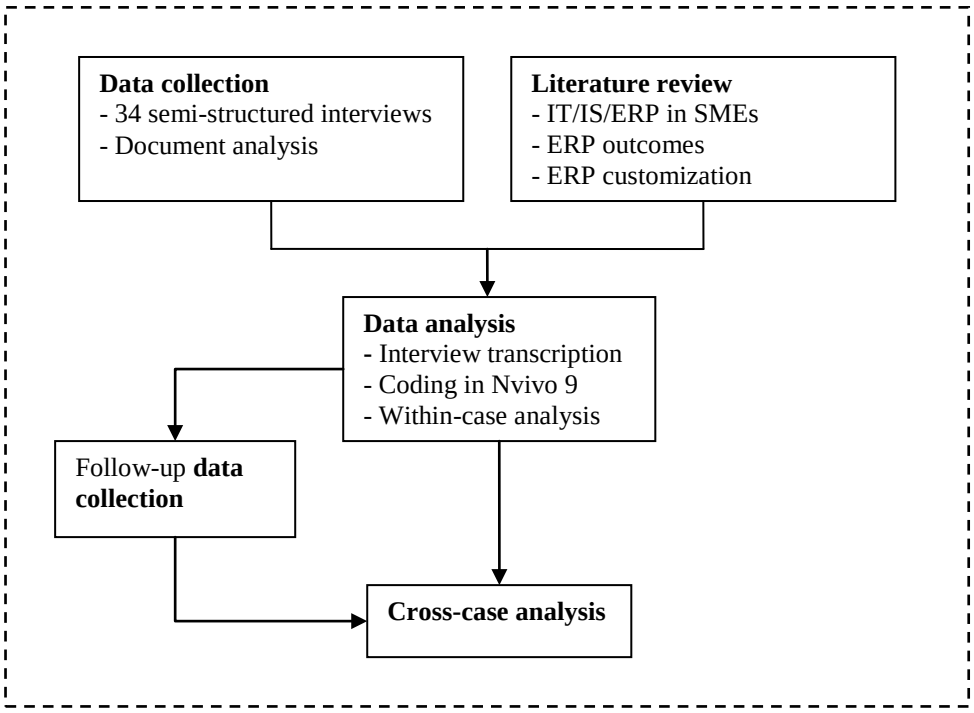

Figure 3.2. Research design

3.4 Validity issues

This section discusses the validity issues of the research. I start with elaboration on internal validity, followed by concerns regarding external validity. I also reflect on potential influences of researcher bias.

3.4.1 Internal validity

To make the research transparent, I have made an effort to document as much details about the conducted research steps as possible. Here, I discuss the validity and limitations of the selected research approach. To do so, I apply the criteria for rigorous assessment of positivist case research developed by Dubé and Paré (2003). The authors proposed a set of criteria and recommendations for improvement of future research. For more details on these issues I refer to Table 13 in Dubé and Paré (2003, p. 621-625). The criteria focus on three main areas: research design, data collection, and data analysis. I reflect on these issues and provide an overview of the assessment in Table 3.3.

Naturally, the interpretation of the results in this study might be influenced by the researcher's bias. The goal of this study was to enhance understanding of the contextual influences on ERP system implementation in SMEs. This perspective applied has shaped my interpretation of the findings. My angle was to investigate the influences of the SME context on the ERP implementation projects, since I postulated that the contextual influences may play an important role. However, focusing on the contextual issues may have limited my attention to other factors that potentially may also have affected the implementation. Furthermore, my point of view has been more from the position of the implementation team members, or even from the vendor's position, than the end user perspective. Thus, some issues which could be relevant for end users may have been omitted. This also relates to my approach during the data collection, where my emphasis was on collecting data from the implementation team members, with less focus on the end users. These considerations might affect my interpretation of the findings.

Table 3.3. Assessment of internal validity issues

Criteria (Dubé and Paré, 2003)	**Assessment Comments**
Research Design	
Clear research questions	The study's purpose and research question were clearly defined.
A priori specification of constructs and clean theoretical slate (exploratory case studies)	The study used a priori constructs derived from literature, ensuring that important issues are not overlooked. Yet, the study recognized a need to be open for new issues emerging from data, ensuring that new constructs can be discovered.
Theory of interest, predictions from theory, and rival theories (explanatory case studies)	The study adapted several theoretical frameworks, e.g. TEO framework (Tornatzky and Fleischer, 1990) and ERP life-cycle framework (Esteves and Pastor, 1999), and predictions following from the theory applied were stated. No rival theories that contradict the findings were explored.
Multiple-case design	The study employs a multiple case study of four companies.
Nature of single-case design and replication logic in multiple-case design	The selection of the case organizations followed several sampling strategies (Miles and Huberman, 1994) and the selection criteria were clearly stated in section 3.1. The study also partially followed the theoretical replication logic (Yin, 2009).
Unit of analysis	The unit of analysis was specified as the ERP system implementation in an SME.
Pilot case	A pilot study was not employed. Yet, the first case helped to clarify the form and structure of subsequent data collection. In addition, the interview guide was slightly modified based on the first case.
Context of the study	The context of the study was described in detail.
Team-based research and different roles for multiple investigators	Being an individual PhD project, the entire data collection and data analysis were conducted by the PhD candidate. Other researchers were involved in the role of co-authors of the research publications, contributing mainly to the process of data interpretation and the presentation of findings.
Data Collection	
Elucidation of the data collection process	A thorough description of the data collection process and data sources is provided. The study also includes a number of tables summarizing information about the data collection process.
Multiple data collection methods and mix of qualitative and quantitative data	This study employed qualitative data exclusively. The primary data source has been personal interviews. In addition, e-mail and telephone communication was used for clarification of some issues. The data collection has been further supplemented by document analysis. Thus, data triangulation was applied by using various data sources (interviews, documents, emails). Moreover, the interviews have been conducted with multiple stakeholders across the four organizations. In addition, vendors or consultants involved in the ERP implementation were also interviewed. This approach enabled to collect various viewpoints from different roles within the ERP implementation projects and thus improve the internal validity of the findings.
Data triangulation	Discussed in the previous point.
Case study protocol and case study database	An interview guide was developed prior to going on site and used throughout the interviews. The guide included an overview of the case organization, roles of people to be interviewed, and interview questions grouped according to the research topics to be covered. A case study database was maintained. The database contains the following material organized according to the cases: audio files of the interviews, interview notes, transcripts of the interviews, files with coded data, and documents collected from the companies and vendors. Both these two principles of data collection increase the reliability of the case study (Yin, 2009).
Data Analysis	
Elucidation of the data analysis	The data analysis process has been described in detail in section 3.3

process	
Field notes, coding, data display, and flexible process	Field notes were used to annotate the informants' answers as well as include additional relevant information during the interviews. The study employed a systematic coding process to analyze the interview data (described in section 3.3). During the analysis process a number of overview tables were developed to get a better understanding of the data. The data collection process was open for potential changes based on the initial data analysis. The first case helped to clarify the form and structure of subsequent data collection, and the interview guide was slightly modified based on the first case.
Logical chain of evidence	Maintenance of a chain of evidence is one of the principles to increase the reliability and internal validity of the case study findings (Yin, 2009). The study maintains a logical chain of evidence in the presentation of the findings. The research publications provide information to trace the arguments developed from the initial research questions to the findings and conclusions. As all the publications went through a peer review process, the way of presenting the findings and demonstration of their grounding in the data is believed to be sufficient.
Modes of analysis: Empirical testing, explanation building, time series analysis	The data analysis is driven by explanation-building analysis strategy (Yin, 2009).
Cross-case patterns	The study employed a cross-case analysis, looking for similarities and differences between the cases. The cross-case analysis looked at data from different perspectives according to the particular issue under study (presented in section 3.3).
Use of natural controls (explanatory case studies)	No explicit use of natural controls were possible in the case studies, but comparison with ERP implementation in large enterprises reported in former research maintains an element of such control.
Quotes	Quotes have been used extensively to support the findings of the research.
Project reviews	To corroborate the case evidence and interpretations, a case report (a brief presentation of the case project) was shared with all participants in the first case organization. As only the project leader responded, the project report was sent only to the projects leaders in the three other cases. In addition, a preliminary version of the thesis summary was also shared with the project leaders to provide their feedback. No discrepancies were recognized.
Comparison with extant literature (exploratory case studies)	The study extensively compares the research findings with extant literature and theoretical frameworks (presented in chapter 2).

3.4.2 External validity

Here, I discuss concerns related to the generalizability of the study findings. In total, four organizations were studied. All of them are SMEs operating within the private sector in the Czech Republic. The Czech economy has undergone significant changes over the last two decades. Being a former Eastern Bloc country, the economy went through the transition from a centrally planned economic system to a market driven system (Roztocki and Weistroffer, 2008). Due to substantial economic success and participation in international institutions such as the EU, several formerly communist European countries including the Czech Republic have been proclaimed to have completed the transition (Roztocki and Weistroffer, 2011). As a member of the EU since 2004, and according to the International Monetary Fund (IMF, 2011) and World Bank (World Bank, 2011), the Czech Republic is now classified as a developed

country. Therefore, the context of this current study of Czech companies is regarded to be sufficiently similar to SMEs in other developed European countries, to argue for a broader relevance of the findings from this study.

Nonetheless, the case implementation projects were characterized by a significant transition from old DOS-based technology to contemporary ERP systems. All four case organizations used obsolete legacy systems and did not convert these until quite recently. This significant transition might influence the study findings and limit their relevance beyond the study sample, for example to companies moving from a less dated technology.

Furthermore, all four case companies selected local ERP systems which could be characterized as less complex compared to “standard” ERP systems such as SAP. This might be considered a limitation of the study’s scope as the selected systems might provide comparatively less outcomes. However, since the literature supports the finding that SMEs are likely to choose systems provided by small national vendors (Yeh et al., 2006; Federici, 2009), it is believed that the findings can be generalized to ERP implementations in other SMEs.

4 Research publications

This chapter provides an overview of the research publications included in the thesis. Table 4.1 presents a list of the articles, while full text versions of these can be found in Appendix C. The articles are presented in chronological order. Article 1 is a literature review covering former research on ERP in SMEs. Article 2 is an exploratory study based on a single case study, while articles 3, 4 and 5 are based on a multiple case study of four cases. The following section presents each publication in more detail, introducing its focus and main findings.

Table 4.1. Overview of research publications

No.	Publication	Published
1	Haddara, M. and Zach, O. (2011). ERP Systems in SMEs: A Literature Review	Proceedings of the 44th Hawaii International Conference on System Sciences (HICSS), Kauai, Hawaii, USA, IEEE Computer Society Press.
2	Zach, O. and Olsen, D.H. (2011). ERP System Implementation in Make-to-order SMEs: An Exploratory Case Study	Proceedings of the 44th Hawaii International Conference on System Sciences (HICSS), Kauai, Hawaii, USA, IEEE Computer Society Press.
3	Zach, O. (2011). Exploring ERP System Outcomes in SMEs: A Multiple Case Study	Proceedings of the 19th European Conference on Information Systems (ECIS), Helsinki, Finland.
4	Zach, O. and Munkvold, B.E. (2012). Identifying Reasons for ERP System Customization in SMEs: A Multiple Case Study	Accepted to the Journal of Enterprise Information Management (JEIM).
5	Zach, O., Munkvold, B.E. and Olsen, D.H. (2012). ERP system implementation in SMEs: Exploring the influences of the SME context	Accepted to the Enterprise Information Systems (EIS) journal.

4.1 Exploring Existing Research on ERP in SMEs

Haddara, M. and Zach, O. (2011). ERP Systems in SMEs: A Literature Review. *Proceedings of the 44th Hawaii International Conference on System Sciences (HICSS-44)*, Kauai, Hawaii, USA, IEEE Computer Society Press.

As in the beginning of any research endeavor it is necessary to review former research within the domain of interest. Therefore, the aim of the first publication was to provide a comprehensive review of the literature on the research area of ERP systems in SMEs.

4.1.1 Presentation

The article applied a comprehensive and systematic methodology for review, with explicit procedures for searching the articles. The review covered articles published in

the period between 1999-2009. In total, 77 articles were included in the review. To organize the findings, the articles were classified according to the phases covered in the ERP life-cycle framework by Esteves and Pastor (1999). Furthermore, research themes, theories and research methods employed by the articles were reviewed. The developed literature review summarized existing research covering various topics. With regard to the focus of this thesis, it also covered the implementation issue. At this stage of the project it was essential to obtain a broad picture of existing literature, to get an overall view of the phenomenon studied.

4.1.2 Findings

Although we found 77 papers in the area of interest, the study identified several research gaps, three of which I discuss here in more detail as these influenced my research.

First, while some studies addressed some aspects of the SME context, only one study focused on this issue specifically and applied a more complete approach (Gable and Stewart, 1999). However, this paper only presents a tentative model describing interacting variables, with no empirical data, and no follow-up empirical study has been published. Thereby, the first thesis publication documents scarcity in research on influences of the SME context on ERP system implementation, and supports the relevance of the research focus.

Second, while the case studies identified were often conducted in manufacturing SMEs, the effect of the manufacturing context has not been discussed explicitly. Yet, differences in production strategies might influence on the research results. This finding, in addition to insights from the data collected in the first case company, influenced the scope of my second article.

Third, the review also identified that ex-post evaluation of ERP system implementation in SMEs has not been adequately addressed in the literature. This was surprising, considering the importance of this research topic in former research in large enterprises. Therefore, in my third article I focused on the issue of ERP system outcomes and evaluation.

In general, the first publication provided a solid knowledge base and better understanding of the phenomenon studied. Importantly, the findings served as a foundation for the remaining publications.

4.2 Investigating ERP System Implementation in Make-to-Order SMEs

Zach, O. and Olsen, D.H. (2011). ERP System Implementation in Make-to-order SMEs: An Exploratory Case Study. *Proceedings of the 44th Hawaii International Conference on System Sciences (HICSS-44)*, Kauai, Hawaii, USA, IEEE Computer Society Press.

Article 2 is based on an exploratory single case study (CompA). In this case the production strategy was important, as the requirements of MTOs are very different from a typical make-to-stock (MTS) manufacturer. Their competitive priorities are associated with volume flexibility and product customization. MTOs are characterized by low production volume, wide product variety, and unstable production schedule (Yen and Sheu, 2004).

We therefore investigated this issue further by addressing the following research questions: *(1) How do characteristics of the Make to Order (MTO) SME sector affect ERP system implementation? (2) Which ERP implementation practices are affected by these characteristics?*

4.2.1 Presentation

The paper aimed to investigate the entire ERP implementation project in the case organization, adopting an exploratory case study methodology. This approach allowed collecting rich descriptive data in its natural setting. The data analysis concentrated on identifying factors influencing the implementation process. In order to better organize the data analysis, the findings were structured according to the implementation phases of the process life-cycle model developed by Markus and Tanis (2000). It consists of four phases: project chartering, the project, shakedown, and onward and upward phases.

4.2.2 Findings

The data analysis recognized six issues particularly important in this case: ERP system customization, system and process flexibility, inappropriateness of MRP module, implementation team composition, ERP system evaluation and external events. These issues were further elaborated and resulted in seven propositions:

- *P1: MTO SMEs need a high degree of ERP customization.*
- *P2: MTO SMEs need to be able to develop the system further after the implementation to allow for dynamically changing business processes.*
- *P3: ERP system development skills are crucial for MTO SMEs.*
- *P4: Traditional MRP modules do not allow enough manufacturing flexibility and are inappropriate for MTOs.*

- *P5: Requirements identification and analysis is constrained by SMEs' limited personnel resources.*
- *P6: ERP outcome evaluation is difficult to perform in MTO SMEs.*
- *P7: ERP implementations in MTO SMEs are vulnerable to economic macro conditions*

With regard to the focus of the thesis on the SME context influences, the article identified a number of implementation issues perceived to be specific for SMEs. The developed propositions were further reflected in the subsequent three publications, to investigate their applicability to other cases. The study also proved the selected research approach to be appropriate for the purpose of the research, and thus helped to organize further research steps including subsequent data collection in the other three organizations.

To conclude, the findings demonstrated influence of the production strategy on ERP system implementation. While a majority of MTO companies are SMEs (Stevenson et al., 2005, Aslan et al., 2008, Amaro et al., 1999), the characteristics of MTOs should not be perceived as SME-specific. Also large companies operating under the MTO production strategy possess similar characteristics related to a need of maintaining flexibility, resulting in low process standardization and high level of ERP system customization (Yen and Sheu, 2004).

4.3 Understanding of ERP System Outcomes in SMEs

Zach, O. (2011). Exploring ERP System Outcomes in SMEs: A Multiple Case Study. *Proceedings of the 19th European Conference on Information Systems (ECIS),* Helsinki, Finland.

Since ERP system implementations are substantial and long-term investments, expected to yield significant positive outcomes for organizations undertaking this endeavor, another issue of research interest was the ERP outcomes perceived by SMEs. I have thus investigated the following research questions: *(1) What are the ERP system outcomes perceived by SMEs? (2) How does the SME context affect the ERP system outcomes?*

4.3.1 Presentation

The purpose of article 3 was to investigate ERP system outcomes in the context of SMEs. The empirical basis for this exploratory study was a multiple case study of four SMEs. First, based on a cross-case analysis, a list of the ERP system outcomes perceived by the case SMEs was presented. Further, the study examined how the SME context affects the ERP system outcomes and the related evaluation practices. As an

underlying framework, the study applied the Enterprise Systems Success (ESS) measurement model developed by Gable et al. (2003). The identified ERP outcomes were grouped according to the four dimensions in the ESS model: information quality, system quality, individual impact and organizational impact. Thus, the study provided a pseudo-comparison of the ESS model and ERP outcomes perceived by the four SMEs.

4.3.2 Findings

The data analysis identified 26 various ERP outcomes perceived by the case SMEs. These partly correspond to the measures from the ESS model. About half of the outcome measures defined in the ESS model were not brought up in the interviews, indicating that these might be less relevant for SMEs. In addition, about half of the identified outcomes were complementary measures in the four ESS model dimensions.

Furthermore, the findings indicated that the SME context has implications on the ERP outcomes as well as on the ERP system evaluation practice. In particular, the nature of work positions, dynamic SME environment, lack of IT strategy and motivation for the ERP system implementation were recognized among the issues that affect the ERP outcomes in SMEs. The study also documented a lack of ERP system evaluation practice in the SMEs. The characteristics of the SME context such as ownership type, resource constraints, limited IT competence, and status of the legacy solutions in SMEs were recognized as factors constraining the evaluation.

Article 3 provides a thorough analysis of outcomes which SMEs can attain from an ERP system implementation. A comparison with the ESS measurement framework, developed mainly based on data from large enterprises, served to elicit potential differences between these two environments.

4.4 Analyzing ERP System Customization in SMEs

Zach, O. and Munkvold, B.E. (2012). Identifying Reasons for ERP System Customization in SMEs: A Multiple Case Study. *Accepted to the Journal of Enterprise Information Management (JEIM).*

The multiple case study indicated that ERP system customization was an important issue for the ERP implementation projects in the case organizations. Since this has been recognized as contrasting to former research findings, article 3 investigates this topic through the following research questions: *(1) What are the reasons for ERP system customization in SMEs? (2) How does the SME context affect this choice?*

4.4.1 Presentation

In all case organizations, ERP system customization has been applied to adapt to the organizational business processes. This is in contrast to "conventional wisdom" founded on studies from large enterprises holding that ERP systems should be implemented without customization. Therefore, the purpose of this article was to investigate possible reasons for ERP system customization in SMEs. Moreover, the study focused on how the decision for ERP customization has been influenced by the SME contextual issues.

The study distinguishes between two types of customization: programming add-ons and ERP source code modifications. Further, we distinguished between three levels of the scope of customization: not used, low, and high. Finally, to be able to focus on ERP system customization practice in different phases of the project, we distinguished between two phases of the ERP life-cycle: prior to "going-live" and after "going-live".

4.4.2 Findings

The cross-case comparison showed that all four organizations have applied some kind of ERP system customization in both phases of the ERP life-cycle. The analysis identified seven various reasons for ERP system customization observed in the SMEs, five prior to "going-live" and two after "going-live". The main reasons leading to customization prior to "going-live" are resistance to change, unique business processes, functional misfit, ownership type and motivation for the ERP implementation. ERP customization after "going-live" is assumed to be related to the maturity level of SMEs and characteristics of the selected ERP systems. The findings corroborate former research on ERP customization in large companies, while also identifying new reasons for customization specific for the SME context, such as ownership type and organizational maturity level.

By identifying the reasons for ERP system customization, the study contributes to better understanding of ERP system implementation in SMEs. The study documents that ERP system customization may in certain contexts be favoured by SMEs. This could be a valuable finding for organizations about to implement an ERP system and for ERP vendors in particular, showing a need to better understand the reasons for ERP system customization. By exploring the effect of the SME context on ERP system customization, article 4 contributes to identify several issues specific for SMEs.

4.5 Exploring the Influences of the SME Context

Zach, O., Munkvold, B.E. and Olsen, D.H. (2012). ERP system implementation in SMEs: Exploring the influences of the SME context. *Accepted to the Enterprise Information Systems (EIS) journal.*

Article 5 is an overarching study addressing the following research question: *How does the SME context affect ERP system implementation?* Based on a thorough cross-case analysis of the four cases, it investigated the influences of SME characteristics on activities across the ERP life-cycle.

4.5.1 Presentation

The purpose of article 5 was to explore the influences of the SME context on the ERP system implementation. Compared to the previous publications, which usually focused on particular issues within the implementation (e.g., ERP outcomes, customization), this article took a broader stance, as it aimed to encompass the entire ERP life-cycle. To do so, the study investigated the effects of SME characteristics on activities across the ERP life-cycle.

First, a list of the SME characteristics was developed from relevant literature. This resulted in a comprehensive overview of characteristics which distinguish SMEs from large enterprises and potentially influence ERP implementation. The identified SME characteristics are grouped into three dimensions according to their character: organizational characteristics, environmental characteristics, and IS characteristics (Table 1 in article 5). Then, based on a cross-case analysis of the four SMEs, the influences of the SME characteristics on various activities across the ERP life-cycle were investigated. The ERP life-cycle framework by Esteves and Pastor (1999) was applied.

4.5.2 Findings

The analysis showed that the SME context influenced the ERP implementation projects in the case organizations. Some of the SME characteristics had a considerable impact, while others had more limited influence. The ownership type was identified among the most influential characteristics of the SME context. Furthermore, limited resources and obsolete legacy systems influenced several phases. In addition, the data analysis identified organizational maturity level (or stage of growth) as an influential characteristic, which is not covered in the former literature on IT and SMEs.

Comparing the distribution of influences across the ERP life-cycle phases, the "implementation phase" in the Esteves and Pastor framework was affected most by the

SME context, with all the SME characteristics affecting the activities within this phase to some extent. Also the activities in the “adoption decision” and “use and maintenance” phases were considerably influenced by the SME characteristics. In contrast, according to the data analysis the “acquisition” phase was only affected by two aspects of the SME context.

In general, the findings demonstrated that the SME context influences ERP system implementation and thus should be taken into consideration by future research. Moreover, the analysis of the case companies in this study illustrates the need for a more nuanced view on what is presented as ‘general’ SME characteristics in former literature, e.g. regarding IS knowledge, business processes and market characteristics. This should be taken into account in future research on contextual influences on ERP implementation in SMEs.

5 Contributions

The purpose of the research presented in this thesis has been to investigate the research question: *How does the SME context affect ERP system implementation?* In order to answer this question, a multiple case study of four SMEs has been conducted. The research endeavor resulted in five publications presented in chapter 4. This chapter discusses the contributions of the study.

The thesis contributes to four research areas. First, the study contributes to the research stream on contextual influences on ERP system implementation, with particular focus on the influence of the SME context. Second, by investigating ERP outcomes perceived by SMEs, the study contributes to the area of ERP implementation evaluation. Third, the study contributes to the issue of ERP system customization. Finally, the study also contributes to the more general research on IS in SMEs, by analyzing the SME characteristics and SME profiles. The following sections elaborate on each of the aforementioned areas in more detail.

5.1 Influences of SME characteristics on ERP implementation

The main contribution of the study is an analysis of the SME context influences on ERP system implementation. This issue has been particularly focused in article 5. But, as can be observed from chapter 4, the effect of the SME context is a recurrent topic in all the research articles. With respect to the overall research question of the thesis, it represents a common theme linking the focus of the publications.

My research approach has been to focus on exploration of the influences of the SME characteristics on activities across the ERP life-cycle. An ERP system implementation is a complex process which is difficult to analyze. The selected approach helped to arrange the investigation in a systematic way following the ERP life-cycle phases. This strategy resulted in analysis of influences of 11 SME characteristics on 13 aspects of the ERP system implementation.

The results show that the SME context influences the ERP implementation projects in a number of ways. Some of the SME characteristics have a considerable impact, while others have more limited influence. Here, I first discuss the influences of the SME characteristics on the activities of the ERP life-cycle. Then, I elaborate on the contextual influences on each of the ERP life-cycle phases.

Table 5.1 maps the identified effects of the SME characteristics on the activities in the phases in the ERP life-cycle, using letters to represent the four case companies. The

phases of evolution and retirement are excluded in the table, as none of the case implementation projects had yet reached these stages. The activities across the ERP life-cycle are interrelated, as the activities in early phases influence subsequent activities. The analysis therefore concentrated on identifying direct effects of the SME characteristics grounded in the data. The nature of the effects is described in detail in article 5 of the thesis.

Table 5.1 shows that a majority of the contextual influences were experienced across all four SMEs, argued to result from similar conditions and features of the organizations and the ERP implementation projects. However, there are also several examples of characteristics that were only reported to influence one or two companies. Especially CompA seemed to be influenced by more contextual aspects than the other cases. There may be several explanations for this. First, CompA was the only case reported to be constrained by environmental uncertainty, by the financial crisis in 2008 in this case. Moreover, the relative size of the company might provide a potential explanation for the observed divergence. With about 220 employees, CompA is close to the defined border between SMEs and large enterprises. The results show that the company embodies some aspects of a large enterprise, which resulted in the differences compared to other cases. For example, the organizational structure and processes in CompA were more complex, influencing several activities during the ERP system implementation. In addition, CompA also had a higher level of IT technical expertise, more often seen in larger enterprises.

The study further shows that limited resources affect various issues of the ERP implementations in SMEs. Limited financial resources affect mainly the acquisition phase, as the ERP system price is usually one of the major selection criteria. Limited financial resources may also negatively influence end user training. Also, the system development approach applied is affected by the financial issue. The study further documents that the ERP implementation projects in SMEs are constrained by limited human resources. This illustrates how SMEs with a limited number of employees may find it hard to assign dedicated staff to an ERP implementation project. Moreover, ERP system outcomes evaluation may also be restricted by limited resources in SMEs.

The ownership type of the SMEs, i.e. owner-managers, significantly influence almost all issues across the ERP life-cycle, such as ERP system selection, implementation team work and system customization. However, the motivation for the ERP system implementation was seemingly limited to replacing the obsolete legacy systems. This shows how the lack of a strategic perspective in SMEs might limit the ability to

acknowledge the potential of an ERP implementation. This is also consistent with the fact that SMEs generally have few personnel available with the necessary competence (Gable and Stewart, 1999). On the other hand, once the need is recognized, decisions can be made fast. This shows that if the need for an ERP system is recognized and supported by the SME's owner-manager, it can be attained quickly.

The study identified organizational stage of growth as an influential characteristic, which is not covered in the former literature on IT and SMEs. The embedded presumption is that each stage of growth represents a unique, strategic context that influences the nature and extent of an organization's external resource needs and resource acquisition challenges (Hite and Hesterly, 2001). I argue that it is likely that different stages of organizational growth imply different needs and requirements while implementing an ERP system.

Limited attention has been given to the importance of the stages of growth in studies on ERP implementation, with companies usually being treated as equal in this respect (Liang and Xue, 2004). This may be because most of the past ERP studies were conducted based on cases of well established large enterprises typically being in a mature (stable) stage (Liang and Xue, 2004; Chen, 2009). However, the four case SMEs were continuously growing and agile organizations, experiencing several changes over time. These changes needed to be reflected in the ERP system and caused a need for system customization after "going-live". This indicates that SMEs in an early stage of growth may have special requirements for ERP system customization. The findings also show that the dynamic character of the case businesses may impede evaluation of the organizational impact of the ERP system.

The dynamic character of the case SMEs is closely related to the age of the companies. All of them are quite young organizations with only 9 to 19 years of existence. According to the stage of growth model by Churchill and Lewis (1983), they can be classified into the 'success-growth' and 'take-off' stages, characterized by high tendency to growth and a dynamic nature. Compared to more mature and larger enterprises also their business processes can be characterized as more dynamic.

Table 5.1. Influence of SME characteristics on the ERP life-cycle activities

Contextual characteristics		ERP life-cycle												
		Adoption decision		Acquisition			Implementation					Use and Maintenance		
		Needs recognition, motivation	System requirements specification	ERP system selection	Implementation partner selection	Selection criteria	Implementation team work	Business process analysis	System customization	Users training	Technical installation	Use of the system, user acceptance	System development	ERP outcomes, evaluation
Organizational characteristics	Resources			ABCD	ABCD	ABCD	ABCD			AB			AB	ABCD
	Ownership type, management and decision making	ABCD	ABCD	ABCD	ABCD	ABCD	ABCD	AD	ABCD				A	ABCD
	Structure		ABCD					A	A		B			
	Culture						ABCD					ABCD		
	Processes and procedures		ABCD					AB	ABCD					
	Stage of growth		ABCD						ABCD			ABCD		ABCD
Environmental characteristics	Market, Customers	A									C			
	Uncertainty						A	A					A	
IS characteristics	IS knowledge		ABCD						B					ABCD
	IT technical expertise								A				A	
	IS function, IS complexity	ABCD					ABCD							ABCD

The thesis further contributes by applying the Esteves and Pastor's framework into the SME context. It demonstrates the usability of organizing the implementation activities along the ERP life-cycle phases. For a better overview, Table 5.2 illustrates the SME context effects on the four phases of the ERP life-cycle. The table indicates any influence of the SME characteristics on particular phases (marked by "x").

Table 5.2. Influence of SME characteristics on the ERP life-cycle phases

	ERP life-cycle			
	Adoption decision	Acquisition	Implemen-tation	Use and maintenance
Organizational characteristics				
Resources		**x**	**x**	**x**
Ownership type, management and decision making	**x**	**x**	**x**	**x**
Structure	**x**		**x**	
Culture			**x**	**x**
Processes and procedures	**x**		**x**	
Stage of growth	**x**		**x**	**x**
Environmental characteristics				
Market, Customers	**x**		**x**	
Uncertainty			**x**	**x**
IS characteristics				
IS knowledge	**x**		**x**	**x**
IT technical expertise			**x**	**x**
IS function, IS complexity	**x**		**x**	**x**

Comparing the distribution of influences across the ERP life-cycle phases, the "implementation phase" in the Esteves and Pastor's framework is affected most by the SME context, with all the SME characteristics affecting the activities in this phase to some extent. Also the activities in the "adoption decision" and "use and maintenance" phases are influenced considerably by the SME characteristics. In contrast, the "acquisition" phase is only affected by two aspects of the SME context.

"Ownership type, management and decision making" is identified as the only characteristic exerting influence on all four life-cycle phases. Another influential factor is "resources", with resource limitations affecting activities across three phases (especially the acquisition phase). Further, the characteristics "organizational maturity", "IS knowledge" and "IS function, IS complexity" also influence various activities in three phases of the ERP life-cycle.

5.2 ERP implementation evaluation

By exploring ERP system outcomes the study contributes to the research stream on ERP system evaluation and its impact on organizations. This issue has been focused in article 3. The study findings provide an overview of outcomes which SMEs can

achieve from an ERP system implementation. In total, 26 various ERP outcomes perceived by SMEs were identified (see Table 5.3). These were grouped according to the four dimensions of the ESS model (presented in Figure 2.2).

The identified outcomes that correspond to the measures from the ESS model are marked by a superscript (*) in Table 5.3. About half of the outcome measures defined in the ESS model were not identified, indicating that these might be less relevant for SMEs. In addition, about half of the recognized ERP outcomes are complementary measures, indicating that these might be relevant for SMEs while not covered by the ESS model. In general, the study demonstrates how the four measurement dimensions defined by Gable et al. (2003) are also applicable in the SME context, as all the new identified ERP outcomes could be related to one of the dimensions.

Table 5.3. ERP system outcomes in SMEs (adapted Table 3 in article 3)

ERP system outcomes
System Quality
Controlling
Communication possibilities
Data analysis
Data import/export
Data integration *
Data transparency
Data security
System extensions/changes *
System stability *
System sustainability
User interface flexibility *
Information Quality
Information accuracy *
Information availability *
Information back tracking
Information timeliness *
Individual Impact
Substitutability
Increased work efficiency *
Work simplification
Organizational Impact
Administration expenses reduction *
Better inventory overview
Business process improvements *
E-commerce *
Increased capacity *
Overall productivity *
Production planning improvements
Staff requirements reduction *

A comparison with the extant measurement framework, developed mainly based on data from large enterprises, serves to elicit differences between these two environments. The study contributes by indicating potential refinement of the Gable et

al. framework in the SME context. The new outcomes identified in this study might be integrated into their framework. The study further provides evidence of SMEs' perceptions of ERP implementation success. All the implementation projects were reported as successful, but the companies' perceptions of success differed. Success was most often reported as the fact that the business activities were not interrupted due to the ERP implementation. The companies' core business was certainly the main concern regarding their perception of success. Another frequently cited success measure was in terms of meeting the allocated budget and time line. Last, the implementation projects were also expressed to be successful based on user acceptance, in terms of the users accepting the new system without any major problems.

5.3 ERP system customization

The thesis also contributes to the research on ERP system customization. This issue has been discussed particularly in article 4. The findings provide evidence of a high level of ERP system customization applied by SMEs. This is in contrast to literature recognizing minimal customization as a critical factor for successful ERP system implementation in large enterprises (Nah et al., 2001; Somers and Nelson, 2001), as well as in SMEs (Loh and Koh, 2004; Upadhyay et al., 2011). On the other hand, the findings corroborate studies indicating that SMEs may rather choose to adapt ERP systems to the business processes (Snider et al., 2009; Poba-Nzaou and Raymond, 2011). By identifying the reasons for ERP system customization in SMEs, the thesis contributes to better understanding of this endeavour in SMEs.

In total, seven reasons for ERP system customization were identified, five prior to "going-live" and two after "going-live" (see Table 5.4). The findings corroborate former research on ERP implementation in large companies, while also identifying new reasons for ERP system customization specific for the SME context. In addition to unique business processes in SMEs discussed in former studies (e.g., Bernroider and Koch, 2001; Vilpola and Kouri, 2005; Quiescenti et al., 2006; Snider et al., 2009), ownership type and stage of organizational growth of the SMEs were identified as reasons which have not been covered in extant research.

Moreover, by classifying the reasons into two phases, prior to "going-live" and after "going-live", the thesis contributes by distinguishing the reasons for ERP customization with regard to the ERP life-cycle. ERP customization after "going-live" is assumed to be related to the stage of growth of SMEs and characteristics of the

selected ERP systems. The businesses in the case organizations were characterized as continuously growing, undergoing many changes in their business processes over time. These changes needed to be captured by the ERP system and caused a need for the system's customization after "going-live". Furthermore, since the selected ERP systems did not offer all required functionality at the time of implementation, it provided a requirement for their further customization according to organizational needs after "going-live".

Table 5.4. Reasons for ERP system customization

Prior to "going-live"
• Resistance to change
• Unique business processes
• Functional misfit
• Ownership type
• Motivation for the ERP implementation
After "going-live"
• Stage of growth
• Maturity of ERP systems

The study documents that ERP system customization may be a preferred option for SMEs under particular circumstances. However, customization incurs increased costs for system maintenance and further development. The study by Ng and Gable (2010), through a case study of an ERP service provider to large governmental agencies, found that the ongoing costs of customization were much higher than was appreciated by the case organization. Thus, it could be argued that the organizations should rather consider investing in a more complete system to avoid the need for extensive further development. Yet, for SMEs in an early stage of growth that experience many changes over time, ERP system customization after "going-live" may appear to be unavoidable and thus needs to be taken into consideration when planning the ERP system implementation.

5.4 SME context

By examining the SME context characteristics, the thesis also contributes to more general research on IS in SMEs. A list of characteristics which distinguish SMEs from large enterprises and which may influence ERP implementation was compiled based on a literature review (presented in Table 2.1.). The identified SME characteristics are classified according to the three contextual dimension of the TOE framework (presented in Figure 2.1). The thesis contributes by applying the TOE framework into the SME context and demonstrates how the SME characteristics can be classified according the three contextual dimensions.

The findings show how well the case companies match with the SME characteristics identified from literature. The case SMEs displayed many of the same characteristics as identified in the literature review on IT and SMEs, but also differed for some of them.

All case SMEs had limited resources for the ERP system implementation project, in terms of money as well as human capital. Also ownership type, management and decision making, IS function and IS complexity were consistent with the characteristics identified in literature.

According to former studies, SMEs generally have less complex business processes than large enterprises (Wong and Aspinwall 2004). One may expect that the business process analysis therefore would be easier to conduct in SMEs. However, this study demonstrated that the business processes as well as organizational structure in SMEs can also be relatively complex (in CompA).

Furthermore, SMEs in general have been reported to mainly serve local markets (Wong and Aspinwall 2004), with small customer bases (Ghobadian and Gallear 1997). The case SMEs were atypical in this sense, as all four case organizations had a large and international customer base. Also, there was not any evidence that major customers or suppliers forced the case SMEs to adopt a system compatible with their extant solution. Yet, some minor issues indicating influence of the major customers were identified.

Only CompA was constrained by environmental uncertainty, in this case by the financial crisis in 2008. The financial crisis was global and one could argue it affected most enterprises worldwide. However, it could be argued that SMEs in general will be more vulnerable to market fluctuations than larger enterprises due to less resources and fewer customers. While this was reported only in one case, I argue that similar circumstances could have severe impacts on ERP implementation projects in other SMEs.

While the SME literature characterizes SMEs as having limited IS knowledge, the findings from this study illustrate that SMEs can also be quite competent in this respect. Thus, the case SMEs seemed not to be significantly constrained by lack of knowledge or limited experience with ERP systems. It can be expected that SMEs in general are gradually advancing in their IS knowledge, and thus are now more aware of IS implementations than a decade ago (e.g., Blili and Raymond 1993; Cragg and Zinatelli 1995; Levy and Powell 2000). However, this does not imply that the case

organizations were able to implement the ERP systems on their own. The IS knowledge here relates to the managerial expertise to plan, organize, and direct the use of information systems in general. The case SMEs still relied on implementation partners as they did not have sufficient IT technical expertise to manage the implementations independently.

In contrast to the level of IS knowledge, the level of strategic planning was limited in the case SMEs, with the companies preferring to keep with the concepts of the old systems. This may be caused by insufficient attention by management to IS (Levy and Powell 2000; Levy et al. 2001). In addition to the characteristics presented in Table 2.1, organizational stage of growth has been identified as an influential characteristic, which is not identified in the former literature on IT and SMEs.

6 Conclusion

The study has demonstrated how different characteristics of the SME context may influence ERP implementation activities. By relating the identified influences to the different phases and activities in the ERP life-cycle, the study contributes a more complete picture of the implementation process compared to former studies usually focusing only on one particular phase.

The ownership type was identified as the most influential characteristics of the SME context. Certainly, the role of the owner-managers is unique compared to the large enterprises. Furthermore, limited resources, low organizational maturity and obsolete legacy systems influenced several phases. Among the ERP life-cycle phases, activities within the implementation phase were affected most by the SME context. In general, the findings demonstrated that the SME context influences ERP system implementation and thus should be taken into consideration in future research.

6.1 Implications for practice

For practice, the results demonstrate how ERP implementation projects in SMEs should consider the unique contextual features of this type organizations. These findings are valuable for SMEs considering ERP system implementation, as well as for ERP vendors and consultants. Due to limited resources or early stage of growth SMEs may be more vulnerable to project failure than larger companies. A proper understanding of these contextual issues may lead to a better comprehension of ERP system implementation and thereby contribute to successful ERP implementation.

Since ERP system implementation is a complex and resource demanding task, SMEs need to be aware of all costs involved. They should consider not only the acquisition costs, but also costs related to system maintenance and further development. For example, if an organization decides to maintain and further develop the system internally, its cost should be considered. As demonstrated in the study, the internal development may require hiring additional human resources. One may question whether this approach really reduces costs. It could be argued that it would be better to purchase a more complete system without the need for such extensive further development.

The study documents that ERP system customization may be favoured by SMEs. This is a relevant finding for organizations about to implement an ERP system and for ERP vendors in particular, showing a need to better understand the reasons for ERP system

customization. In particular, the vendors need to consider the SME context while implementing an ERP system in such organizations. Besides the SMEs' unique business processes, the vendors and/or consultants should consider the stage of organizational growth as an important factor that in particular may influence on further system development after "going-live". Furthermore, since the role of the owner-manager is essential in SMEs, vendors and/or consultants need to assure that the owner-manager(s) takes a strong role in the implementation.

Moreover, SMEs should put an emphasis on a thorough business process analysis. However, the business process analysis can be constrained by insufficiently mapped business processes in SMEs, as a number of the activities are governed by informal rules and procedures. Therefore, SMEs need to pay particular attention to this important activity in the ERP system implementation. The analysis might eliminate needs for heavy system customization, as the companies may acknowledge the potential of the business processes embedded in the ERP systems. Furthermore, SMEs should also assure that the implementation team members do have sufficient time allocated for the ERP implementation project.

For SME managers, the study findings can be useful for increasing their understanding of the concerns related to ERP system implementation. They need to improve their strategic planning of IS utilization, instead of the motivation for the ERP implementation being mainly technology-driven. Better strategic planning of IS in SMEs may increase utilization of ERP system functionality in its standard version, and thus reduce the level of ERP system customization required. Therefore, selection of an ERP system should not be based only on the conceptualization of the legacy systems.

The level of ERP system maturity should be also considered while selecting an ERP system. Selection of ERP systems from local vendors offering less functionality compared to more expensive solutions, may result in a need for further customization after "going-live" that incurs increased costs for system maintenance and further development.

Finally, SMEs may increase their attention to outcome evaluation of the ERP system, as recognition of the ERP outcomes could improve further the use of the system. Therefore, SMEs should be aware of existing frameworks which can assist them in evaluating an ERP system implementation. The identified list of ERP outcomes may serve as a guideline for SMEs in a quest of ERP system implementation evaluation.

6.2 Implications for further research

The study findings form the basis for further studies of the influences of the SME context. By demonstrating the potential effect of the SME context, the thesis serves as a good foundation for further research on ERP system implementation in SMEs.

The analysis of the case companies in this study illustrates the need for a more nuanced view on what is presented as 'general' SME characteristics in former literature, e.g. regarding IS knowledge, business processes and market characteristics. This should be taken into account in future research on contextual influences on ERP implementation in SMEs. A list of the SME characteristics identified here may serve as a useful starting point for defining the SME context.

Since the current research on ERP in SMEs has not adequately looked at the affects of the SME context on ERP implementation, further research may follow in the research direction posed in this thesis. Table 5.1 serves as a useful framework for further studies on ERP system implementation in SMEs. Future studies can utilize this framework for analysis of SME context influences and demonstrate its relevance in other contexts. The studies may be based either on conducting more qualitative case studies or using a quantitative approach. The research presented here demonstrates how in-depth qualitative case studies are suitable for investigating contextual influences on ERP system implementation.

Further research is needed to investigate the applicability of the findings for other types of SMEs. All four case companies in this study are characterized as continuously growing and dynamic organizations, undergoing many changes in their business processes over time. This setting might be in contrast to more mature and stable SMEs without a need for further expansion, working with established business processes. The market, industry, and size of the SME can also be expected to influence on the findings.

Further research is also needed that covers the last two phases of the Esteves and Pastor framework, to provide insights about the SME context influences in these later stages of the ERP life-cycle.

The study has demonstrated the applicability of the four measurement dimensions of Gable et al.'s framework in the SME context. At the same time, the study indicates potential refinement of the framework to reflect the unique conditions of SMEs. The discrepancy identified in this study could form the basis for further research on validation of the ESS model in the SME context.

The findings indicated that the stage of organizational growth is an important factor influencing the EPR implementation. Due to the scarcity of this aspect in the ERP literature, this opens a window of opportunity for future research. It would be attractive to apply some of the developed growth stage models in studies on ERP system implementation, and investigate differences in the implementation practice in relation to various growth stages. This would require a longitudinal study or a study of several companies in different stages of organizational growth.

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Appendix A – Interview guide

As mentioned in section 3.2.1, the interview guide covered two main areas. The first area included information about the organization, business activities, market conditions, and the ERP system implementation project in general. This part was typically discussed with project leaders and their assistants. The second area covered questions regarding various issues of the ERP system implementation through the entire ERP life-cycle. This part is presented here.

The interview guide was slightly updated based on what was learnt from the first case analysis. The main modification was inclusion of questions regarding influences of the production strategy on the implementation project. Here, I present the modified version, used for data collection in the other three cases. The original interview guide was in Czech, I enclose its English translation.

Every interview started with an introduction of myself and the research project, followed by a question about recording of the interview. Then, I asked about details related to the informant's job position. After that, I moved to the questions from the interview guide. The guide comprised open-ended questions and my intention was to allow for an open discussion about the intended issues. Therefore, I did not follow the sequence of the questions strictly, and several prompting questions were raised in addition to the guide. In the end of every interview, I went through the entire guide and checked whether we covered all planned issues.

Interview guide
General information
How do you use the ERP system?
What is your opinion about the ERP system?
Are you satisfied with the ERP system?
What were your expectations from the ERP system?
How are your expectations fulfilled?
What were the main reasons/motivation for the ERP system implementation?
ERP implementation project details
Were you involved in the system implementation? If yes: - How? - Were you a member of the implementation team? - What was your role/responsibility? - Which phases did you take part in?
What problems/complications did you experience during the ERP system implementation?
Was the implementation project according to plan? - On time

- Within budget - Other criteria?
Organizational context
Which characteristics/features of the company do you consider unique/specific?
Which characteristics/features of the company do you consider influential for the ERP system implementation?
How did these characteristics affect the implementation?
How did these characteristics affect the different phases/activities of the implementation project? - Selection - Technical implementation - Usage/ utilization - Maintenance - Other….
Do you think that the fact that the company is a SME has affected the implementation? - How? - Which phases?
(if applicable) In your opinion, how did the production strategy (MTO/MTS) affect the ERP implementation? - How? - Which phases
ERP implementation success
What is your opinion about the implementation project?
Do you perceive the project as a success? (your personal opinion) - Why / why not?
How do you define the success of ERP system implementation?
What is a success for you in this context?
Is the implementation considered as a success by the company? - Why / why not? - How was success defined? - Were there any defined success measures/criteria?
ERP evaluation/outcomes
Was the system implementation evaluated in the company? If yes: - Who did the evaluation? - Was there any evaluation team? - Were you involved in this team?
What are the outcomes of the ERP system? Prompting questions: - What is the impact of the ERP system on the company/yourself? - What improvements were gained through the ERP system? - What changes are caused by the ERP system? - How do you perceive the system quality? - How do you perceive the quality of information provided by the ERP system? - What are the main business process improvements?
Acceptance, usage
To what extent has the system been accepted by the users so far?
What have been the barriers of acceptance? (if any)
Training
What kind of user training was applied?
How many hours of user training were provided?
Was the training sufficient?

Critical Success Factors
Which factors do you consider the most important for the success of the ERP system implementation? Prompting questions: - Top management support - The implementation team - The project champion - Vendor support /consultant - Partnership with vendor - Business process reengineering/ERP system customization - User involvement - Careful package selection - Data analysis & conversion - User training provided
Overall evaluation
What are the limitations of the current ERP system?
What problems / complications do you face now (if any)?
What could be done to overcome these problems?

Appendix B – Coding example

The table below illustrates an example of the coding procedure applied in article 5. The middle column comprises the original text of the interview transcriptions (for the illustrative purposes of this example it contains random interview quotes, translated into English). The left column comprises activities of the ERP life-cycle, while the right column comprises codes representing contextual characteristics.

ERP life-cycle activities	**Original text**	**Contextual characteristics**
Needs recognition Implementation team work Business process analysis Customization	The old system was insufficient. It was almost on the border, as it was not possible to modify or expand it. So the CEO decided that we should change the system. Because we did it during our work, it was difficult to have common meetings, it was very time demanding. That was because our production, it is very complicated, we have 6 divisions. And each of them is completely different, so it took a long time to manage it. I think it is very strict here; there was no toleration and willingness for any kind of adaptation to anything. So it was clear that the system had to be able to adapt to everything they required.	Legacy IS solution Owner-managers IS knowledge Human resources Structure

Relevant parts of the text have been assigned with a code whenever any contextual characteristic was indicated. In a similar way, these parts were also assigned to particular activities of the ERP system implementation. Thus, the analysis served to indicate which parts of the text were concerned with particular SME characteristics and activities of the ERP life-cycle. In addition, I assigned codes indicating the interviewee identification throughout the entire text.

Appendix C – Research publications

No.	Publication	Published
1	Haddara, M. and Zach, O. (2011). ERP Systems in SMEs: A Literature Review	Proceedings of the 44th Hawaii International Conference on System Sciences (HICSS), Kauai, Hawaii, USA, IEEE Computer Society Press.
2	Zach, O. and Olsen, D.H. (2011). ERP System Implementation in Make-to-order SMEs: An Exploratory Case Study	Proceedings of the 44th Hawaii International Conference on System Sciences (HICSS), Kauai, Hawaii, USA, IEEE Computer Society Press.
3	Zach, O. (2011). Exploring ERP System Outcomes in SMEs: A Multiple Case Study	Proceedings of the 19th European Conference on Information Systems (ECIS), Helsinki, Finland.
4	Zach, O. and Munkvold, B.E.. (2012). Identifying Reasons for ERP System Customization in SMEs: A Multiple Case Study	Accepted to the Journal of Enterprise Information Management (JEIM).
5	Zach, O., Munkvold, B.E. and Olsen, D.H. (2012). ERP system implementation in SMEs: Exploring the influences of the SME context	Accepted to the Enterprise Information Systems (EIS) journal.

ERP Systems in SMEs: A Literature Review

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Abstract

This review summarizes research on enterprise resource planning (ERP) systems in small and medium-size enterprises (SMEs). Due to the close-to-saturation of ERP adoptions in large enterprises (LEs), ERP vendors now focus more on SMEs. Moreover, because of globalization, partnerships, value networks, and the huge information flow across and within SMEs nowadays, more and more SMEs are adopting ERP systems. Risks of adoption rely on the fact that SMEs have limited resources and specific characteristics that make their case different from LEs. The main focus of this article is to shed the light on the areas that lack sufficient research within the ERP in SMEs domain, suggest future research avenues, as well as, present the current research findings that could aid practitioners, suppliers, and SMEs when embarking on ERP projects.

1. Introduction

ERP systems have received a substantial attention from both academia and practice. Many research articles dealing with ERP systems have been published, covering various topics and issues. Moreover, a number of ERP literature reviews have been conducted [e.g., 1, 2-4]. These reviews provide overviews of existing ERP literature from a general point of view. Since ERP literature is a broad topic, we focused our review on ERP in SMEs which would provide a more detailed analysis and deeper understanding of this domain.

SMEs have been recognized as fundamentally different environments compared to large enterprises [5]. In relation to ERP implementations, organizational size plays an important role [6, 7]. The literature argues that little attention has been given to research on ERP in SMEs, as the majority of the ERP studies are based on findings from large enterprises [8, 9]. Up to our knowledge, there are no existing literature reviews covering this particular area.

The objective of this paper is to present a comprehensive review of literature on ERP in SMEs in order to illustrate the status of research in this area, and to assist researchers in pinning down the current research gaps. A total of 77 articles were reviewed and organized into ERP life-cycle phases as described by Esteves et al. [10].

The rest of the paper is organized as follows. Section 2 presents the research methodology. Section 3 provides an overview of the articles reviewed. Section 4 provides our findings. Section 5 discusses our observations and recommendations for future research. Finally section 6, discusses the paper implications on research and practice.

2. Research methodology

Literature reviews represent a well-established method for accumulating existing knowledge within a domain of interest. In this article we have applied a *systematic review approach* [11]. This approach is characterized by adopting explicit procedures and conditions which minimize bias [11].

The review covers articles published between the years 1999-2009. We have narrowed down the search process through a condition, that the articles need to be published in peer reviewed journals or conference proceedings. Moreover, no delimitation has been imposed on the outlets' field, to enable potential research results from various fields. The following search procedures have been applied to provide a comprehensive and systematic methodology.

1. An initial search was done through Google Scholar. The search option was limited to articles' titles. The keywords: ERP, Enterprise Recourse Planning, SMEs, Small and Medium Enterprises, and their combinations were used.
2. Due to their high relevance for IS research, another search in EBSCOhost and Web of Science was conducted. The search procedure was restricted to

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the same keywords as in the previous step. In addition to the title area, the abstract and keyword parts of the articles have been included into the search.

3. In order to ensure that no articles were missed by the search engines used in the previous steps, we went through tables of contents of selected outlets. These included top IS journals (MISQ, ISR, CACM, JMIS, ISJ, and EJIS) and journals related to the research field (JEIM, EIS, and IJEIS). We searched for the keywords across all issues published during the delimitated period. The same procedure was applied to the proceedings of four top IS conferences (ICIS, ECIS, AMCIS, HICSS).
4. The articles' abstracts were carefully read by both authors to check their relevance for the review. Only articles directly addressing ERP in SMEs were selected.
5. In addition, we conducted a secondary search through scanning all the selected articles' reference lists, in order to identify further potential literature sources.

In order to better organize the review arrangement, we adopted the ERP life-cycle framework developed by Esteves et al. [10]. It consists of six phases representing different stages an ERP system goes during its life-cycle within an organization. The phases are: adoption decision, acquisition, implementation, use and maintenance, evolution, and retirement. A brief description of each phase is provided in section 4. In addition, the authors independently classified the articles into a concept matrix [12], which included the research themes, approaches, theories, and methodologies. Results were consequently compared and discussed in order to achieve consensus on the articles' classification. It is important to mention that an article could fall in one or more phases and themes.

A number of research articles proposed various ERP life-cycle models [e.g., 10, 13, 14, 15]. There are two important reasons why we adopted Esteves et al. [10] framework. First, it applies more granular approach compared to other models. It provides more detailed understanding of the ERP life-cycle and thus better classification of the articles. In particular, the framework clearly distinguishes between system adoption and acquisition, as these are two diverse phases which are usually merged in other models. Furthermore, the framework separates between system evolution and retirement. Second, it has been already applied by other researchers reviewing ERP literature [3, 16]. This enables a comparability of our findings with formal literature reviews.

3. Overview of the articles

In total, we reviewed 77 articles. Of these, 48 are journal articles and 29 conference proceedings. The articles were published in 43 various outlets, involving 25 journals and 18 conferences.

The review shows a gradual increase in research interest in ERP in SMEs, with a maximum of 20 publications in 2008. Figure 1 illustrates the research methods distribution among the articles. Case studies and surveys are clearly the most used methods, while other methods are comparable less frequent.

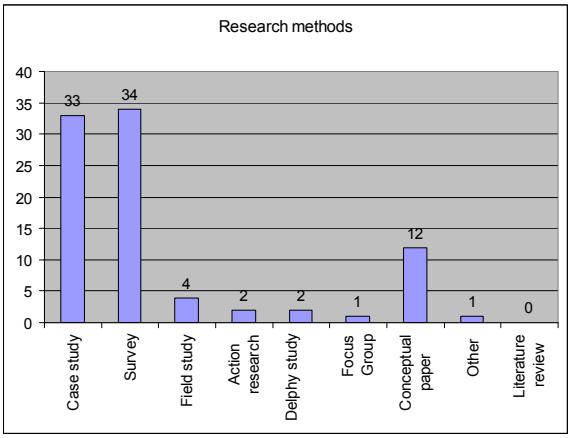

Figure 1. Research methods

As shown in Figure 2, the implementation is the most discussed phase in literature, which is in alignment with several formal literature reviews on ERP systems [3, 16]. Moreover, the figure illustrates the clear difference of research focus among the phases.

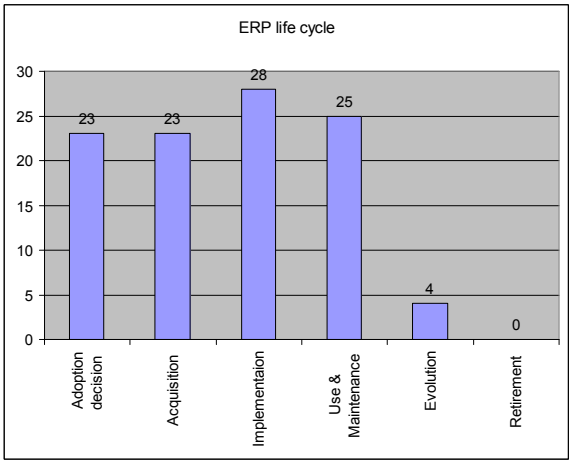

Figure 2. ERP life cycle

4. Findings

In this section, a brief overview of the articles for each phase is presented. It is not intended to provide a detailed discussion of each article, but rather an attempt to briefly present the topics and issues discussed in literature. For the articles reviewed in each phase, refer to Table 1 below.

Table 1. Article categorization

Life-cycle phase	Issues	Reference articles
Adoption decision	Adoption drivers	[6, 7, 17-26]
	Adoption evaluation	[17, 22, 24-31]
	Organizational characteristics	[6, 7, 22, 24, 26, 31, 32]
	Other adoption issues	[8, 14, 28, 33-35]
Acquisition	Factors affecting selection	[18, 19, 36-41]
	Selection criteria	[29, 38, 39, 42-44]
	In-house developed systems	[45-47]
	Other acquisition issues	[8, 14, 33, 42, 47-52]
Implemen-tation	CSFs	[9, 40, 41, 49, 53-57]
	SME characteristics	[6, 50, 53, 57-60]
	Impact of consultant	[58, 61, 62]
	Risk management	[33, 48, 63]
	Other implementation issues	[6, 8, 14, 40, 62, 64-69, 81]
Use and maintenance	Benefits	[6, 40, 41, 70-77]
	Use	[6, 14, 48, 50, 63, 77-81, 85]
	ERP impact	[36, 37, 82-84]
Evolution		[14, 86-88]
Retirement	-	-

4.1. Adoption decision

During this phase, organizations identify their business and technical needs, and question the need for an ERP system. Current ERP literature has tackled several issues related to ERP adoptions in an SME context and environment.

Adoption drivers. Several papers discussed ERP adoption drivers in SMEs from different angles. Few studies [20, 21] have adopted the Technology-Organization-Environment framework (TOE) to develop a model that can be applied to predict which SMEs are more likely to become adopters of Enterprise Systems (ES) in general. Although, the model developed was applied to predict the factors influencing the willingness of SMEs to adopt ES, nevertheless it does not differentiate between factors that affect each type of system solely (e.g. ERP, SCM). In [20, 21] they concluded that SMEs' ES adoptions are more influenced by internal organizational and technological factors, sooner than industry and market related factors. On the contrary, a study [23] suggests that, the higher an SME collaboration within a network of organizations, the more likely to adopt an ES, and more environmental influence it will get.

Adoption evaluation. A study conducted in India argues that business needs, competition, market survival, and customer retention are among the main drivers that force SMEs to adopt ERP system [29]. Ravarini et al. [30] propose a pre-adoption framework for evaluating the suitability of an ERP system in alignment with the degree of business complexity, and the extent of change that a company envisions to achieve. Blackwell et al. [27] developed a decision-support systematic methodology that assists decision makers in regard to adoption decisions and could enhance the overall outcomes from the ERP adoption project. Other studies states that CEO's characteristics and the ERP perceived benefits are correlated with ERP adoptions' outcomes in Taiwanese SMEs [25]. ERP cost *per se* is not a major factor in adoption decisions [25], especially in the adoption or non-adoption of free open source ERP systems in comparison to proprietary ERPs [17].

Organizational characteristics. Other researchers studied the influence of specific organizations' characteristics on ERP adoption decisions. Research results shows that business complexity is a weak predictor of ERP adoption [7], while organization size is a strong adoption predictor [6, 7, 22, 26]. Moreover, SMEs' willingness and readiness of adopting ERP systems are affected by industry type in manufacturing firms [22, 31]. Other studies argue that the scarcity of financial resources, and the challenges that face SMEs while evaluating and selecting ERP do not have an influence on ERP adoption decisions [24], and that adoption drivers may vary according to SME size [32].

Other adoption issues. Several adoption-related issues were discussed in literature. A study by Muscatello et al. [8] reported that project management activities have a huge influence on the success or failure of ERP adoption projects in US manufacturing SMEs. On the contrary, another research shows that formalized management does not promise implementation risk minimization in small manufacturing companies [33]. In [34, 35] they developed and applied a multi-disciplinary Customer-Centered ERP Implementation (C-CEI) method. They present C-CEI as a tool that could assist SMEs in

selecting appropriate ERP Systems, which match their process requirements. They argue that this method would decrease the risk of ERP and organizations misalignment.

One of the few ERP marketing studies has been done by [28]. The research had a vendor-customer perspective. The paper construes that ERP suppliers' marketing abilities and customer reach strategies determine ERP diffusion and adoption success in SMEs, rather than SMEs' low demand or failure in the adoption process.

4.2. Acquisition

This phase includes the process of ERP package and vendor selection that best *fit* the organization requirements.

Factors affecting selection. In order to better understand and evaluate the acquisition and selection process, many studies identified the factors that affect ERP selection in SMEs, and proposed criteria to optimize the selection process. Results show that internal organizational factors like business complexity, change management, and external factors like supply chain partners, and the pressure of value networks affects the ERP selection process in Greek SMEs [36-38]. While other research conducted in Australian SMEs, suggest that cost drivers, functional requirements, flexibility, and scalability of the ERP system [41], and the degree of ERP alignment/fit with the business processes [40] have a great influence on acquisition decisions. Moreover, in [18, 19], they compared Finnish small, medium, and large enterprises. They explored the relationship of enterprise size with the ERP selection process. Their results show that small companies appear to have problems with the ample information for decision-making, and sufficiency of participation from different organizational functions in the ERP system selection phase.

Selection criteria. This part presents research that developed or explored the criteria that SMEs use in order to select their ERP systems. In [44], they stated that the ERP fit with organization business processes appeared to be the most important selection criterion in Nordic European SMEs, whilst others developed criteria that can aid SMEs in the selection process. The dimensions were local support, affordability, suppliers' business domain knowledge [29], or a methodology for selecting the best-fit ERP system with make-to-order (MTO) SMEs' environments [39].

In-house developed systems. In ERP for SMEs literature, few research papers questioned the feasibility of in-house developed systems over off-the-shelf ERPs as in [45, 46]. These papers argue that standard ERP packages could compel rigid structures and inflexibility on niche SMEs, and in-house developed systems might be more suitable in some cases. Correspondingly, Sledgianowski et al. [47] conducted a case study and reported that in some cases, ERP off-shore outsourcing could be more feasible and beneficial for SMEs.

Other acquisition issues. CEOs' technology awareness, employees' IT competence, firm size, ERP compatibility [49, 51], and project management [8], are among the CSF for selecting the right ERP for SMEs. Other researchers furnished recommendations and methods that could be of assistance in managing and minimizing the key risk factors during the ERP selection process [33, 48]. Other studies went further and conducted a comparative analysis of the impact of size on the selection procedures in LEs and SMEs [42, 52], as well as, across industrial sectors in Taiwan [50].

4.3. Implementation

This phase includes the actual ERP installation, customization, business process re-engineering (BPR), and all other activities that align the system with the organization requirements. The ERP implementation phase is very critical, as well as, the most resource consuming phase. Several studies focused on different corners during the implementation process.

Critical success factors. The adequacy of general-ERP implementations CSF in relation to Belgian SMEs-specific characteristics were examined in [53]. The study discovered that most of ERP CSF apply to SMEs with some exceptions. Likewise, a study analyzed implementation success factors in small size firms and concluded that the CSF in literature are adequate when applied on small organizations [49]. Another article presented an analysis of the CSF related to Chinese SMEs' characteristics [57]. While top management support, ERP system quality, and knowledge sharing during implementations, were found key CSF in Thai SMEs [54], however, BPR was found to be a key factor of success [57].

In [56], the authors developed a framework for ERP implementation CSF assessment in small manufacturing firms. Moreover, Loh et al. [9] used the Process Theory in order to identify the implementation critical elements through case studies in the UK. The study concluded that critical success factors, critical people and critical uncertainties contribute to the success or failure of ERP implementations in SMEs. Reuther et al. [41] and Marsh [40] carried out an analysis to determine the key success and failure factors of ERP implementations in Australian SMEs. Further, in Snider et al. [55], they presented a detailed case analysis of successful and unsuccessful

implementations in five Canadian SMEs. Finally, a new CSF ranking that would be more adequate to SMEs environments is needed [57].

SME characteristics. As organization-specific characteristics and contexts have been always important research aspects, they attracted researchers to investigate their implications on the ERP implementation process. A study presented a conceptual model that could help implementers, vendors, and consultants implementing SAP R/3 ERP to better understand the system expectations by SMEs in certain contexts or regions (e.g. Australia) [59]. Since organization size and business complexity affect ERP implementations, it was reported that implementations in Irish SMEs are usually easier and shorter in duration than those reported in ERP literature [58]. In [60], through adopting a vendor's perspective, they recommend that ERP systems need to be localized according to the local management features. SMEs' characteristics and culture play an important role in the success or failure of ERP implementations in Belgian SMEs [53], while cultural issues did not play a major role in ERP implementations within Chinese SMEs [57]. Moreover, ERP implementation methodologies differ between different organization sizes and business complexities, as LEs are more reluctant to adopt a Big-Bang approach than SMEs [6]. Further, a comparative analysis on ERP implementation rates and success, between different organization sizes and industrial sectors in Taiwan shows that ERP implementations in electronic and science industry SMEs are usually more successful than those in traditional industry [50]

Impact of consultants. Although experienced consultants can play an important role in correcting their client companies' "unrealistic expectations" of ERP implementations [58]; however, a study in Taiwan shows that consultants could still face resistance from SMEs' managers [58]. On the contrary, through Grounded Theory approach, [62] states that if SMEs implement an SME-specific ERP system, they will not need external consultancy, which will decrease their investments dramatically. Moreover, SMEs will save time and high costs of training, which are usually, associated with standard ERP packages.

Risk management. Few papers discussed risk management during ERP implementations in SMEs. In [63], they portrayed how SMEs should deem and manage the risks in their ERP implementation projects. Poba-Nzaou et al. [33] discuss methods for ERP implementation risk management and minimization in manufacturing SMEs. Iskanius [48] applied and advocated for using the risk analysis method (RAM), to identify and asses the critical risks of the ERP implementations, and to apply the characteristics analysis method (CAM) in order to help SMEs in dividing ERP implementation projects into sub-projects.

Other implementation issues. Project activities, coordination, and project sponsors [8], employee behaviour, individual characteristics of ERP project management's team, and organization culture have a great effect on the success of ERP implementations in SMEs [64].

Chan [67] emphasized the importance of knowledge capturing and management during implementations in SMEs. The study identified the essential knowledge required for ERP implementations, and proposed a framework to manage it, through matching the required knowledge with the ERP capabilities and features. Moreover, Zain [69] proposed the application of the FAST (Framework for Application of Systems Thinking) system development methodology while implementing ERP systems in cigarette manufacturing SMEs. The study concludes that using such an agile method could assist in reducing and filtering common problems that occur during ERP implementations.

Newman et al. [66] conducted a study on two Chinese small and medium companies. Through business process modeling, the study compares and analyzes the process of ERP implementation in these two companies, and discusses their decisions concerning business process re-engineering. Likewise, in [68], they emphasized the importance of business process modeling, management and re-engineering ex ante implementations. Their study was a simulation on niche Italian SMEs. They conclude that in some cases, ERP systems should be customized to fit with niche SMEs and not vice versa, as they might lose their competitive advantage by complying with standard ERP processes.

In comparison with LEs, SMEs suffer scarcity of financial resources; however, only two papers have discussed ERP costs in an SME context. Through a survey analysis, Equey et al. [65] investigated and evaluated the costs that occurred during ERP implementations in several Swiss SMEs. They found that size, consultants' experience, and people characteristics have a great influence on ERP projects costs. Moreover, implementations at larger companies generally cost much more than at smaller companies, however, a survey by Mabert et al. [6] shows that cost of ERP software at SMEs is higher as a percentage of overall cost than at LEs.

4.4. Use and maintenance

After the sizeable efforts and investments in ERP implementations, companies start to use the systems.

Many issues emerge after the systems' ''go-live'', like system acceptance, user satisfaction, benefits realization, system utilization, and maintenance.

Benefits. ERP benefits expectations and realization have always been problematic issues for the majority of companies. The difficulty originates to several reasons. Here we present some of the issues discussed in literature.

Although benefits realized could differ in each SME industry [41], or organization size [6], several studies argue that realizing benefits from ERP systems can not be done unless there has been an *ex-ante* efforts to define and audit these expected benefits [41, 70-72, 75]. However, if SMEs make the right choices in the ERP selection phase, some benefits from ERP systems could be self-evident [41, 73, 74] and tangible [40]. Moreover, a study in Swiss SMEs concludes that the benefits realized from ERP systems exceed their costs [76]. Whilst another study reports that benefits realized from ERP systems are higher in LEs than SMEs [77].

Use. Even if the ERP implementation was successful, for many practitioners and researchers, the usage of the systems is considered the *moment of truth* of an ERP system. If the implementation was successful but the system was not used or "accepted" by users, then it is considered a failure. Thus, many studies were focused on use, user motivation and satisfaction related issues.

Adopting ERP's standard best practices is the aim of many SMEs, as they see it as a gateway for standardization and regional or international markets. However, through a dialectic perspective, Nathanael et al. [81] argue that best practices, when imposed on SMEs, might affect the motivation of the users, and lead to the loss of the *know-how* and the competitive edge of these companies. Moreover, if ERP systems were more agile and responsive, this would utilize the system use and offer a competitive edge for MTO and traditional manufacturing SMEs [78-80]. A case study results show that user satisfaction and system acceptance rates in LEs are higher than those of SMEs [77]. Further, Wu et al. [50] argue that user satisfaction in Taiwanese electronic and science industries' SMEs are higher than of LEs in the same industry and SMEs in other industrial sectors. In order to minimize the risk of challenges related to user acceptance and motivation, Huin [85] developed a multi-agent model that can decrease the risks related to system use and user acceptance, through organizing the ERP project management activities. In addition, enhancing user communication, training, and obtaining short-term successes could positively impact the motivation and users' system acceptance rates within SMEs [48]. In [63], they state that risk management is a continuous process. They also recommend that benefits and risks in the use and maintenance phase should be re-assessed once or twice a year, in order to manage the impact of stirring risks, and to govern system usage and avoid slipping into old procedures

ERP impact. Introductions of new information systems in companies are accompanied by changes with their business processes, structure, and communications within those companies. Likewise, ERP systems affect many corners within organizations. A case study in an MTO medium-sized company reports that, the ERP adoption had a positive impact on visibility, quality, and control of information, which in turn enhanced the decision making process [84]. Using the Six Imperatives framework, Argyropoulou et al. [36, 37] evaluated the impact of ERP systems on Greek SMEs' business performance. In [82], they attest that ERPs impact on productivity is moderated by SMEs size. Another study [83] adopted an organizational cross-functional point of view in order to evaluate the impact of ERP implementation on different business functions. The study concludes the smaller the size of the organization, the more cross-functionality it will benefit from the ERP system.

4.5. Evolution

This phase involves the extension of ERP systems through integrating other systems or applications, such as customer relationship managements, supply chain management, and advanced planning and scheduling systems.

In [86], the authors state that SMEs which had successful ERP system implementations, are now investigating means of how to extend it in order to support their external operations. The study concludes that, with the use of Internet, ERPs can be extended to cover SMEs' entire supply chain, which in turn will enhance their external operations and relationships. Another study developed an ontology-based conceptual framework. The study argues that, representing the implementation processes using ontology domains, classes, and relations could enhance the coordination and project management during ERP implementations in SMEs [88]. Further, Metaxiotis [87] carried out a study to investigate the raison d'être for integrating knowledge management (KM) systems and ERP systems in SMEs. The study suggested an ERP extension and KM integration framework.

4.6. Retirement

Retirement phase corresponds to the stage when an ERP system is substituted by another information system. No articles were identified in this phase.

5. Discussion and future research avenues

The reviewed articles are spread across 43 various outlets. Among the outlets, we have recognized only one special journal issue focusing on adoption of ICT by SMEs, which included several ERP related research papers. As the research interest on ERP in SMEs is increasing, research outlets should pay more attention to this issue.

In general, 77 articles across 10 years period is relatively a low number of publications. Despite the need for research on ERP in SMEs was recognized in previous literature, still the amount of research conducted on this issue is limited. Thus, more research needs to be carried out in order to gather sufficient knowledge about this phenomenon, as SMEs did not receive appropriate attention in comparison with ERP in LEs.

Based on our ERP in SMEs literature review, in the following part we present some research gaps and suggestions organized according to life-cycle phases:

Adoption. In IS literature in general, and in ERP literature in specific, the term "adoption" is variably perceived by authors. Some authors perceive it as a final stage in which users accept the ERP system, and others define it as the preliminary stage when companies decide on investing in an ERP system.

Although some papers tackled the pressures or motivations imposed by suppliers and partners for ERP adoptions by SMEs, still there is a gap in studying national government policies, rules and laws and their consequences on ERP adoptions in SMEs.

Acquisition. The current literature lacks focus on new technologies (e.g. Software as a Service-SaaS) and their implications on ERP projects. Moreover, ex-ante cost estimation, financial feasibility, and investment evaluation studies of ERP projects have not been identified in our review of literature. Furthermore, literature lacks cases that compare between SMEs'-specific ERP and general ERP systems, as well as, industry-specific ERP packages vs. general ERP ones.

Implementation. Some articles examined ERP projects' success and CSF in SMEs, however, there was no clear definition for *success*. Moreover, the differences of ERP implementation methodologies and their impact on ERP projects had scant attention.

Use and maintenance. Interface language and ERP localization and their effect on user satisfaction are rarely discussed in literature. In addition, post implementation audit strategies and ex-post investment and financial evaluations were not discussed in literature.

Evolution and retirement. Regarding the ERP life-cycle phases, the first four phases were noticeably captured in literature. As recently SMEs started to adopt ERP systems to enhance their operations, value networks, and expansion goals. Thus, it is not surprising to find very few papers discussing ERP evolution, as ERP systems require time to mature enough and recompense in order to convince organizations to extend them further.

We were not able to find any article that directly addresses the *retirement* phase. Thus, we recommend more focus on the evolution and retirement phases, as they can shed the light on the motivations for extending or replacing ERP systems.

General comments. Although comparisons between SMEs and LEs cases were found in literature, yet the size differences among SMEs were seldomly discussed, and they could provide valuable research insights. In relation to type of organizations, the cases studied were often conducted in traditional manufacturing SMEs. Only few articles elaborated on the manufacturing context or type of industry, however, difference in production strategies or industries could produce different research findings.

While there were many studies with a national perspective, however, we were not able to find any cross-national studies. This kind of comparison might be fruitful for ERP literature in SMEs. Also, most of the studies were embarked in America, Australia, Europe or Asia. It would be prolific to have some studies on African or Middle Eastern SMEs as well.

In general, existing literature have adopted a one sided perspective (in data collection) e.g. customer side, while other perspectives could enhance the understanding of certain phenomena. Finally, it could be beneficial if research provides some reports on ERP failure cases, which might assist stakeholders in avoiding previous pitfalls.

6. Conclusion

This paper contributes to both research and practice through providing a comprehensive literature review of ERP in SMEs. For practice, the paper sheds the light on past and recent issues, challenges, and success stories that can guide consultants, vendors, and clients in their future projects. For research, the organization of literature in ERP-lifecycle phases can aid them in identifying the topics, findings, and gaps discussed in each phase of interest. Finally, we have provided our observations and future research suggestions that would enrich our knowledge in this domain.

7. References

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ERP System Implementation in Make-to-Order SMEs: An Exploratory Case Study

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Abstract

The purpose of this paper is to investigate the issue of Enterprise Resource Planning (ERP) system implementation in the context of Make-To-Order (MTO) Small and Medium-size Enterprises (SMEs). No prior study has investigated the whole ERP implementation process in MTO SMEs. Because of the special requirements of both the SME and the MTO context, ERP implementations under these conditions are challenging. We investigate how these organizational characteristics influence the implementation of an ERP system. This study is part of a larger research project to investigate ERP implementation issue in SMEs. We present the empirical findings from an exploratory case study of an ERP implementation in a manufacturing MTO SME. The study provides a valuable insight into issue of ERP implementation in MTO SME sector. The findings are further discussed in a broader context and propositions for further research are presented.

1. Introduction

Enterprise Resource Planning (ERP) systems have become one of the most widespread IT solutions in organizations [1]. Since the large enterprise market is close to saturation, the ERP vendors have begun focusing on Small and Medium Sized Enterprises (SMEs). However, even though the main ERP vendors offer pre-configured low cost solutions designed especially for SMEs, ERP investments are still significant for these companies [2]. Because of limited resources and other constrains, such as lower level of experience with IT, and lack of Information Systems (IS) management in general, investment into new IT is a critical issue for SMEs. Wrong IT investment decisions can have a huge impact on the enterprise's business results. This applies particularly to an ERP system due to its complex implementation process and high resource requirements.

Organizational size plays an important role in relation to ERP implementation [3]. SMEs represent a significant proportion of the economy in European countries. In 2007 SMEs constituted 98,8 % of the almost 19 million enterprises in the EU-27 countries' non-financial business economy [4]. Thus, SMEs represent a huge potential market for ERP systems.

SMEs are forced to replace their obsolete legacy systems to be capable of competing with large enterprises. The information requirements of their supply chain partners are another factor forcing SMEs to upgrade their systems [2]. Usually large companies, already using an ERP system, require their business partners to follow suit to make the business exchange more efficient.

Research on IT innovation implementation within SMEs is still limited [5]. Although a number of researchers have focused on the ERP implementation process, most of the ERP literature is based on findings from large organizations [6, 7]. Prior studies argue that findings from large companies cannot be applied to SMEs since they represent a fundamentally different environment [3, 8]. It is argued that SMEs are not smaller versions of large enterprises [9]. A number of important aspects likely to affect ERP implementation differentiate SMEs from large companies, such as lack of leadership and planning, lack of defined structure, and lack of procedures formalization [10, 11].

This is particularly relevant for companies operating in a make-to-order (MTO) environment. In recent years, many manufacturers have switched to MTO production. This phenomenon is caused by increased demand for specialized products [12]. Almost all MTO companies are SMEs [12-14]. MTOs are characterized by low production volume, wide product variety, and unstable production schedule [15]. The requirements of MTOs are also very different from

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a typical make-to-stock (MTS) manufacturer. Their competitive priorities are associated with volume flexibility and product customization [15].

It is imperative for MTO SMEs to maintain their flexibility, as it is a core competitive competence. They need to be able to conform their products according to customer requirements. When implementing a standardized solution as an ERP system is, the flexibility and thus competitiveness may be threatened [16]. The standardized systems employ embedded standard business processes. That may be in conflict with a need for idiosyncratic business processes. We conjecture that given these limiting factors, MTO SMEs become more vulnerable to ERP implementation failure.

Hence, the production strategy is likely to significantly affect the ERP implementation. However, little attention has been given to research on ERP implementation in MTOs [10, 12, 13]. It remains unclear whether EPR systems can meet the needs of MTO companies [13].

The purpose of this paper is to explore the issue of ERP implementation in the context of an MTO SMEs. This study is part of a larger research project aiming to investigate how specific organizational characteristics of SMEs influence implementation of an ERP system. The remainder of the paper is organized as follows. First, we review ERP literature to identify prior research. We then describe the research method including the data collection and the case company. Next, the data analysis and findings are presented. Then, we discuss the research results and present propositions. Finally, we elaborate on the propositions' implications and provide some alternative routes.

2. Literature review

A substantial number of researchers has studied ERP systems. ERP literature has become extensive over the last decade, covering a wide range of ERP issues. Based on a comprehensive review of ERP literature, Moon [17] demonstratred that the main body of ERP articles (40%) investigated the implementation theme. However, despite the research effort to understand the issue of ERP implementation in organizations, the proportion of ERP system implementation that has failed in recent years is astonishingly high. A recent ERP report found that out of nearly 1600 ERP implementation projects conducted in the last four years, 57% took longer time than expected, 54% went over budget, and 41% of companies failed to realize at least half of the expected business benefits [18]. The high failure rate calls for further research to improve our understanding of ERP implementation processes in organizations.

A possible way to improve our ability to investigate implementation processes is to focus on more specific organizational issues. For example, Moon [17] presented that out of 313 articles they reviewed, only seven focused on a particular sector. These articles are particularly interesting since common attributes and unique features can be analyzed in a particular sector [17]. Another way may be to distinguish between different organizational sizes. Base on a review of ERP literature, Shehab et al. [2] concluded that there is a need for further research investigating the differences in ERP implementation between large enterprises and SMEs.

The influence of company size on ERP implementation has been recognized in recent research literature [3, 8, 19]. Some studies have investigated critical success factors (CSFs) in SMEs [7, 20]. Buonanno et al. [19] conducted a comparative study between SMEs and large companies, investigating factors affecting ERP system adoption. A study conducted by Muscatello et al. [6] applied a broader view of ERP implementation, covering planning, selection and installation activities. The study focuses on implementation activities that affect successful ERP installation. The authors investigated implementation processes in four manufacturing SMEs. They found a strong relationship between manufacturing strategy and ERP implementation success. Unfortunately, this issue has not been further elaborated.

Resent research literature emphasizes the need to address the specific requirements of the MTO production strategy [10, 12, 13]. Typically, prior research on ERP has treated all the enterprises as make-to-stock (MTS), neglecting the needs of the MTO sector.

An exceptional study has been conducted by Aslan et al. [13] who assessed applicability of ERP systems in MTO sector. The literature review revealed a gap between the requirements of MTO companies and ERP functionality. The authors conclude that a greater body of knowledge should be developed about the issue of ERP in the MTO companies. In particular, there is a need for empirical studies exploring MTO sector and industry-specific issues of ERP system adoption [13].

Stevenson et al. [12] provide an assessment of production planning and control (PPC) concepts from a MTO viewpoint. The applicability of ERP systems in MTO companies has been recognized as limited. However, the applicability of the concepts is not supported by empirical data. The findings are derived based on prior studies on ERP implementations. Moreover, the study provides an assessment for the right selection choice between various PPC concepts. Thus, it employs a more general point of view, not particularly aiming at ERP systems.

A valuable research on ERP implementation in MTO SMEs has been done by Olsen et al. [16, 21]. Even though the authors do not recognize the affect of production strategy explicitly, the research is based on cases of MTO and engineer-to-order (ETO) enterprises. The companies are described as niche-oriented SMEs characterized by idiosyncratic business processes, customer-orientated production, and need for flexibility. The findings indicated that proprietary software developed in-house is a suitable solution for niche companies. It enables organizations to keep their idiosyncratic business processes and thus leverage their competitive advantage. The presented approach acknowledges the specific needs of MTO SMEs. However, this solution may not be suitable for all SMEs. Because of a lack of IT competence, SMEs are usually not capable of software in-house development.

The only empirical study on ERP focusing on specific conditions of MTO SMEs sector has been conducted by Deep et al. [10]. The study investigated factors affecting selection of ERP systems. The authors developed a framework for ERP system selection. While valuable, the study investigated only the selection phase. No prior study has investigated the whole implementation process, including the later implementation process phases.

3. Research method

The literature review suggests that there are major gaps in our knowledge of ERP implementations in MTO SMEs. While Deep et al. [10] investigated the ERP selection process in a MTO SME, no prior study has investigated the implementation process as a whole. Single case studies are useful to represent unique cases when there is lack of theory [22]. While a single case has limited generalizability to the population, it can give important propositions for future research. We have therefore chosen an exploratory case study methodology. This would allow us to collect rich descriptive data on an ERP implementation project in a MTO SME in its natural setting. The purpose of this study is thus to increase our knowledge of the factors which influence the implementation process in MTO SMEs. The questions that this study addresses are:

- How do characteristics of MTO SME sector affect ERP system implementation?
- Which ERP implementation practices are affected by these characteristics?

The data were collected through 14 qualitative interviews. All interviews were face-to-face involving one interviewee, except an introductory interview where the project leader and his assistant were both present. We gathered data from employees representing various positions within the company. We interviewed 13 different respondents, among them the project leader, project leader assistant, middle and top management (including CEO), key users, end user, and IT staff. The respondent variety yielded different perspectives to enrich the findings though data triangulation [23].

13 of the interviews were recorded. On average the interviews lasted for approximately one hour, varying between 20 up to 90 minutes. All interviews were conducted by one researcher, thus ensuring equal conditions during the data collection process. The data collection took place within one week (5 working days) and all interviews were carried out inside the company (in meeting rooms). All recorded interviews were carefully listened to and analyzed. The important parts and supporting quotes were transcribed.

The interviews were semi-structured, and employed an interview guide with open-ended questions following Myers & Newman's [24] guidelines for conducting qualitative interviews. The questions covered various issues of the ERP implementation project, diverging in a level of abstraction (from general to very concrete). The interviewees were asked about their personal experiences and opinions about the implementation project and the ERP system itself, about its outcomes and limitations, specific issues regarding the company characteristics, etc.

In addition, we collected information from the vendor. We conducted a telephone interview with the vendor's CEO. The telephone interview lasted for approximately 20 minutes focusing on questions regarding specificity of the implementation project in the case company. Another supplementary telephone interviews was also conducted with the project leader and sales manager. Furthermore, emails and documents provided by the company were utilized as additional data sources.

4. The case company

The case company is a manufacturing SME with approximately 220 employees engaged in fiberoptic equipment production. The company manufactures a variety of products in six product divisions. The divisions include planar and fused components, monitoring line systems, fiberoptic connectors, and optoelectronic components. The company is a dynamically developing organization cooperating with international partners and customers. It is located at one location, without any subsidiaries and branches. This company was selected because of its characteristics meeting the focus of the study, offering a case of ERP system implementation in a MTO SME.

The company is presently moving towards MTO production. It predominantly manufactures high-variety bespoke products. The company also comprises a technological center providing development and design of new products and production technologies.

In the middle of 2007 the company decided to invest in a new ERP. The main reason was an unsatisfactory legacy system. The outdated system became significantly limiting. The legacy system used a technique for creation of predicative product codes based on alphabetic and number combinations. The company was running out of the possible combinations and it was therefore impossible to continue the use of the system. Beside the fact that the system was not user friendly and did not provide any analytical tools, the DOS-based technology created a number of problems (e.g. very slow response time, break downs). It did not provide sufficient data security or user rights regulation.

Moreover, the company was using other separate systems including an accounting system, attendance system, and software for production control. A number of Excel spreadsheets and other tools were used in addition. Since all these applications worked separately, data export and import between them were complicated, and were often solved by manual data transcription. As the company has expanded through the years this has become very time consuming and inefficient.

In the very beginning of 2008 an ERP system selection was initiated. A small local IT company operating as a certified agent of the biggest domestic ERP vendor was selected. However, right after the system selection, the implementation project was discontinued by top management. The reason was the market uncertainty resulting from the financial crisis in 2008. The project was refreshed in mid-November, one and half month before the planned start of the system. However, as a consequence the project was launched in a reduced version. An accounting module was implemented in the beginning of January and the full system was launched by mid-April.

5. Data analysis and findings

In order to organize the data analysis, we structured the findings into implementation phases. We adopted the enterprise systems implementation process life-cycle model developed by Markus and Tanis' [26]. It consists of four phases: project chartering, the project, shakedown, and onward and upward phases. Organizing the analysis in this manner provided better overview and logical structure. Although a number of ERP implementation process models exists in literature [e.g. 25], however, Markus and Tanis' model is one of the most recognized and cited in ERP literature. In our investigated case, the model was well applicable, as the project did follow the implementation phases, and we were able to classify and fit the implementation processes into the model.

5.1. Project chartering

Project chartering includes all activities before the project officially starts. These involve an organizational decision about investment into new IS solution, mapping currents business processes, analyzing potential benefits and limitations, specification of needed functionality, and in the final the system selection.

As mentioned above, the main goal of the implementation project in the case company was to replace the legacy system. From the very beginning the company knew that they wanted an ERP system. The unsustainable situation with the existing IT solutions became a strong driver for implementing a new ERP system. Another driver for a new ERP was the company reputation among customers. These are usually big international enterprises and presenting them outputs from DOS-based system became inconvenient. To sum up, there existed a strong need and motivation for the implementation project, which significantly contributed to its procedure and a successful implementation in the end.

The system selection was conducted by an internal team of five persons (project leader and his assistant, two IT staff, and one key user). The selection documentation involved a detailed specification of requirements and needs, both on a system and a vendor, including technical, security, maintenance, hardware, and financial considerations. Seven selection criteria with different weights were defined. The selection was run in two rounds. Vendor presentations took place in the company during the first round. Visits by the final two vendors and reference companies were conducted in the second round.

The system selection fully relied on the team members' experiences, no external consultant was used. The project leader stated that "regarding the knowledge and experience the team members had about information system implementation, we decided that we were able to select and decide about the system ourselves." This was corroborated by statements from other interviewees and by the vendor. The company knew exactly their needs and requirements for the system. Therefore, the selection was appropriate and well done.

One of the main requirements was a need for system customization. The company decided that it was necessary to apply a high level of system

customization. Many interviewees also expressed the system customization as one of the factors which contributed to the successful implementation. The project leader stated that "we knew that our processes are not standard and the system had to be customized a lot to suit our processes." The company selected a vendor who was willing to adjust the system based on the company's customization requirements. The project leader assistant commented that "we did not want a software nor a vendor who would force us into their standardized solution. We […] really needed […] some software and somebody who would help us with that and would adjust it towards our [processes]."

5.2. The project

This phase encompasses all activities between the system selection and its "going live" [26]. It involves activities such as project team building, business process modeling and reengineering, system customization and configuration, end users training, data conversion, testing and debugging, and in the end, rollout.

The implementation project was governed by an implementation team. The implementation team consisted of 10 key internal users. In addition to the project leader, his assistant, and two IT staff, there were six more key users representing various departments within the company. The key users were chosen based on their experience and attitude to the old system, their interest in the project, and good knowledge of business processes. Not only department managers were assigned as the key users. Particular key users were responsible for the collection of requirements from their field of competence. These were then discussed and analyzed during implementation team meetings.

Despite the complicated situation caused by the financial crisis, the project was renewed. "With the old system we could not live any more," the project leader stated. However, the costs were reduced by two thirds compared to the original project. Only the most necessary functionalities were left. They did not consider the integration of the legacy systems, except the accounting system. Human resources (HR) and material requirements planning (MRP) modules were excluded from the implementation. Furthermore, planned hardware innovations, training time, and the number of licenses were reduced. As one of the interviewees commented, "it was a minimalist variant of the system which functionally corresponds to the old system."

In addition, the delay caused a reconsideration about the project feasibility. The financial manager required that the transition to the new system should be at the beginning of a new year. "We were [discussing] either to manage it in one and half month or wait one more year," the project leader said. The sharp deadline and the lack of time created a pressure. Since there was only one and half month before the system start, it became very hectic. The project leader assistant expressed: "We were pressed already in November,…we had planned [to use] one year for that, and suddenly we had just one month." Consequently the implementation strategy was changed. Instead of implementing all modules at once, it was decided to implement only the accounting module by January 1. The rest of the system was planned to be implemented by the end of February.

As can be observed, the financial crisis had significant implications for the implementation process. Under such uncertain conditions any planning or predictions become very inaccurate. The EPR implementation project was initially carefully planned and a detailed time schedule had been developed. However, the financial crisis significantly changed the market conditions for the company and in consequence the whole project.

The lack of time caused further problems after the accounting module implementation. The tight time schedule of the renewed project led to an insufficient analysis. The ambition was to implement the rest of the system by end of February. "Then the problems occurred," the project leader assistant stated. "The things that should have been detected by longer analysis, […] were not," he further explained. The project leader seconded that. He expressed that the fact that it had been postponed was mainly caused by the lack of time for a proper analysis earlier. "There were many last-time changes resulting from that there was not enough time for the process model design," he added. Most of the interviewees corroborated that the little time for proper analysis was the most significant complication in the implementation.

The analysis was further complicated by the production complexity in the case company. As commented above, the company has six product divisions which differ in the manufactured product as well as the employed technology. This diversity made it challenging to map and define the business processes. "Every production division is a little unique, so it demanded time," the project leader expressed. The system requirements specification had to be done separately for each product division.

The requirement specification had to be done in very detail because of the high level of system customization. A complication mentioned during the interviews was that the vendor underestimated the production complexity. One of the interviewees said that "the production was more complicated than the

vendor expected." They were not able to absorb all the processes. "We knew that our processes are not standard," one of the interviewees stated. Also, it took a long time to debug the system because the production was very complicated.

The production complexity is related to the production strategy issue. The MTO strategy offers high-variety products, which implies frequent changes in the production structure. Moreover, MTO companies must have an ability to react to frequent changes quickly. The interviews indicated that a standardized ERP system would be inappropriate for the case company. Therefore it was imperative that the company had access to system development competence to make appropriate changes to the system. The internal programmer was seen as crucial in this respect, and was evaluated as the second most important factor for the successful implementation.

The implementation team was evaluated as the most important factor for the successful implementation. Many of the interviewees expressed that the composition of the implementation team was crucial. The project leader stated that "it is the main aspect which made the [implementation successful]." However, all the implementation team work had to be done in addition to the regular work duties, and no extra time resources were assigned for the project. Therefore the project seriously strained key personnel resources. The project leader expressed that the team spent a huge number of hours and "nights" there during the implementation. It was evident that the requirements identification and analysis was constrained by the limited personnel resources. The project leader expressed that the fact that processes were poorly mapped complicated the implementation, and that it was related to the lack of well defined responsibilities.

The MTO environment had an effect on the implementation process. The company was not convinced about the applicability of an MRP module. The requirements analysis indicated that the MRP module was unable to meet the specific needs of the company. Based on requirements analysis and reference visits in companies with similar conditions and experiences with ERP implementation, the MRP module was disregarded from the project.

Many interviewees expressed their concern about the applicability of an MRP module and questioned its benefit for the company. "It is possible that it would not be such a contribution, because we are make-to-order production, we are not series production," the project leader assistant argued. In general, the interviewees expressed that MRP is more suitable for MTS production companies. Production planning under MTO conditions was seen as more complicated. "If this [MTO] was not here, it [the ERP implementation] would be much easier," one of the interviewees commented on MTO production strategy. A minimum of the company's products and technologies is repeatable. MRP was expected to be less effective in MTO than in MTS where there normally are just a few changes in the production. Long time forecasts of material purchases were expressed to be very difficult. Another concern was regarding embedded changes. "It [the MRP] would be connected to many changes, in all the processes," the project leader assistant stated. Therefore, MRP was found to not be an effective solution for the case company.

5.3. Shakedown & onward and upward

Project shakedown is a period between "going live" and when the operations are in routine use. During this period the system performance is tuned, bugs are fixed, and additional training is conducted if needed. The end users are getting used to work with the system and operations are becoming "normal." The onward and upward phase is defined as a period from "normal" operations until the system is replaced with an upgrade or a different system. Characteristic activities of this phase are additional user skill building, continuous business improvement, and benefits assessment. Moreover, organizations may also decide about the success of the project [26].

We found it difficult to distinguish between these two phases in the presented case. Therefore we present them together. It was hard to determine when the operations had become "normal." It is an ongoing process and we were not able to recognize such boundary.

The company did not define explicit success definitions or measures. The ERP system implementation project was interpreted as successful by all the interviewees, although perceptions of a success differed. The success was most often cited as the fact that the production was not stopped. "I think a huge success is that we managed to shift, de facto from day to day, from one system to another one without stopping the production," one of the interviewees expressed. The company core business was certainly the main concern regarding the success perception.

Another often expressed perception of the success was the user acceptance of the system. Employees have taken the system into use without any serious trouble. They also learned to work with the system in quite a short time. "We have used to work and live with it quite fast," one of the interviewees said. In general the system has been accepted well. Some minor negative opinions occurred, but they were purely individual

problems. As the project leader noted, "some people are not satisfied from the reason that they must learn something new, and they must do something differently then what they were used to do before." The project leader assistant further added, "of course, information system implementation is nothing easy, it is a change and people do not like changes […] but as a whole it works fine and I see it as 100% success." To conclude, system acceptance is highly individual and human factor plays an important role.

However, no evaluation of the system benefits or outcomes has been carried out in the case company. No parameters for ERP outcome assessment were specified a priori. There existed some general expectations from the system (e.g. increased responsiveness to the customers, faster delivery), but they were not evaluated retrospectively after the implementation. Actually, these parameters were identified as inappropriate because of higher system requirements as discussed above.

Another problem is the lack of use monitoring in the old system. This limits any comparison. The project leader was not happy about the lack of outcome assessment parameters. "When there are no data, it is not possible to compare the outcomes," the project leader explained. Moreover, it was stated that it is not possible to use general parameters (e.g. overall turnover, number of reclamations) because the external changes have more significant influence than the system implementation. In addition, since the company is dynamically developing, it was seen as difficult to isolate the effects of the system. The project leader assistant noted that "the effect of the system contribution would need somehow to be highlighted." However these criteria were found to be difficult to quantify. "Nevertheless numbers would be the best, preferably in money," he further added. A desire for the visibility of outcomes was also expressed by the CEO.

As already stated, flexible business processes was an important characteristic of this company. Its core competence lies in the ability to reconfigure business processes quickly in response to the dynamic business environment. Changing business processes implies changing systems support. The project leader explained: "we must be very flexible towards both customer demands and changes of external environment. The changes must be done quickly." He further expressed that the business environment is difficult to predict. The changes can be radical. The business environment can become totally different. He further added "If we say today it is like this, it can be totally different in 14 days." A number of other interviewees also corroborated this view, and stated that one of the most important aspects of the system was that it should be a "platform for further development." The IT manager stated that "possibility of own further development" was the most important criterion for his satisfaction with the system. The vendor expressed that the company had a very specific environment. He characterized it as a private, small, dynamic, agile company.

6. Discussion

We found that six issues were particularly important in this case: ERP system customization, system and process flexibility, inappropriateness of MRP module, implementation team composition, ERP system evaluation and external events. We conjecture that these issues would be important for other MTO SMEs planning ERP implementations. We discuss each of these issues below.

ERP system customization. The ability to reconfigure the system with the business processes was a key issue in the ERP system selection. The ERP system customization was crucial for achieving flexibility in the business processes.

These findings diverge from ERP literature on large enterprises [27-29], and even research on ERP implementation in SMEs in general [7], which argue that minimal customization is one of the crucial factors for successful ERP implementations. Our findings suggest that we need to take the organizational context into consideration. Particularly, based on our study, we have identified production strategy as an important factor influencing ERP implementations.

Compared to a typical MTS manufactures, competitive priorities of MTOs are associated with volume flexibility and product customization. Therefore, it is imperative for MTOs to maintain their idiosyncratic business processes and thereby their competitiveness in the market. The findings corroborate the research by Olsen et al. [16, 21], who also investigated cases of MTO SMEs. They recognized the inability of commercial ERP solutions to meet MTOs' business requirements. Thus we propose that:

P1: MTO SMEs need a high degree of ERP customization.

Process and system flexibility. We found that the ability to quickly reconfigure both the business processes and the system support was a core competitive capability in this company. Many business processes needed to be changed on a dynamic basis. We argue that the ability to quickly and effectively change business processes is in fact a competitive necessity for most MTOs. Such companies need

flexible business processes that can be adapted to changing customer requirements as well as external market changes. It should therefore be possible to perform system modifications quickly and efficiently and provide add-ons when needed at later stages. Deep et al. [10] also defined the need for flexibility in system modification as one of the desired outcomes of the effective selection process. This leads us to our second proposition:

P2: MTO SMEs need to be able to develop the system further after the implementation to allow for dynamically changing business processes.

In this company, an internal employee was highly capable of developing the implemented system further. This was a critical issue in this implementation, and makes it likely that the company will be able to further maintain and develop the system when needed. They will therefore also be able to do system development independently of the vendor. However, the company will be vulnerable to this employee leaving the company. They should make sure that they have access to this competence either by training more employees or by hiring new IT staff. We propose that system development competence will be crucial:

P3: ERP system development skills are crucial for MTO SMEs.

Manufacturing resource planning (MRP) module. The company found that the MRP module would constrain the manufacturing flexibility. Production planning was seen as complicated because of the dynamic character of MTO environment. Forecasting material purchase in the long terms was deemed to be very difficult. Therefore, MRP was seen as an ineffective and the company decided not to implement it.

This indicates that MRP modules incorporated in ERP systems may not be appropriate and not yield enough manufacturing flexibility for MTO companies. This finding is consistent with Aslan et al. [13] who questioned whether MRP is feasible in today's manufacturing conditions. Furthermore, Deep et al. [10] noted that traditional MRP or old ERP systems are limited in their applicability to the MTO context. We forward the following proposition:

P4: Traditional MRP modules do not allow enough manufacturing flexibility and are inappropriate for MTOs.

Implementation team composition. The implementation team played a key role during the project. In particular, the composition of the team turned to be crucial. Mapping the business processes is an important activity to achieve a good fit between the system and business processes. However, it requires the involvement and time from many employees, and strains the limited SME resources.

Poorly described business processes in SMEs leads to imprecise definition of employees' roles and responsibilities. Therefore, clear responsibilities and tasks need to be granted in the very beginning of the implementation project. The SMEs usually do not have personnel resources to dedicate full-time to the implementation project. In contrast to large companies, employees in SMEs often perform unique work duties and cannot easily be replaced by other employees. Thus, the implementation team members must deal with ERP system implementation in parallel with their day-to-day work duties. Work overload and the lack of time can affect the quality of requirements identification and analysis.

P5: Requirements identification and analysis is constrained by SMEs' limited personnel resources.

ERP system outcomes evaluation. We saw in the previous chapter that the company was unable to perform ERP system outcome evaluation. Compared to any other IS, the outcome evaluation of ERP systems requires a more complex approach. Since ERP systems are organization-wide systems encompassing processes from whole organizations, a careful thorough analysis is needed.

Moreover, the MTO environment implies additional constrains in conducting ERP system outcomes evaluation. MTO companies face a dynamically evolving environment. Therefore the assessment of general business parameters (such as cost reduction, overall productivity, increased capacity, business process change) in relation to ERP system implementation are considered to have limited validity. In such environment, conditions change repeatedly and fast. The case company found that the effect of other, usually external forces, on the measured parameters was more significant than the implementation of an ERP system. Therefore we conclude that:

P6: ERP outcome evaluation is difficult to perform in MTO SMEs.

External events. The financial crisis led to the rejection of the initial implementation plan, and eventually to a scaled down version that was implemented in a rush. This illustrates how SMEs may be very vulnerable to economic macro events such as recessions. Especially MTOs may be subject to dramatic falls in orders as major customers cut production to protect their own financial positions. ERP implementations in MTO SMEs would likely be adversely affected in such scenarios.

P7: ERP implementations in MTO SMEs are vulnerable to economic macro conditions.

7. Conclusion

This exploratory case study has highlighted a number of critical ERP implementation issues for MTO SMEs. We saw that this ERP implementation was troubled by several issues. These issues were rooted mainly in two underlying causes: the particular challenges of MTO production environment, and the resource poverty that characterizes SMEs in general.

The standardized ERP systems force companies to employ embedded standard business processes. That may be in conflict with a need of MTOs for idiosyncratic business processes. Implementing an ERP system may threaten the flexibility and thus competitiveness of MTO SMEs. Therefore, ERP implementations in MTOs require a high degree of customization, and the organizations are more likely to experience problems during the implementations.

We argue that it is imperative for MTO SMEs to maintain their flexibility, as it is a core competitive competence. They need to be able to customize their products based on customer requirements. MTO companies, most of them SMEs, play an important role in the facilitation of the just-in-time supply chains of large manufacturing companies. The MTOs' business agility and manufacturing flexibility are therefore important for an agile and competitive economy. That also means that MTOs must accommodate a significant portion of the impacts of market corrections.

ERP acquisition and implementation was a challenging task for this company even though they have quite competent IS personnel. On the contrary, most SMEs may not have the appropriate system development competence. An alternative is to establish a closer relationship with a competent external provider, such as an ERP vendor or a consulting company. There may be need for radical changes in the MTO processes, and one can conceive that not all system development can be done internally. Then quick response from a competent provider may be necessary. A close long term relationship may be essential for the external party to invest in and maintain the appropriate competence.

Based on the findings we propose that traditional MRP modules are not appropriate for MTOs. We further argue that Advanced Planning and Scheduling (APS) systems may yield enough manufacturing flexibility and be appropriate for MTOs. ASP is the next generation of MRP and is more accurate than the classic MRP systems [10]. However, the case company decided not to implement the MRP module, and we cannot conclude that it would not have worked. The finding indicates a problem, but it is not possible to assess MRP module applicability. Therefore, further research should explore this issue.

The adoption of process modeling methods has been very slow among SMEs, and few of them map the business processes. If a company decide not to map the business processes, team members need to be knowledgeable about business processes. They also need to understand the business requirements on an ERP system. Therefore, the team members should not be selected based only on their position, but based on their potential contribution for implementation project success. Moreover, they should be able to communicate and influence other employees at their department. Personal interest and self motivation are also important aspects for the selection of team members.

SMEs usually do not have resources for a proper ERP outcome evaluation. Moreover, the ability to evaluate the ERP outcomes in SMEs can be limited due to the lack of comparable historical data. Developed measurements tools such as by Gable et al. [30] or Ifinedo [31] could be helpful for MTO SMEs to assess the outcomes of ERP implementation. A demonstration of the contributions and outcomes would increase the motivation for further system utilization and development. However, we are aware that SMEs in general, restricted by limited resources, will not give such evaluations high priority. It would be a comprehensive task that would take resources away from more pressing tasks, such as getting the system up on time without any stops in the business.

This article is intended to emphasize effect of the production strategy on ERP implementation, as it is not recognized in extant literature. Very few studies have considered this aspect. Based on the presented study we have identified production strategy as a key influencing factor on the ERP implementation. Therefore, we argue that the research on ERP in manufacturing SMEs should consider production strategies as an important factor.

This is a case study of a single company, and thus the findings can not be generalized to a larger population of MTO SMEs. This context is, however, an area with little empirical knowledge, and it needs cumulative empirical studies. We forward seven propositions that should be further investigated in subsequent research. Furthermore, the results may have practical value to other MTO SMEs which are about to acquire an ERP system. Our findings and propositions can help such companies to identify key issues for the implementation success.

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EXPLORING ERP SYSTEM OUTCOMES IN SMEs: A MULTIPLE CASE STUDY

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Abstract

The purpose of this paper is to investigate Enterprise Resource Planning (ERP) system outcomes in the context of small and medium-sized enterprises (SMEs). Most of the former research on ERP outcomes is based on data from large enterprises, and this study examines how the SME context affects the ERP system outcomes and the related evaluation practices. The paper reports findings from a multiple case study of ERP implementation in four SMEs. The case companies put more emphasis on system and information quality improvements from the ERP systems, compared to individual and organizational outcomes. This can be related to the lack of a strategic perspective on ERP implementation in these companies, with replacement of the legacy systems serving as the main motivation for the implementation projects. Moreover, the findings indicate that the identified lack of ERP system evaluation practice in these SMEs can be explained by ownership type, resource constraints, limited IT competence, and status of the IT legacy systems in SMEs.

Keywords: ERP system outcomes, ERP implementation, IT evaluation, SME, case study.

1 Introduction

Enterprise Resource Planning (ERP) system implementations are substantial and long-term investments, expected to yield significant positive outcomes for organizations undertaking this endeavor. Organizations thus need to assess whether they have achieved the intended contribution from their investment, and the ERP literature includes several studies investigating ERP system outcomes in organizations (e.g., Gable et al., 2003; Shang and Seddon, 2002; Staehr, 2007; Velcu, 2007; Wieder et al., 2006; Williams and Schubert, 2010). While it could be argued that return on investment is even more critical for small and medium-sized enterprises (SMEs), for whom ERP system implementations constitute a comparatively larger investment than for large enterprises (Mabert et al., 2003), there has yet been limited focus on the evaluation of ERP outcomes in the SME context.

The majority of existing measurement frameworks have been developed based on data from large enterprises. Only a few studies have tried to explore this phenomenon within the SME context. The research on ERP implementation argues that findings from large companies cannot be applied to SMEs since they represent a fundamentally different environment (Buonanno et al., 2005; Mabert et al., 2003). This also applies to the evaluation of ERP impact. Large organizations have been reported to receive more benefits compared to small organizations (Sedera et al., 2003), and several differences in areas benefited from ERP systems between companies of different sizes have been recognized (Mabert et al., 2003). For example, organizational size has been identified as a moderator of ERP impact on SMEs' productivity (Bohórquez and Esteves, 2008).

Compared to large organizations, SMEs have been reported to be constrained by limited resources and limited IS competence (Levy and Powell, 2000; Thong, 2001). Besides this, SMEs are represented by a spectrum of inherent characteristics which distinguish them from their big counterparts, such as structure, ownership, culture, decisional specificity, etc. (Blili and Raymond, 1993; Wong and Aspinwall, 2004). These aspects of the SME context are likely to determine the way in which these organizations conduct ERP system implementations and in turn their evaluation as well. There exist various definition of SMEs, and this study adopts the EU definition of SME as an enterprise with fewer that 250 employees and annual turnover less than 50 million euro (Eurostat, 2008).

The purpose of this paper is to contribute to the scarce literature on evaluation of ERP system outcomes in SMEs. The study is based on two research questions: (1) *What are the ERP system outcomes perceived by SMEs?* (2) *How does the SME context affect the ERP system outcomes?* The empirical basis for this exploratory research is a multiple case study of ERP implementation in four SMEs in the Czech Republic. Based on a cross-case analysis, a list of the ERP system outcomes perceived by the case SMEs is presented. Further, the paper discusses how characteristics of the SME context may influence on the evaluation practice.

The rest of the paper is organized as follows. Section 2 briefly presents relevant literature on ERP outcomes, with particular focus on SMEs. Section 3 describes the research methodology applied in this study. Section 4 introduces the case companies and presents findings from the cross-case analysis. Section 5 discusses the effect of the SME context on the ERP system outcomes and ERP system evaluation practice in SMEs. Finally, section 6 presents conclusions and implications.

2 Related Research

Over the years various approaches to ex-post evaluation of ERP system outcomes have been developed. This research includes studies employing ERP success assessment tools (Gable et al., 2003; Ifinedo, 2006; Tan and Pan, 2002), ERP benefit frameworks (Shang and Seddon, 2000, 2002; Staehr, 2007; Williams and Schubert, 2010), and ERP balanced scorecard frameworks (Chand et al., 2005; Uwizeyemungu and Raymond, 2009; Velcu, 2007).

A significant contribution in this area is the multidimensional model for Enterprise Systems[1] Success (ESS) measurement developed by Gable et al. (2003). This model builds upon the models by DeLone and McLean (1992) and Myers et al. (1997), with the success dimensions and measures revised in order to meet the ERP characteristics. In total the model involves 27 measures of ERP success distributed into four dimensions: information quality, system quality, individual impact, and organizational impact. *Information quality* is a measure of the quality of the information the ERP system produces. *System quality* includes measures of the ERP system performance from a technical and design perspective. *Individual impact* measures the extent to which the ERP system has influenced the capabilities and effectiveness of workers. The extent to which the ERP system has promoted improvements in organizational results and capabilities is captured by the *organizational impact* dimension (Gable et al., 2008).

Petter et al. (2008) in their thorough literature review found the ESS model to be the most comprehensive tool for IS success measurement. The instrument captures the multidimensional and complex nature of ERP success. One of its strengths is that it avoids overlap between the constructs and measures (Petter et al., 2008). The ESS model is selected as an underlying framework for investigation of ERP outcomes in this study.

Former research has recognized the effect of organizational size on ERP outcomes. A study conducted by Bohórquez and Esteves (2008) identified organizational size as a moderator of ERP impact on productivity in SMEs. Sedera et al. (2003) confirmed the proposition that organizational size contributes to differences in achieving benefits of ERP systems. The findings indicate that large organizations received higher positive outcomes compared to small organizations. By applying the ESS assessment model (Gable et al., 2003) the results showed that larger organizations gained higher mean values for all the constructs within the four dimensions. This has been supported by Mabert et al. (2003) who found several differences in areas benefited from ERP systems between companies of different sizes. Small companies reported higher benefits in inventory management and procurement, while large companies reported more benefits in financial and personal management.

A limited number of studies have focused on ERP system outcomes in SMEs. As an example, Esteves (2009) conducted a survey to investigate ERP benefits realization in SMEs. The author applied the ERP benefit framework by Shang et al. (2000). The study determines a link between the benefits and the point in time when the various benefits are expected to materialize, resulting in a benefit realization road-map for ERP usage in SMEs.

Another attempt of ERP outcome assessment within SMEs was reported by Federici (2007, 2009). The author aimed at a post-introduction assessment of ERP outcomes in SMEs with regard to factors influencing the outcomes. The study adopted a list of the five most cited benefits that were promised to large companies by ERP adoptions. The results of the survey of 50 SMEs showed that the most common benefits were procedure simplification, easier information retrieval, improved performance management and production efficiency improvements. The factors observed to mostly affect the benefits are depth of organizational change and type of chosen ERP producer.

Recently, Kale et al. (2010) investigated performance evaluation of ERP implementation in Indian SMEs. The study employed a survey of 130 SMEs. The ERP performance was studied through a list of 19 ERP benefits. The findings indicate that SMEs benefited mainly in reducing the need for support, improving customer services and improving communication.

Although these studies utilized data from SMEs they did not examine the specificity of this environment. By basing the studies only on existing frameworks or lists of ERP outcomes, the studies lose the potential to identify and explore new outcomes which might be specific for SMEs. Thus, while these studies present quantified measures of the listed ERP outcomes, they include limited discussion regarding how the SME context may influence these outcomes or the evaluation practice itself.

[1] The terms enterprise system and ERP have been used interchangeably. The authors investigated implementations of the SAP system.

3 Research Methodology

The review of studies on ERP outcomes in SMEs showed that the quantitative research approach is dominant. While these studies provide measurements of ERP outcomes, they do not explore the particuliarities of the SME context and its effect on the outcomes. Qualitative research can thus bring new light to this domain (Ballantine et al., 1998; Jones and Hughes, 2001; Uwizeyemungu and Raymond, 2009). As the purpose of this research is to identify new insights within the SME context, a qualitative research approach employing a multiple case study method is applied. Case studies allow collection of rich data and are appropriate to study a contemporary phenomenon within its natural setting (Yin, 2008).

In total, four organizations were studied. All of them are SMEs operating within the private sector in the Czech Republic. The case companies differ in terms of organizational characteristics (e.g., size, business type, industry) as well as ERP project characteristics (e.g., brand of ERP system, number of implemented modules). In order to ensure anonymity, the organizations are labeled as CompA, CompB, CompC, and CompD. Table 1 provides an overview of the studied organizations.

Personal interviews were utilized as the primary data collection technique. Recognizing the importance of a multiple stakeholder perspective while conducting ERP system evaluation (Jones and Hughes, 2001; Sedera et al., 2004; Sedera et al., 2007), interviews with various respondents within each organization were conducted. The interviewed respondents represented different positions, including top and middle management, IT responsible persons, end users, etc. While these different stakeholders may represent different perceptions on outcomes (Sedera et al., 2004; Sedera et al., 2007), the focus in this analysis was mainly on what could be interpreted as the common view in each company. In addition, vendors or consultants who have been involved in the ERP implementation were also interviewed. In total, 34 interviews were conducted across the four organizations. More information about the number of interviews and participants in each of the companies is presented in Table 1.

	CompA	**CompB**	**CompC**	**CompD**
Industry	Fiber optic components	Electronic components	Cosmetics	Agriculture machinery
Business type	Manufacturer	Distributor/ Manufacturer	E-shop	Manufacturer
# of employees	220	100	50	200
# of interviews	14	7	4	9
Participants	Project leader (production manager), project leader assistant, CEO, financial/ technology managers, IT/IS administrators, end users, vendor's CEO.	Project leader assistant, financial/, technology/sales managers, IT/IS administrator, end user, consultant.	Sales manager (responsible for the IS), wholesale manager, end user, vendor.	Project leader (purchasing manager), economic/warehouse/technology /production manager, IT/IS administrator, payroll clerk, end user, vendor.

Table 1. Overview of the case companies

The interviews were semi-structured and face-to-face, following Myers & Newman's (2007) guidelines for conducting qualitative interviews. With regard to the issue of outcomes evaluation the respondents were asked to answer an open-ended question: *What are the outcomes of the ERP system*? The participants were asked to name as many outcomes as possible, while they were provided sufficient time for reflection. When an interviewee had problems with answering the question, probing questions were asked: e.g., *What is the impact of the ERP system on the company/yourself? What improvements were gained through the ERP system? What changes are caused by the ERP system*?

How do you perceive the system quality? How do you perceive the quality of information provided by the ERP system?

To enrich our understanding of the case projects, different material served as supplementary data sources: documents provided by the organizations, company presentations, company web pages, web pages of the vendors. In addition, follow-up e-mails and telephone communication were used for clarification of some issues. The data collection was carried out during the period from February to October 2010. The interviews were conducted on-site at the companies, usually in meeting rooms. On average the interviews lasted for one hour, varying between 20 to 100 minutes. The interviews were recorded and relevant parts were fully transcribed and coded using NVivo 9 software. The codes represented particular ERP system outcomes mentioned by the interviewees. While the four dimensions of the ESS model (Gable et al., 2003) were used as an underlying framework, the analysis also identified additional outcomes emerging from the interview data.

4 Findings and Analysis

The qualitative interviews provided rich data about the ERP system implementation projects in the studied organizations. The following section gives a brief overview of the four cases. Then a cross-case analysis of the ERP system outcomes is presented.

4.1 The case overview

Table 2 lists key characteristics of the ERP implementations in the four companies. The case companies represent different phases in the ERP-life cycle, varying between 11 months (CompA) up to 5,5 years (CompD) of experience with an ERP system at the time of data collection. According to the life-cycle stages modelled by Esteves and Pastor (1999), three of the companies (CompA, CompB, and CompC) were in the "use and maintenance" phase, while CompD was in the "evolution" phase, as they extended the ERP system with a Business Intelligence module in 2010.

	CompA	**CompB**	**CompC**	**CompD**
Time of ERP implementation	April 2009	October 2006	August 2007	January 2005
Time since "going-live"	11 months	3,5 years	3 years	5,5 years
ERP system	Helios Green	ABRA G4	ABRA G3	ALTEC Aplikace
Implemented modules	FI, CO, LO, PC	FI, CO, LO, PC, AM, HR	FI, CO, LO, AM, HR, CRM (limited)	FI, CO, LO, PC, AM, HR, MRP, PP, BI (extension in 2010)
Legacy information systems	4 separate DOS-based systems (accounting, production control, payroll, time attendance system)	2 separate DOS-based systems (accounting, production control)	DOS-based accounting system	2 separate DOS-based systems (accounting, production control)
Implementation partner	Certified agent	Vendor	Certified agent	Vendor

Table 2. The case ERP project characteristics

All four companies selected domestic ERP solutions. Helios Green is developed by the largest Czech ERP vendor, Asseco Solutions. ABRA is offered by the second largest Czech ERP vendor, ABRA Software. ALTEC Aplikace is an ERP system developed by a smaller Czech ERP vendor, ALTEC. While these systems basically cover the same functionality, different selections of modules were implemented in the four companies. The following three modules were implemented in all projects: FI–Finance (including accounting), CO-Commerce (purchase and sale), and LO-Logistics (warehouse). In addition varying combinations of the following modules were implemented: PP-

production Planning, AM-Asset Management, HR-Human Resources, CRM-Customer Relationship Management, MRP-Material Resource Planning, BI-Business Intelligence.

The companies' legacy systems replaced by the ERP system varied in terms of areas covered. All the case companies were using DOS-based information systems that were not integrated. In addition, several Excel sheets, and other software tools were utilized.

Two of the organizations selected a local IT company as their implementation partner operating as a certified agent of the ERP vendors. CompB and CompD used a vendor directly. The implementation projects were conducted by implementation teams consisting of 4 to 10 employees. Only CompB used a consultant as a member of the implementation team. None of the implementation projects involved any form of evaluation of the ERP system outcomes.

4.2 ERP system outcomes

This section presents the results of a cross-case analysis of the ERP system outcomes. The findings are based fully on the conducted interviews, as no relevant documentation about outcome evaluation existed in the case companies. Table 3 lists the ERP outcomes perceived by the four organizations. The outcomes are grouped according to the four dimensions in the ESS model (Gable et al., 2003). The identified ERP system outcomes partly correspond to the measures from the ESS model, those matching are marked by a superscript (*) in Table 3. About half of the outcome measures defined in the ESS model were not brought up in the interviews, indicating that these were perceived to be less relevant by the SME companies. Further, as indicated in Table 3, almost half of the identified ERP system outcomes represent complementary measures in the four dimensions of the ESS model.

In general, the ERP outcomes were most often reported in relation to system quality. All the four companies perceived various system quality improvements. Most importantly the ERP systems provided integration of data within the companies. As expressed by the technology manager in CompB: *"It [data] is at one place, I can see several things at once, […]. That was more difficult before. I had to call particular people, now I can find it in the system."* The data integration contributed toward data transparency: *"The main benefit is that everything has become transparent. Every activity across the company is reflected in the system and thus all divisions can see what is happening."* (Purchase manager, CompD). Most of the companies reported that the ERP systems improved controlling and data analysis options. Furthermore, system extensions and changes have become easier, and the ERP system provided easier data import and export. Some companies also reported improved system sustainability, security, and stability as positive outcomes. For example, as stated by the project leader from CompA: *"The old system sometimes even broke down, so we were also afraid about our data. […] The new system is definitely more stable."* In some cases the ERP system also offered a communication channel and facilitated user interface changes.

The organizations also perceived improvements in terms of information quality. The ERP systems significantly increased information accuracy and its availability. The sales manager from CompD reported: *"For me it is important to quickly get the information I need for my job. Now, I do not need to search for the information for long time, […]. I know where to find it."* Another perceived outcome of the ERP system was that the information became more timely. For example, as expressed by the wholesale manager from CompC: *"We are able to change the price for the whole range of goods within a couple of minutes according to currency rates, so the price is always updated."* In addition, due to the ERP system it became possible to track information back in history.

Interviewees across all the four organizations mentioned that the ERP system affected their work tasks. Most often they claimed that their work routine has become simpler. One aspect of the simplification is that the system has reduced manual work, which again has increased work efficiency: "*Before, when the director called and asked for some price, it took me some time to calculate it from the papers. Now it is only about six clicks away."* (Technology manager, CompD). Interestingly, two of the companies perceived improved substitutability of workers to result from the ERP system implementation: "*When somebody is suddenly missing anybody else can substitute."* (Technology manager, CompB).

ERP system outcomes	CompA	CompB	CompC	CompD
System Quality				
Controlling	x		x	x
Communication possibilities			x	
Data analysis	x		x	x
Data import/export	x	x		x
Data integration *	x	x	x	x
Data transparency	x	x	x	x
Data security	x			
System extensions/changes *	x		x	x
System stability *	x		x	
System sustainability	x			x
User interface flexibility *	x			x
Information Quality				
Information accuracy *	x	x	x	x
Information availability *		x	x	x
Information back tracking	x			x
Information timeliness *			x	x
Individual Impact				
Substitutability		x		x
Increased work efficiency *	x	x	x	x
Work simplification	x	x	x	x
Organizational Impact				
Administration expenses reduction *			x	
Better inventory overview			x	x
Business process improvements *	x	x	x	x
E-commerce *			x	
Increased capacity *			x	
Overall productivity *			x	
Production planning improvements				x
Staff requirements reduction *			x	

Table 3. ERP system outcomes identified in the four cases

With regard to the organizational impact, business process improvements were perceived as the main outcome of the ERP system. All the four organizations reported improvements in their business processes, e.g.: *"We have optimized our processes due to the system."* (Project leader, CompA). CompC and CompD perceived improvements in inventory overview, and CompD also recognized improvements in production planning practice. However, besides this, only CompC stated other organizational impacts of the ERP system. For example, the ERP system resulted in reduction of administrative expenses and also enabled increased utilization of E-commerce in the company. Moreover, the ERP system contributed to higher overall productivity and resulted in an increased capacity to manage a growing volume of activities. As reported by the sales manager: "*Because we implemented the system we could improve and develop our portfolio and volume of the business."* The ERP system also reduced the need for further staff hiring since more operations can be managed by the system without requiring additional human resources: *"We were able, compared to competitors, to grow the same size in terms of sales without burdening the company with new staff."* (Wholesale manager, CompC).

5 Discussion

The former section presented the ERP system outcomes identified in the four case SMEs. This section elaborates on the question of how the SME context affects the ERP outcomes and the ERP system evaluation practice.

5.1 ERP system outcome measures

In general, the study demonstrates how the four measurement dimensions defined by Gable et al. (2003) are also applicable in the SME context, as all the identified ERP outcomes could be related to one of the dimensions. The following section discusses how the SME context has been found to affect the ERP outcomes related to each of these dimensions.

System and information quality. The results showed that the case organizations reported a substantial number of ERP outcomes within the system and information quality dimensions, compared to the individual and organizational impact dimensions. This might be influenced by the lack of a strategic perspective on the ERP system implementation in the studied SMEs. In all four cases the main reason for implementing an ERP system was to replace the legacy system. The legacy systems were so unsatisfactory that their replacement was necessary for continuing the companies' operations. In all four SMEs the legacy systems were old DOS-based solutions, functionally and technically insufficient for further utilization. Thus, the motivation for the ERP system implementation was mainly technically driven (Chand et al., 2005; Velcu, 2007). The technically driven motives for ERP system implementations are also related to the lacking of an IT strategy in the case companies. In fact, only CompC had a partial IT strategy, as the ERP system was seen as a solution enabling further growth of the firm. Otherwise, the ERP system implementations were not associated with the companies' overall business strategy plans. The motivation has an implication for the ERP outcomes. Since the companies did not intend to improve their business as such through ERP system implementations, they do not seek for the effect of ERP systems on their operations. Therefore, more emphasis is put towards the systems' functionality and information quality provided by the systems, captured by the system quality and information quality dimensions in Table 3.

Individual impact. An interesting issue arose about the relevance of the individual impact outcomes. While interviewees across all the case organizations reported that the ERP system simplified and speeded-up their individual work, several interviewees reported that this is not so "black and white." Since the ERP systems offer far higher functionality compared to the legacy systems, they also require more work to provide sufficient data. Moreover, the companies have started to place emphasis on data correctness and accuracy, and compared to the previous practice it can take more time to provide required information into the system: *"At the expense of speed we have clearer, more accurate data"* (Project leader assistant, CompA).

The findings also identified some outcomes which seem to be specific for the SME context. One of the ERP outcomes identified by CompB and CompD is that the ERP system increased substitutability of workers. In general, compared to large enterprises, the employees' roles and responsibilities in SMEs are poorly defined and employees often perform various tasks. Therefore, they can not be easily substituted by other employees. It is even further constrained by the limited number of employees in SMEs. By data integration and transparency the ERP systems simplified substitutability of workers, for example in case of their absence.

Organizational impact. The findings revealed a difficulty in relating the ERP system to overall business measures such as cost reduction, overall productivity improvements, increased capability, etc. (the organizational impact dimension in the Gable et al. framework). A number of interviewees expressed limited relevance of assessing these general measures in relation to an ERP system implementation. This was explained by the dynamic environment of the case companies. All of them are continuously growing and experience many significant changes (e.g., widening assortment , new division opening, etc.) which have more significant influence on the overall business measures than an ERP system implementation. Thus, it was perceived too complex to evaluate the effect of an ERP system because there are many other influencing factors taking part. To conclude, the dynamic environment of SMEs may impede evaluation of ERP system organizational impact.

The results show that CompC reported more organizational impact outcomes compared to the rest of companies (see Table 3). This corroborates the findings by Staehr (2007) who concluded that companies with primarily technical reasons for implementing an ERP system achieve few strategic business benefits, in the sense of outcomes that support business growth and competitive advantage. In

general, the results support former literature recognizing how the motivation for implementing ERP systems may influence on ERP outcomes (Staehr, 2007; Velcu, 2007).

Former research presented that ERP systems provide labour cost savings (Gable et al., 2003; Shang and Seddon, 2000). None of the four organizations reported any HR lay offs as a result of the ERP system. This might be related to the nature of work positions in SMEs. In large enterprises there are usually several employees working in the same position. When work routine gets more efficient and speeded-up by an ERP system, lay offs in large enterprises are more likely. In SMEs, since there are not precisely defined employees' roles and responsibilities, ERP system implementations are not expected to bring significant HR cost reduction. Only CompC reported a reduced need for future labour costs (staff requirements reduction). In contrast, the ERP system implementation in CompA imposed a need for more IT staff. This was caused by the specific situation in that company. The company operates under a make-to-order (MTO) production strategy which requires many further configuration changes and development requirements for the implemented ERP system (Zach and Olsen, 2011). The company decided for further internal development of the ERP system because this was seen to be a faster and cheaper solution than to use a vendor for all the required work. At the time of the interviews the company was in the process of hiring one additional programmer to handle this job.

5.2 ERP system evaluation practice in SMEs

Even though the ERP system implementation projects in all the four organizations were considered successful, no evaluation of the ERP outcomes has been conducted by any of the companies. None of the companies explicitly defined any evaluation criteria in the beginning of the projects as a set of outcomes which were expected to be fulfilled. There existed some general expectation from the ERP system (e.g., system integration, improved information quality), however these were not formally stated. Neither has any ex-post evaluation of ERP outcomes been carried out by the case companies. The lack of IS evaluation practice in SMEs has been discussed by Ballantine et al. (1998), and the findings from this study show that this phenomenon is still prevailing.

One of the reasons explaining this might be related to the ownership type in the studied organizations. As is typical for SMEs, the case companies were privately owned businesses, where the main owner also is the CEO (in CompC there were two owners/CEOs). In all four companies the CEOs were actively involved in the operating business. Thus, they were in contact with the system on a daily basis and got feedback on this all the time. Therefore, they were able to perceive the effect of the ERP system and recognize ERP outcomes based on the practice. There was no perceived need for identifying and evaluating outcomes in order to justify its success. Thus, the ownership type of SMEs may influence the ERP system evaluation practice.

Another reason for not conducting the ERP system evaluation mentioned during the interviews was an obviousness of the outcomes. Since the legacy systems in the studied companies were functionally limited and insufficient, 'everything' has improved by implementing an ERP system. As stated by the wholesale manager from CompC: *"It is not comparable with the old system, […]. The improvement is in everything."* Since the ERP outcomes are perceived obvious and apparent, there is no need for their evaluation. Thus, the status of legacy IT solutions in SMEs may influence the evaluation of ERP system outcomes.

Compared to large organizations, SMEs have been found to be constrained by limited resources and limited IS competence (Levy and Powell, 2000; Thong, 2001). These aspects are likely to affect IS/ERP implementation projects as well as their evaluation. Since the ERP outcomes evaluation was not part of any implementation project in the studied organizations, it would require additional resources. Thus, it would take resources away from the primary business activities, which would be seen as improper. SMEs, restricted by limited resources, might therefore not be able to assign sufficient resources for conducting the ERP system outcomes evaluation.

An exception to the lack of perceived need for ERP evaluation was observed in CompA. The project leader and his assistant here expressed a desire for ERP outcomes evaluation and recognized its importance, stating that the effect of the system contribution would need somehow to be highlighted.

However, the evaluation was expressed to be difficult to conduct. The project leader was dissatisfied with the fact that they did not designate any parameters for ERP outcome assessment. This might be caused by limited IT competence in the company, typical for SMEs.

6 Conclusion

This study has explored ERP system outcomes in SMEs. The aim was to improve our understanding of this phenomenon through focusing on distinguishing characteristics of the SME environment. The findings indicate that the SME context has implications on the ERP outcomes as well as on the ERP system evaluation practice.

The cross-case analysis provided a list of ERP outcomes perceived by the case organizations. In the individual impact dimension, the ERP systems simplified work and increased work efficiency. In addition, the ERP systems improved substitutability of workers, which may seem to be specific for SMEs due to the nature of work positions in these organizations. Furthermore, the study shows how the SMEs perceived it to be difficult to relate the ERP system to overall business outcomes as defined in the organizational impact dimension. The dynamic environment of SMEs has been observed as the main constraint for evaluation of ERP system organizational impact. In particular, the labour cost savings might be limited by the nature of work positions in SMEs. The case companies reported more emphasis on the system and information quality improvements provided by the ERP systems. This was observed to be affected by the lack of IT strategy in these companies and their motivation for the ERP system implementation being limited to replacing legacy systems. To sum up, the study findings show that the nature of work positions, dynamic SME environment, lack of IT strategy, and motivation for the ERP system implementation are among the issues that may affect the ERP outcomes in SMEs.

The study documents a lack of ERP system evaluation practice in the SMEs. The characteristics of the SME context such as ownership type, resource constraints, limited IT competence, and status of the legacy IT solutions in SMEs were recognized as factors constraining the evaluation. Nevertheless, it may be argued that recognition of the ERP outcomes could increase utilization of the systems and help in its further development.

The study has identified major ERP system outcomes in the SME context and thus contributes to the research on ERP system implementation projects in SME. The findings indicated that the ERP system implementations in the case SMEs were mostly perceived as technical replacement of the legacy systems, limiting the focus on more overall organizational outcomes of the ERP systems. As demonstrated by CompC, a more strategic approach enables organizations to gain more organizational outcomes from the ERP implementation. Thus, SMEs should align the ERP system implementation projects with their overall business strategy plans in order to better utilize the ERP system potential.

Naturally, the study has several potential limitations. First of all, the interpretation of the results might be influenced by the author's biases. The motivation of this study was to enhance understanding of the outcomes of ERP system implementation projects in SMEs, and thus contribute to improve evaluation practice in these organizations. This applied perspective might shape my interpretation of the findings.

Furthermore, all four case companies selected local ERP systems which could be characterized as less complex compared to "standard" ERP systems such as SAP. This might be considered as a limitation of the study's scope as the selected systems might provide comparatively less outcomes. However, since the literature supports our findings that SMEs are likely to choose systems provided by small national vendors (Federici, 2009; Yeh, 2006), it is believed that the findings can be generalized to ERP implementations in other SMEs.

In addition, the date of the case ERP implementation varies between 2005 to 2009. Considering the fast pace of technology advancements, in these four years the experience of ERP vendors regarding the problems and challenges with ERP implementations might have an impact on the system quality and information quality of the ERP system. This may raise differences in the perception of the ERP system outcomes among the four companies.

Finally, all case companies are characterized as continuously growing and dynamic organizations, undergoing many changes in their business processes over time. While these are often reported characteristics of SMEs, there might also be more mature, stable SMEs, working with traditional business processes. Therefore, the applicability of the results to other types of SMEs needs to be investigated by further research.

The presented analysis demonstrated the applicability of the four ESS model dimensions (Gable et al., 2003) in the SME context. However, the identified ERP system outcomes only to some extent matched with the measures from the ESS model, and a number of additional ERP system outcomes were also reported. The discrepancy identified in this study could form the basis for further research on validation of the ESS model in the SME context. Another possibility for further research would be to apply a longitudinal approach to relate the ERP system outcomes to different stages in the ERP implementation in SMEs (Shang and Seddon, 2004).

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Identifying Reasons for ERP System Customization in SMEs: A Multiple Case Study

Abstract

Purpose - The purpose of this article is to investigate possible reasons for ERP system customization in small and medium-sized enterprises (SMEs), with a particular focus on distinguishing influential factors of the SME context.

Design/methodology/approach - An exploratory qualitative research approach was employed, as the study aims to identify new insights within the SME context. A multiple case study of four SMEs was conducted. Data were collected through 34 qualitative interviews with multiple informants across the four cases.

Findings – The study reports findings from four SMEs where ERP customization has been applied to match organizational needs. First, the level and type of ERP system customization applied by the case organizations were investigated. Then, the reasons for ERP system customization were explored. The analysis identified seven possible reasons leading to ERP system customization, classified according to two phases of the ERP life-cycle (prior to “going-live”, after “going-live”). Reasons specific to the SME context include unique business processes, ownership type, and organizational stage of growth.

Research limitations/implications - The study is based on four cases only. Further research is needed to investigate the applicability of our findings in different contexts.

Practical implications - The study findings are believed to be valuable for organizations about to implement an ERP system as well as for ERP vendors. By identifying the reasons leading to ERP system customization and investigating the effect of the SME context, the study contributes to better understanding of ERP system implementation in SMEs.

Originality/value – The article contributes to the scarce literature on reasons for ERP system customization in SMEs. By classifying the reasons into two phases of the ERP life-cycle, the study also contributes by exploring ERP system customization practice in different phases of the ERP life-cycle.

Keywords: Enterprise Resource Planning, ERP implementation, Customization, SME.

Article Classification: Case study

1 INTRODUCTION

Enterprise Resource Planning (ERP) systems can be characterized as packaged software developed to meet general needs of organizations (Luo and Strong, 2004). Embedding standard business processes based on "best practice", ERP systems in many cases will not meet the unique needs of a particular organization. Thus, finding the right fit between ERP systems and the business processes of the target organization is critical for successful ERP implementation (Hong and Kim, 2002). In the case of a misfit between the ERP system and the organization's established practices, the organization can respond by two approaches: ERP system customization or organizational adaptation (Buonanno et al., 2005; Kholeif et al., 2007). An important decision is then the scale of ERP system customization and/or business process change that should be applied.

The ERP literature includes a number of studies exploring the issue of ERP system customization. Many studies advocate that ERP systems should be implemented with minimal customization (Somers and Nelson, 2001; Upadhyay et al., 2011), as ERP customization is problematic and may increase costs and limit maintainability (Kholeif et al., 2007). Despite this, a number of studies have documented how ERP system customization may occur (Light, 2005; Pollock et al., 2003; Rothenberger and Srite, 2009). Reasons identified for this include resistance to change (Rothenberger and Srite, 2009), functional misfit (Brehm et al., 2001; Light, 2005), and cultural differences (Soh et al., 2000; Amida et al., 2012).

In recent years, with the market for large enterprises mostly saturated (Morabito et al., 2005), ERP vendors have begun to target the small and medium-sized enterprises (SME) market, and many midrange and less complex ERP systems have been developed (Koh and Simpson, 2007). However, despite existence of pre-configured low cost solutions designed especially for SMEs, ERP system implementation remains a challenge for many SMEs (Malhotra and Temponi, 2010; Olson and Staley, 2011). Research on ERP system implementation in SMEs indicates that system flexibility is important for these organizations (Bernroider and Koch, 2001; van Everdingen et al., 2000), and that SMEs may rather choose to adapt ERP systems to the business processes (Quiescenti et al., 2006). Recent studies report cases of ERP customization in SMEs (e.g., Poba-Nzaou and Raymond, 2011; Snider et al.,

2009). Despite the importance of ERP customization being recognized by former studies, there has been little research exploring this issue further. Several questions remain unanswered, with a core question being: why do SMEs seem to favour ERP system customization?

SMEs are considered fundamentally different from large enterprises on several aspects and studies on ERP implementations also argue that findings from large companies cannot be applied to SMEs (Buonanno et al., 2005; Laukkanen et al., 2007; Mabert et al., 2003). Examples of distinguishing characteristics of SMEs include ownership type, structure, culture, and market orientation (Ghobadian and Gallear, 1997; Wong and Aspinwall, 2004). With regard to the issue of IT/IS adoption, SMEs have been found to be constrained by limited resources, limited IS knowledge, and lack of IT expertise (Levy and Powell, 2000; Thong, 2001). It is important to recognize these distinguishing characteristics and consider how they may influence the ERP implementation issues faced by SMEs (Gable and Stewart, 1999). We thus presume that the specific characteristics of SMEs may also influence on the reasons for ERP system customization.

The purpose of this article is to investigate reasons for ERP system customization in SMEs. The article reports findings from a multiple case study of four SMEs where ERP system customization has been applied to adapt the system to the organization's business processes. We focus explicitly on how ERP system customization has been influenced by contextual issues of the SMEs. Thus, the study is driven by two research questions: *(1) What are possible reasons for ERP system customization in SMEs? (2) How does the SME context affect ERP system customization?*

The next section briefly reviews relevant literature on ERP system customization, with particular focus on SMEs. Section 3 describes the research methodology applied in this study. Section 4 presents the case companies and findings from the cross-case analysis. Section 5 discusses the findings in light of former research and demonstrates the contribution of the paper. Section 6 presents conclusions and implications of the study.

2 RELATED RESEARCH

2.1 The concept of ERP system customization

The primary goal of ERP system customization is to achieve a fit between an ERP system and the business processes of the organization (Luo and Strong, 2004), to fill the potential gap between ERP functionality and organizational requirements. Different conceptualizations of ERP system customization in former research include related terms such as tailoring (Brehm et al. 2001), modification (Rothenberger and Srite, 2009) and functional alignment (Hong and Kim, 2002) of the system. For example, based on a review of the ERP literature, and complemented by fieldwork and interviews with ERP vendors and consultants, Brehm et al. (2001) developed a framework of ERP tailoring options. The framework distinguishes between 9 different types of ERP package tailoring, ranging from "light" configuration up to "heavy" package code modification. When implementing an ERP system, an organization can choose to modify an ERP system by using almost any combination of the tailoring types (Brehm et al., 2001). The framework was further modified by Rothenberger et al. (2009) who grouped ERP modification options into three areas: configuration/selection, bolt-ons and system change. By selecting appropriate system components and setting parameters, an organization may configure a system to its needs. Since this may not accommodate all existing business needs, an organization may implement bolt-ons (or third-party packages) that supplement the ERP functionality, or build custom features on top of the ERP platform. Lastly, the ERP system code may be modified to fit the business needs (Rothenberger et al., 2009). We do not distinguish further between these forms of customization in this section. However, in the empirical part of this paper (section 4) we will further define the view on customization guiding our study.

2.2 Reasons for ERP system customization

Minimal ERP customization has been reported as one critical success factor for ERP implementation (Nah et al., 2001; Somers and Nelson, 2001; Upadhyay et al., 2011), and some studies have documented how ERP projects applying customization have failed (Hawari and Heeks, 2010; Kholeif et al., 2007). On the other hand, several studies have reported how ERP system customization has been applied by organizations (e.g., Light, 2001; Pollock et al., 2003; Rothenberger and Srite, 2009;

Soh et al., 2000), also documenting positive results from this (Chou and Chang, 2008; Hong and Kim, 2002).

A frequently mentioned reason for ERP system customization is a functional misfit between the standard ERP system functionality and existing business processes (Brehm et al., 2001; Light, 2005). The study by Light (2005) discussed further potential reasons for ERP package customization. Besides functional misfit, several reasons for ERP system customization rooted in the influence of diverse social groups were identified. For example, ERP system customization may be performed because of a consultant's lack of knowledge about a product or its context, insufficient development work from the vendor, or as an act of safeguarding a work position by internal information systems personnel (Light, 2005).

Based on a multiple case study of eight organizations, Rothenberger and Srite (2009) studied how a high level of customization occurs. The study investigated interrelations between various factors leading to ERP system customization. The results indicate that high customization may occur due to resistance to change based on low ERP project acceptance, organizational culture, or fear of personal disadvantage from change. Further, unnecessary redevelopment of functionality available in the standard version of ERP system may also lead to system customization. This is argued to be related to the experience of the implementation team and the ERP knowledge available at the beginning of the project. Also, insufficient weight given to the implementation team's recommendations and the implementation team's lack of opposition to customization requests may affect the level of ERP system customization applied. Both the aforementioned studies (Light, 2005; Rothenberger and Srite, 2009) are based on cases of large enterprises.

2.3 ERP system customization in SMEs

Research on ERP system implementation in SMEs has indicated that ERP system customization might be adequate for these organizations, with system flexibility and adaptability being among the most important ERP selection criteria in SMEs (Bernroider and Koch, 2000; van Everdingen et al., 2000). Several studies also report cases of ERP customization in SMEs (Poba-Nzaou and Raymond, 2011; Quiescenti et al., 2006; Snider et al., 2009). For example, exploring how vendor activities can

improve ERP implementation success in the context of Chinese SMEs, Liang and Xue (2004) suggested that ERP systems should be customizable at a variety of levels with minimal need for business process reengineering. Olsen and Sætre (2007a; 2007b) went even further and proposed that in-house development of ERP is the best alternative for many SMEs. In a similar vein, Olson and Staley (2012) reported that open-source software ERP is suitable for SMEs, as it provides the needed flexibility through modifying the open software code.

For SMEs, unique business processes may often provide their competitive strength, and changing or removing these could then threaten the very existence of the companies (Quiescenti et al., 2006). Thus, former research on ERP in SMEs indicates a need to adapt to the existing business processes for strategic concerns (Bernroider and Koch, 2001; Snider et al., 2009). However, there is still scarce research on ERP system customization in SMEs. Particularly, the reasons for ERP system customization within the context of SMEs have received very limited attention. The purpose of this study is thus to contribute to fill this knowledge gap. Through investigation of new insight on ERP customization in the SME context, the study attempts to identify the reasons for ERP system customization, as well to explore the influences of the SME context on this endeavor.

3 RESEARCH METHODOLOGY

Since the aim of this study is to identify new insights on ERP customization in the SME context, an exploratory qualitative research approach employing a multiple case study design was applied. Case studies allow collection of rich data and are appropriate to study a contemporary phenomenon within its natural setting (Yin, 2009). Moreover, an exploratory approach prevents limiting the research to only confirming previously identified findings (Rothenberger and Srite, 2009). Case studies have also been widely used in ERP research (Schlichter and Kraemmergaard, 2010). The main reason for choosing a multiple case study was to enable a cross-case comparison of the reasons for ERP. A multiple case study approach has been applied in a number of recent ERP studies (e.g., Poba-Nzaou and Raymond, 2011; Snider et al., 2009). For example, Rothenberger et al. (2009) investigated customization in ERP system implementation based on a multiple case study of eight organizatons. Our study falls into this research stream of employing a multiple case study research method.

Four SMEs were studied. This number is believed to provide sufficient empirical grounding for generating theory (Eisenhardt, 1989). The case selection was based on a mixture of opportunistic, stratified purposeful, snowball, and theory based sampling strategies (Miles and Huberman, 1994). All case organizations are operating within the private sector in the Czech Republic. In addition, the variety between the cases was desired, with particular emphasis on business type. To ensure anonymity the organizations are labeled as CompA, CompB, CompC, and CompD. Table 1 provides an overview of the studied cases.

[Table 1 here]

The data were collected through personal interviews, with a total of 34 interviews conducted across the four organizations. The main data collection took place in the period from February to October 2010. To collect different perspectives in the ERP system implementation, the interviews were conducted with multiple stakeholders representing different positions in each organization (ref. Table 1). The emphasis was to collect data from informants involved in the ERP implementation projects, while also end users were included in the interviews. Furthermore, vendors or consultants involved in the ERP implementation were also interviewed. This approach enabled to collect viewpoints from various roles within the ERP implementation projects and thus improve validity of the findings.

The interviews were semi-structured, following the guidelines by Myers and Newman (2007). Apart from two telephone interviews with the vendors in CompA and CompD, all interviews were conducted face-to-face at the companies' locations. The interviews lasted from 20 to 100 minutes, with an average of one hour. As this study is part of a larger research project investigating ERP systems implementation in SMEs, the questions covered various issues of ERP system implementation through the entire ERP life-cycle, including issues such as ERP implementation motivation, selection process, implementation team activities, critical success factors, user training, ERP system usage, ERP outcomes, maintenance, etc. A recurring topic in the interviews was the need for ERP system customization as a way of reaching fit between the ERP system and organizational business processes.

The interviews were supplemented by documents provided by the organizations, company presentations, company web pages, and web pages of the vendors. E-mails and telephone communication were also used for clarification of some issues. With regard to the issue of ERP system customization, a follow-up e-mail was sent to one representative per case, considered to be the most competent informant for the customization topic (project leader in CompA, consultant in CompB, certified agent in CompC, and vendor in CompD). The purpose was mainly to provide additional information about the applied level of ERP system customization and its reasons.

All interviews were recorded and the parts covering issues related to ERP system customization were transcribed in full and coded using NVivo 9 software. The data analysis concentrated on identifying reasons for ERP system customization emerging from the interview data. First, within-case analysis was conducted in order to well understand the individual cases (Eisenhardt, 1989). This provided a preliminary list of reasons contributing to ERP system customization in each case. Then, a cross-case analysis was conducted, looking for similarities and differences between the cases. The reasons identified in former literature were used as underlying constructs during the analysis. Figure 1 illustrates the research design.

[Figure 1 here]

4 ANALYSIS AND FINDINGS

The data collection provided rich information about the ERP system implementation projects in the case organizations. First, we provide the results from the cross-case comparison of ERP system customization in the four companies. Second, we present the identified reasons for ERP system customization.

4.1 Cross-case comparison

Table 2 lists key characteristics of the ERP implementation projects in the four cases. The selection of these characteristics is grounded in the literature on ERP implementation. The characteristics have

been identified by previous studies as factors affecting ERP implementation, with potential implications for ERP system customization.

[Table 2 here]

The time perspective plays an important role in ERP implementation, as different phases of the ERP life-cycle are characterized by different activities, key players, and problems typical for particular phase (Markus and Tanis, 2000). The case companies represent different phases in the ERP-life cycle, varying from 11 months (CompA) up to 5,5 years (CompD) of experience with the ERP system at the time of data collection. According to the life-cycle stages modelled by Esteves and Pastor (1999), three of the companies (CompA, CompB, and CompC) were in the "use and maintenance" phase, while CompD was in the "evolution" phase, as they extended the ERP system with a Business Intelligence module in 2010.

A functional misfit between an ERP system and existing business process has been reported as a common reason for ERP system customization (e.g., Brehm et al., 2001; Light, 2005). Therefore, the type of ERP system and the scope of modules implemented are important characteristics of the implementation project. All four companies selected domestic ERP systems, and the following three modules were implemented in all projects: finance (including accounting), commerce (purchase and sale), and logistics (warehouse). Apart from this, different module selections were implemented in the four companies. While particular modules differ between these ERP systems, they provide similar functionality. In all four companies the selection of the ERP system was carried out by an appointed selection team. Naturally, the companies' owners were involved in the final decision phase. Besides the financial and functional requirements, openness of the system for modifications according to the companies' needs was one of the main selection criteria in all the cases.

Compatibility of the ERP system with legacy IT solutions and work practices has been identified as crucial to ERP system adoption in SMEs (Chang and Hung, 2010). The status of legacy information systems may also influence on the motivation for ERP system implementation (Rothenberger and

Srite, 2009). The companies' legacy systems replaced by the ERP system varied in terms of areas covered. All the case companies were using DOS-based information systems that were not integrated. In addition, several Excel sheets and other software tools were used.

The role of the implementation partner and implementation team is essential in the ERP system implementation projects. Lack of experience of the implementation team, as well as a consultant's lack of knowledge about a product or its context, may lead to unnecessary system customization (Light, 2005; Rothenberger and Srite, 2009). Two of the organizations selected a local IT company operating as a certified agent of the ERP vendors. CompD selected a vendor whose headquarters is located in the company's region. CompB did not select a local vendor, but they used a local consultant as a member of the implementation team. Selection of the implementation partner was influenced by their willingness for ERP system customization changes, and their accessibility in the companies' region. The size of the implementation teams varied from 4 to 10 internal employees.

Further, our cross-case analysis focuses on two forms of customization, building on the work of Brehm et al. (2001) and Rothenberger and Srite (2009). First, businesses may employ programming of additional applications on top of the ERP platforms (*add-ons*), without changing the ERP source code. This can be done by using the ERP system programming language or standard programming languages. Second, companies can *change the ERP source code* to fit organizational needs. This requires a substantial development effort using the ERP system programming language or standard programming languages. Some authors also consider module selection as a part of ERP customization (e.g., Liang and Xue, 2004; Luo and Strong, 2004). However, in line with former studies (Light, 2001; Rothenberger and Srite, 2009), we do not consider configuration as part of customization, as configuration does not imply significant changes of the ERP system.

We distinguish further between three *levels of usage* (not used, low, and high) to indicate the scope of the customization (Brehm et al., 2001). Finally, to be able to focus on ERP system customization practice in different phases of the project, we distinguish between two phases of the ERP system life-cycle: prior to "going-live" and after "going-live". Table 3 presents the results of our cross-case

comparison, applying the two ERP system customization types, level of usage, and the two life-cycle phases.

[Table 3 here]

As can be observed from Table 3, all four organizations have applied some form of ERP system customization. Usually the companies employed a higher level of programming of add-ons, while ERP source code modification was applied to a comparatively lower level. Yet, any source code modification imposes significant changes to the ERP systems. CompD applied a higher level of ERP source code modification than programming of add-ons. This was explained by the characteristics of the ERP system in this case, as any change of the system requires modifications of the source code. The findings also indicate that ERP system customization did not end by the ERP system "going-live", but was further employed during the usage and maintenance phase. Surprisingly, CompC and CompD applied even higher levels of both customization types after "going-live." In the following section we elaborate on the reasons behind applying the high level of ERP system customization in the case organizations.

4.2 Reasons for ERP system customization

The identified reasons for ERP system customization are presented according to the two phases of the ERP life-cycle, i.e. prior to "going-live" and after "going-live". However, it should be noted that the issues are often interrelated.

4.2.1 Reasons for ERP system customization prior to "going-live"

Resistance to change. In all four cases, openness of the ERP system for modifications was one of the key selection criteria. All of the companies had decided that they did not want to adapt their processes to the ERP system, but wanted the system to adapt according to the organizational needs. The project leader assistant from CompB stated, "*We did not want to modify the company procedures according to the system.*" All the organizations were characterized by a high resistance to change. For example,

the vendor from CompC reported, *"I think it is very strict here, there was zero tolerance and willingness for any kind of adaptation to anything. Thus, it was clear that the system had to be able to adapt to everything they required."* Resistance to change could thus be identified as an overall reason for ERP system customization in the companies studied. However, to provide more explanatory power we need to dig deeper into the possible reasons behind ERP system customization.

Unique business processes. The main reason for ERP system customization emerging from the interviews was that the companies wanted to keep their existing business processes because these were perceived as unique for their operations. In fact, keeping the idiosyncratic processes was reported as critical for the further functioning of the business: *"we knew that our processes are not standard and the system had to be customized a lot to suit our processes."[…]"It was one of our initial requirements during the selection process that we did not want a software or vendor which would press us into their standardized solution. That would ruin us."* (Project leader, CompA). A very similar situation was observed in the other cases, where the organizations wanted to keep their idiosyncratic processes which were perceived to be working well. The business processes have evolved over time and closely reflect the structure of the companies. For example, in the case of CompA the specific organizational structure was mentioned as one of the reasons for ERP system customization. The company consists of several production divisions which differ in terms of the manufactured product as well as the employed technologies.

Functional misfit. The unique business characteristics caused a functional misfit between the ERP systems and established business processes which in turn required ERP system customization. As an example, the functional misfit was observed regarding the pricing policies in all case companies. In CompC and CompD the pricing mechanisms of warehouse items embedded in the ERP systems did not correspond to calculations required by the companies. In CompC there was a need for customized calculation of average stock price, while in CompD the need for customization was related to the pricing of unfinished products. Furthermore, both CompA and CompB produce according to a Make-To-Order (MTO) production strategy, which affects their pricing policy. They do not work with

"standard" pricing lists, instead they operate by offer-demand tenders. However, this functionality was not available in the standard ERP system solutions.

Ownership type. Another identified reason for ERP system customization in the case organizations is the ownership type. Typically for SMEs, all four case companies are privately owned businesses, where the main owner is also the CEO (in CompC there are two CEOs). The owner-managers have a substantial power and are able to enforce their opinions and decisions. As one of the interviewees characterized CompD, *"it is a company of more or less one man."* Naturally, the CEOs significantly influenced the ERP system requirements and their selection. The need for ERP system customization originated from their initial decision that they did not want the organization to change. This has been decided from the very beginning of the projects and was very difficult to alternate. An illustrative example can be a decision of data transfer in CompB. The CEO required that all data from the legacy system needed to be transferred to the ERP system. As the consultant reported, this decision was difficult to negotiate and its solution was very complicated.

Motivation for the ERP implementation. In all four cases the projects were mainly technically motivated. The main reason for implementing an ERP system was to replace the unsatisfactory legacy systems. The lack of strategic motivation observed in the case organizations might influence the level of ERP system customization, as better strategic planning might potentially increase utilization of ERP system functionality in its standard version.

4.2.2 Reasons for ERP system customization after "going-live"

In this section we elaborate on the identified reasons leading the case organizations to continue with ERP system customization also after "going-live."

Stage of growth. The business in all the case organizations can be characterized as dynamic, agile, and growing, with a resulting need for further flexibility in the business processes. This is also closely related to the age of the companies. All of them are quite young organizations with only 9 to 19 years of existence, and compared to more mature and larger enterprises their business processes are more dynamic. This characteristic is likely to influence their requirements for ERP system customization. All four companies applied substantial customization also in the further stages of the ERP

implementation. We argue that this is related to the nature of their business activities. As agile organizations which are continuously growing they experience many changes over time, and the ERP systems need to be modified to accommodate these changes.

However, this does not imply changing the core business processes discussed in the previous section. Rather, it denotes adding new ERP functionality as the companies grow and develop new business processes. For example, in CompA a new production division of optoelectronic components started three months after the ERP system "going-live", which required substantial modifications of the ERP system and development of a new module for production rendering. The effect of organizational growth was also mentioned by the vendor in CompC: *"The company has such dynamics that we still implement further."* The growth of the company causes new requirements which have radical influence on the behavior of the system. The scope of the system in terms of user licenses has increased almost ten times during three years, since the ERP system implementation in 2007. Thereby, we postulate that the stage of growth of the case SMEs affected the level of ERP system customization applied after "going-live".

Maturity of ERP systems. The maturity level of the ERP systems is another potential reason for applying a high level of ERP system customization after "going-live." All the selected systems can be considered less sophisticated compared to the more established and comprehensive ERP systems such as SAP. The interviews indicated that some modules were not offered at the time of implementation and they were further developed after the implementation projects. Some modules were immature as they did not offer the required functionality, and had to be further developed based on the company's requirements. This was especially the case in CompD. The organization collaborated intensively with the vendor on further development of the system also after the implementation project and even became a testing partner of the ERP system. To conclude, we argue that the maturity level of the selected ERP systems required a high level of customization.

5 RESEARCH SYNTHESIS

The previous section presented reasons for ERP system customization identified in the four case SMEs. In this section, we discuss the findings in relation to literature and elaborate on the question of

how the SME context affected ERP system customization. As reported in the following, while some of the findings corroborate results from former research in large companies, we also identified new reasons for ERP system customization in the SME context.

The unique business processes were reported as critical for the further functioning of the business in the case companies, considered typical for SMEs which usually gain their competitive advantage by excellence within some niche market. This was thus identified as one of the main reasons for ERP system customization, in corroboration with former studies (Bernroider and Koch, 2001; Quiescenti et al., 2006; Snider et al., 2009; Vilpola and Kouri, 2005). This is closely related to the finding of functional misfit identified as another reason for ERP system customization. As ERP systems are generic products, it might be preferred to apply ERP system customization in order to differentiate from the mainstream (Holland et al., 1999; Light, 2005). Thus, the resistance to change observed in the case companies might also be related to fear of losing a competitive advantage.

In all four cases the main owner was also the CEO with a substantial power. This is typical for small companies where the owners are often managers who oversee all aspects of the business operations (Wong and Aspinwall, 2004). This implies that if the owners decide that they do not want to change their organizations because of the ERP system implementation, their decision is difficult to negotiate. Thereby, the ownership type can significantly affect the level of ERP system customization.

The primarily technical motivation for ERP system implementation in the case companies was found to be a driver for customization. This is in line with former studies reporting that a lack of strategic motivation resulted in a reluctance to business process change and a high level of ERP system modifications (Robey et al., 2002; Rothenberger and Srite, 2009). Companies which are able to recognize the business benefits of an ERP system are more likely to be willing to adopt the standard processes of the system (Rothenberger and Srite, 2009). While this finding has also been reported in studies of large enterprises, we argue that this lack of strategic motivation is more frequent in SMEs.

In line with the general shortage of IT competence in SMEs (Fink, 1998; Levy and Powell, 2000), it could be expected that lack of knowledge or experience with ERP systems could be a potential reason for ERP system customization in the case organizations. However, the implementation teams were

reported by their implementation partners as knowledgeable and as giving careful attention to the implementation projects. Thus, lack of ERP knowledge or limited experience was not identified as a direct reason for customization. However, it could be argued that the lack of strategic focus in the implementation projects also partly resulted from a limited knowledge about the potential of the system, and thus indirectly influenced the level of customization applied.

Limited attention has been given to the importance of the growth stages among studies on ERP implementation, as most of the former ERP studies were conducted based on cases of well established large enterprises typically being in a mature (stable) stage (Chen, 2009; Liang and Xue, 2004). Our findings showed that the growth aspect of the case companies influenced ERP system customization. The businesses in the case organizations were characterized as continuously growing, undergoing many changes in their business processes over time. These changes needed to be captured by the ERP system and caused a need for the system's customization after "going-live". Thus, the often immature stage of SME businesses might influence requirements for ERP system customization.

The maturity level of the ERP system itself is identified as another issue affecting customization. All four case companies selected domestic ERP systems offering less sophisticated ERP systems compared to "standard" ERP systems such as SAP. As the selected systems did not offer all required functionality at the time of implementation, it provided a requirement for their further customization according to organizational needs after "going-live". Thus, while the selected ERP systems did not offer all the functionality needed, they allowed for required modifications. The case SMEs thus preferred to have a customizable system with limited functionality that could be further developed, rather than a mature ERP system which did not fit their business processes. It could be argued that the more limited functionality of the ERP systems implemented in the case organizations represent a limitation of the relevance of our findings. However, previous studies have also reported that SMEs prefer smaller ERP systems provided by local vendors (Federici, 2009; Yeh et al., 2006). Due to their ability to meet special requirements and support the flexibility and dynamics of SMEs, local vendors are considered better capable of supporting SMEs (Yeh et al., 2006). Furthermore, local ERP vendors have greater ability to accommodate contextual factors such as history, culture, social value, and

management style of SMEs (Liang and Xue, 2004). In light of this we believe that our findings can be generalized also to ERP implementations in other SMEs.

6 CONCLUSION

The aim of this study was to identify reasons for ERP system customization in SMEs. Based on the cross-case analysis of four SMEs, seven reasons for ERP system customization were identified. By identifying the reasons for ERP system customization and exploring the effect of the SME context, the study contributes to better understanding of ERP system implementation in SMEs. The findings corroborate former research on ERP implementation in large companies, while also identifying new reasons for ERP system customization specific for the SME context.

The study provides several implications for further research on the issue of ERP system customization in SMEs, by demonstrating the potential effect of the SME context.

- In addition to unique business processes in SMEs discussed in former studies, ownership type and stage of growth of the SMEs were identified as reasons for customization which have not been covered in extant research.
- By classifying the reasons into two phases of the ERP life-cycle, prior to “going-live” and after “going-live”, the study also contributes by providing evidence of how a high level of ERP system customization is applied also in the later phase. This is assumed to be related to the growth stage of the SMEs and characteristics of the selected ERP systems.
- Further research is needed to investigate the applicability of our findings for other types of SMEs. All four case companies in this study were characterized as continuously growing and dynamic organizations, undergoing many changes in their business processes over time. This setting might be in contrast to more mature and stable SMEs without a need for further expansion, working with established business processes. The market area, industry, and size of the SME can also be expected to influence on the practice related to ERP customization. Moreover, since all the case companies are from one country, the relevance of the findings for other counties needs be investigated.

- The findings may also form the basis for further studies of the reasons for ERP system customization, based on both qualitative and quantitative research. The study presented in this article demonstrates how in-depth qualitative case studies are suitable for identifying underlying reasons for system customization.

The study documents that ERP system customization may be a preferred option for SMEs under particular circumstances. This is a relevant finding for organizations about to implement an ERP system and for ERP vendors in particular, showing a need to better understand the reasons for ERP system customization.

Adequate internal IS knowledge and support from a local implementation partner were identified as important success factors for ERP system customization in the cases studied. However, selection of ERP systems from local vendors offering less functionality compared to more expensive solutions, may also result in a need for further customization after "going-live" that incurs increased costs for system maintenance and further development. Thus, it could be argued that the SMEs should rather consider investing in a more complete system to avoid the need for extensive further development. Yet, for SMEs in an early stage of growth that experience many changes over time, ERP system customization after "going-live" may appear to be unavoidable and thus needs to be taken into consideration when planning the ERP system implementation.

In particular, the vendors need to consider the SME context while implementing an ERP system in such organizations. Besides their unique business processes, the study showed that the SMEs' owner-managers significantly influence the level of ERP system customization. Therefore, vendors should assure that the owner-managers are fully engaged in the ERP implementation projects. Furthermore, they need to take into account the level of organizational stage of growth, as it significantly influences on further system development after "going-live".

For SME managers, the findings can be useful for increasing their understanding of the concerns related to ERP system implementation. Better strategic planning of IS in SMEs may increase utilization of ERP system functionality in its standard version, and thus reduce the level of ERP system customization required. Therefore, selection of an ERP system should not be based only on

conceptualizations inherited from the legacy systems. SMEs also need to consider the effect of ERP system maturity on the system customization and its further development in particular. All these aspects might lead to lower resistance to change and enable SMEs to better recognize the potential of ERP systems.

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Table 1. Overview of case companies and informants

	CompA	**CompB**	**CompC**	**CompD**
Industry	Fiber optic components	Electronic components	Cosmetics	Agriculture machinery
Business type	Manufacturer	Distributor/ Manufacturer	E-shop	Manufacturer
# of employees	220	100	50	200
# of interviews	14	7	4	9
Participants	Project leader (production manager), project leader assistant, CEO, financial/technology managers, IT/IS administrators, key users, end user, vendor's CEO.	Project leader assistant, financial/technology/ sales managers, IT/IS administrator, end user, consultant.	Sales manager (responsible for the IS), wholesale manager, end user, vendor.	Project leader (purchasing manager), IT/IS administrator, economic/warehouse/ technology/ production managers, payroll clerk, end user, vendor.

Table 2. ERP implementation project characteristics

	CompA	**CompB**	**CompC**	**CompD**
Time of "going-live"	April 2009	October 2006	August 2007	January 2005
Experience since "going-live"	11 months	3,5 years	3 years	5,5 years
ERP system	Helios Green	ABRA G4	ABRA G3	ALTEC Aplikace
Implemented modules	Finance, Commerce, Logistics, Production Control	Finance, Commerce, Logistics, Production Control, Asset Management, Human Resources	Finance, Commerce, Logistics, Asset Management, Human Resources, CRM (limited)	Finance, Commerce, Logistics, Production Control, Asset Management, Human Resources, Material Requirements Planning, Production Planning, Business Intelligence (extension in 2010)
Legacy information systems	4 separate DOS-based systems (accounting, production control, payroll system, attendance system)	2 separate DOS-based systems (accounting, production control)	DOS-based accounting system	2 separate DOS-based systems (accounting, production control)
Implementation partner	Certified agent	Vendor	Certified agent	Vendor
Implementation team	10 internal employees	4 internal employees + consultant	2 internal employees	6 internal employees

Table 3. Cross-case comparison of ERP system customization

Cases	Level of usage prior to "going-live"			Level of usage after "going-live"			ERP system customization type
	Not used	Low	High	Not used	Low	High	
CompA			x			x	Programming of add-ons
		x			x		ERP source code modification
CompB			x		x		Programming of add-ons
		x		x			ERP source code modification
CompC		x				x	Programming of add-ons
	x				x		ERP source code modification
CompD	x				x		Programming of add-ons
		x				x	ERP source code modification

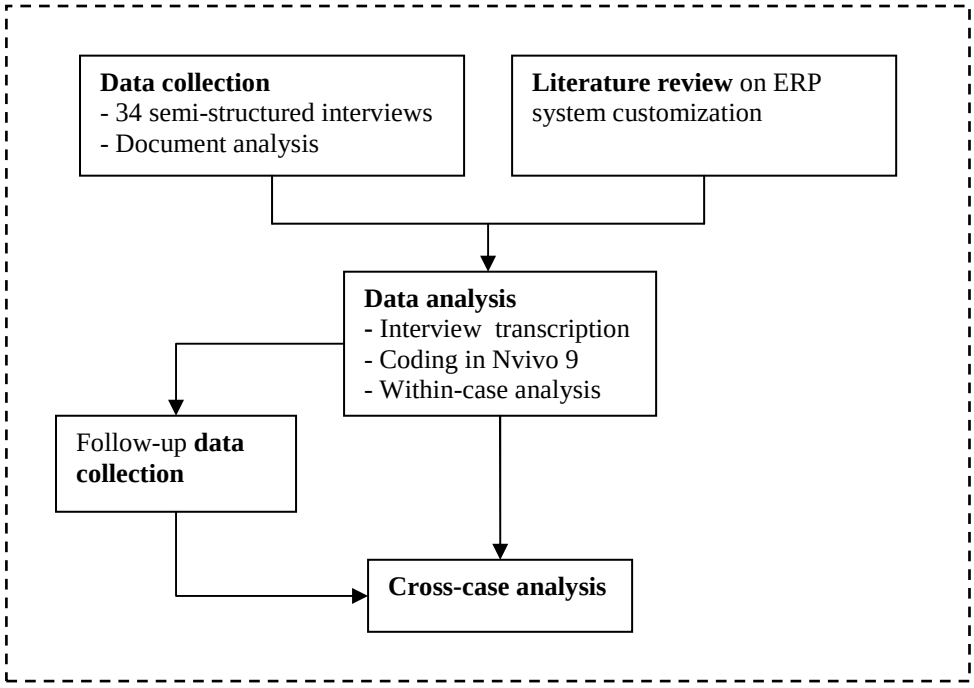

Figure 1. Research design.

ERP system implementation in SMEs: Exploring the influences of the SME context

Small and medium-sized enterprises (SMEs) are increasingly implementing Enterprise Resource Planning (ERP) systems. Compared to large enterprises, SMEs differ in a number of inherent characteristics, which are likely to impact the ERP system implementations in these organizations. The purpose of this study is to explore these influences of the SME context on the ERP system implementation process. First, a list of SME characteristics is synthesized from relevant literature. Then, the influences of the contextual factors on various activities across the ERP life-cycle are investigated. The study presents findings from a multiple case study of four SMEs. Based on the results, the ownership type of the companies and limited resources were identified as the most influential contextual factors. Among the ERP life-cycle phases, the implementation phase was affected most by the SME context. The case studies also illustrate the need for a more nuanced view on what should be considered general characteristics of SMEs, e.g. regarding level of IS knowledge, business processes and market characteristics.

Keywords: enterprise resource planning system; ERP implementation; ERP life-cycle; small and medium-sized enterprise; case study

1 Introduction

Organizations worldwide have adopted Enterprise Resource Planning (ERP) systems in order to leverage business performance (Beheshti and Beheshti 2010). In recent years, with the large enterprise market being close to saturation, the ERP vendors have begun focusing on small and medium-sized enterprises (SMEs). The SME sector constitutes the backbone of the economy in European countries. In 2007 SMEs constituted 98,8 % of the almost 19 million enterprises in the 27 EU countries' non-financial business economy (Eurostat 2008). There exist various definitions of SMEs, and this study adopts the EU definition of an SME as an enterprise with fewer that 250 employees and annual turnover less than 50 million euro (European Commission 2005).

Even though the ERP system vendors have been moving their attention towards SMEs by offering simplified and cheaper solutions deemed to be suitable for these organizations, ERP system implementation remains a challenge for many SMEs (Malhotra and Temponi 2010, Olson and Staley 2012, Upadhyay *et al.* 2011). Because of various fundamental differences between large and small businesses, the findings from studies of IT/IS adoption in large enterprises are unlikely to be applicable to SMEs (DeLone 1981, Welsh and White 1981, Blili and Raymond 1993, Thong 1999). Similar, the research on ERP implementation argues that findings from large enterprises cannot be applied to SMEs since they represent a fundamentally different environment (Mabert *et al.* 2003, Buonanno *et al.* 2005). Although a number of researchers have focused on the ERP implementation process, most of the ERP literature is based on findings from large enterprises (Muscatello *et al.* 2003, Loh and Koh 2004). The research on ERP in SMEs is still limited and more research needs to be carried out in order to gather sufficient knowledge about this phenomenon (Haddara and Zach 2011).

In comparison to large enterprises, SMEs have fewer resources and experience in terms of management of new technologies (Blili and Raymond 1993). Besides, SMEs are represented by a spectrum of unique characteristics which distinguish them from large enterprises, such as ownership, structure and culture (Wong and Aspinwall 2004). These aspects of the SME context are likely to determine the way in which these organizations conduct ERP system implementation. Therefore, it is important to recognize these distinguishing characteristics and consider how these differences may influence the ERP implementation issues faced by SMEs (Gable and Stewart 1999). The extant research provides only scarce findings about the effect of the SME characteristics on ERP system implementation.

The purpose of this research is to investigate the influence of unique SME characteristics on ERP implementation, and explore how the SME context affects different

activities within the ERP life-cycle. Thus the research addresses the following research question: *How does the SME context affect ERP system implementation?* It is believed that a proper understanding of the SME context will lead to a better comprehension of ERP system implementation and thereby contribute to future successful ERP implementation projects in these organizations.

The rest of the paper is organized as follows. Section 2 summarizes existing literature on contextual influences of IT implementation in SMEs, and introduces an ERP life-cycle framework. Section 3 describes the research methodology, while section 4 provides an overview of the investigated cases. The main findings of the analysis are presented in section 5. Section 6 discusses the findings and section 7 presents the conclusions and implications.

2 Related Research

This section provides a summary of research related to the contextual influences on adoption of IT/IS in general in SMEs, as well as specific for ERP implementation. We also present a life-cycle model of ERP implementation that will guide the analysis of our empirical findings.

2.1 Research on IT in SMEs

Several studies have investigated various factors affecting IT/IS adoption in SMEs (e.g., Thong and Yap 1996, Thong 1999, Sharma 2009), such as CEO characteristics, employees' IS knowledge, information intensity, or competition. A number of barriers to IT adoption in SMEs has been identified (e.g., Cragg and Zinatelli 1995, Iacovou *et al.* 1995, Fink 1998, Levy and Powell 2000, Thong 2001), including resource constraints, limited internal IT/IS expertise, and limited IS knowledge.

Blili and Raymond (1993) focused on the threats and opportunities of SMEs during IT adoption. The authors developed a schematic summary of the unique SME characteristics

with respect to strategic information systems, classifying the SME specificity features into five areas: environmental specificity, organizational specificity, decisional specificity, psycho-sociological specificity, and information systems specificity.

In a similar vein, several studies investigated the influence of various organizational, environmental, or technological factors on ERP system adoption in SMEs (Raymond and Uwizeyemungu 2007, Seethamraju and Seethamraju 2008, Ramdani *et al.* 2009, Shiau *et al.* 2009, Chang and Hung 2010), such as business size , CEO characteristics, industry type, competitive pressure, employees' competence of IS, and availability of resources. These studies provide valuable findings about the influence of particular factors on the adoption of an ERP system. However, few studies have examined the influence of the unique SME characteristics on the studied factors.

An exception is an article by Gable and Stewart (1999), focusing on the implementation issues in SMEs adopting SAP R/3. They defined four dimensions of SME specificity (organizational, decisional, psycho-sociological, and information systems specificity) and discussed application of these in the context of ERP systems implementation. However, the paper only presents a tentative model describing interacting variables, with no empirical data. Unfortunately, no follow-up empirical study has been published.

In addition to the literature about IS and ERP in SMEs, we also reviewed more general literature exploring the influence of SME characteristics on organizational initiatives. Here, two studies exploring the SME context with relation to Total Quality Management (TQM) (Ghobadian and Gallear 1997) and Knowledge Management (KM) (Wong and Aspinwall 2004) were particularly relevant. These studies provide an excellent overview of inherent characteristics distinguishing SMEs from large enterprises.

Ghobadian and Gallear (1997) analyzed the relationship between the SME characteristics and TQM practices. The authors compiled an extensive list of issues

distinguishing SMEs from large enterprises, grouped into six areas: structure, procedures, behavior, processes, people, and contacts. The influence of these issues on TQM implementation practices was investigated through four exploratory case studies, resulting in a framework for successful implementation of TQM in SMEs.

Wong and Aspinwall (2004) looked at specific SME characteristics and their key problems and issues associated with KM. Inspired by Ghobadian and Gallear (1997), the authors propose a list of SME characteristics which can have an influence on implementation of KM. The characteristics were classified into six groups: ownership and management; structure; culture and behavior; systems, processes and procedures; human resources; customs and market. This conceptual paper concludes that recognition of these elements is crucial in order to provide a compatible KM approach for SMEs.

2.2 Summary of SME characteristics

Based on our literature review, Table 1 lists all the identified SME characteristics that could potentially influence on ERP implementation with selected key references. The identified SME characteristics are grouped into three dimensions: organizational characteristics, environmental characteristics, and IS characteristics.

[Table 1 here]

In the following we present each of the SME characteristics in more detail, based on the literature referenced in Table 1. It should be noted that some of the literature on IT/IS in SMEs is somewhat old and not specifically related to ERP systems. Thus, one of the aims for our analysis is also to investigate whether the assumptions about SME characteristics in extant research also hold for contemporary ERP system implementations in SMEs.

2.2.1 Organizational characteristics

Resources. SMEs are constrained in terms of their financial as well as human resources. They usually do not dispose of capacity to develop and manage their own IS and thus they are likely to rely on third parties such as vendors and consultants. This might lead to limited control over the information resources and thus increase the level of risk. In addition, because of the resource constraints SMEs generally invest less into employees' training, as opposed to large enterprises which have resources to develop customized training and educational programs.

The research on ERP systems shows that affordable cost and short implementation time are among the most important selection criteria in SMEs. With limited availability of resources the enterprises were less disposed to the adoption of an ERP system, and the financial constraints were identified to be the main cause of the non-adoption of ERP systems among SMEs.

Ownership, management, and decision making. The managers of SMEs are often owners who have the ultimate power of control and commonly oversee every aspect of the business. Often they are the only ones with responsibility and access to the information needed to identify opportunities for using IT for strategic or competitive purposes. The owner-managers usually do not have enough time to reflect on strategic issues, as they are busy with day to day operations and their attention is more on core business operations.

Decision-making is generally centralized with fewer layers of management and decision makers. The centralized decision-making implies that the CEO can either be the main obstruction or the main catalyst for change. Furthermore, the decision-making cycle is usually short-term. In addition, the decision process in SMEs is more intuitive and based on experience, as a limited number of formal information and decision models are employed.

Structure. Compared to large enterprises, SMEs in general have a simpler, flatter, and less complex structure. A simpler structure facilitates a change initiative across the organization. A flat structure results in a more flexible working environment and less complex communication process. Moreover, SMEs often operate on a single site. In addition, SMEs are also likely to have an organic structure. Workers in small firms often perform a variety of tasks, implying a low degree of specialization in the employees' jobs.

Culture. Culture in SMEs is often characterized as unified, with few interest groups. Employees usually have a corporate mindset emphasizing the company as a single entity. The unified culture may provide SMEs with a strong foundation for change, as employees easily understand what the company is trying to achieve. In addition, compared to large enterprises, culture in SMEs is more organic and fluid. In the same time, as a result of the strong dominance of owner-managers in SMEs, culture is easily shaped and influenced by their personality and outlook.

Processes and procedures. The operations and processes in SMEs are smaller in scale and less complicated than those in large enterprises. Moreover, the processes in SMEs are also often more flexible and adaptable to changes taking place around them. Therefore, SMEs are likely to be more adaptable to implementing new initiatives, as they are less likely to be "locked-in" to their existing processes. On the other hand, the need to react quickly in SMEs causes that most of the activities are governed by informal rules and procedures, with low degree of standardization and formalization. Rapid changes in SMEs imply that procedures become obsolete quickly.

2.2.2 Environmental characteristics

Market and customers. The market encompassed by SMEs is mostly local, while only few of them have an international range. In general SMEs are dependent on a small customer base

with more frequent and closer contacts with customers. Major SMEs' customers or suppliers, who are typically powerful in their supply chain, may force SMEs to a system compatible with their extant solution and thus influence ERP system implementations in these organizations.

Uncertainty. SMEs are typically characterized by a high level of environmental uncertainty. The uncertain and unstable environment with doubtful viability of the business influences any long term investments on information technologies. Uncertainty relating to the technological environment and the competition is likely to significantly affect IS implementation in SMEs.

2.2.3 Information Systems characteristics

IS knowledge. SMEs have been reported having limited IS knowledge, as there is usually not enough managerial expertise available to plan, organize, and direct the use of information resources. Traditionally, most CEOs in SMEs focus on management issues and pay less attention to technology. The lack of IS knowledge may lead to insufficient attention by management to IS and in turn to a lack of strategic planning of IS.

A recent study assessing the ERP adoption in SMEs concluded that lack of IS knowledge may inhibit SMEs from adopting ERP systems (Shiau *et al.* 2009). The findings showed that the more IS knowledge CEOs have, the more they incline to adopt ERP systems. Also the results by Chang and Hung (2010) indicated a positive influence of the CEO's IT knowledge as well as employees' IT knowledge on ERP system adoption.

IT technical expertise. SMEs are constrained by their limited IT internal technical expertise. Many SMEs possess insufficient level of in-house IT/IS expertise necessary for successful IS adoption. It is because of their limited internal IT/IS expertise that SMEs are more likely to purchase a package software, instead of developing a system in-house.

This argument has been supported by a recent study of ERP system adoption in SMEs (Chang and Hung 2010), which reported lack of IT professionals and a shortage of developing resources. Also Shiau *et al.* (2009) indicated that SMEs do not have the technical IT expertise to evaluate information systems. On the other hand, the studies by Olsen and Sætre (2007b, 2007a) propose in-house development of ERP systems as the best alternative for SMEs, stating that nowadays SMEs may have sufficient IT competence. Olson and Staley (2012) reported in-house development of an ERP system as an option considered by the case SME, as the company had experience in software engineering.

IS function, IS complexity. The IS function in most SMEs is typically perceived to be in its earlier stage of evolution, usually subordinated to the accounting function. However, more recent studies indicate a need for nuancing this view. A study evaluating readiness of SMEs for ERP adoption recognized that most of the studied SMEs used quite complex IS solutions (Raymond *et al.* 2006).

2.3 ERP life-cycle framework

The objective of this study is to investigate how the SME characteristics influence ERP system implementation. We apply the ERP life-cycle framework by Esteves and Pastor (1999), distinguishing six phases of the implementation process (Figure 1). Each of the phases involves several issues and activities typical for a particular phase. Based on a set of case studies, we will investigate how each of the phases has been influenced by the SME context.

[Figure 1 here]

Organizations recognize their need for a new ERP system in the adoption decision phase. This phase includes the definition of system requirements, its goals and benefits, and an analysis of the ERP system impact on a business and organizational level.

The acquisition phase consists of selection of the product that best fits the organizational requirements. A vendor is selected based on factors such as price, vendor location, maintenance services, etc. It is also important to analyze the return on investment (ROI) of the selected product in this phase.

The implementation phase in the Esteves and Pastor framework consists of activities such as ERP system customization, business process management, and user training. The actual technical installation, when an ERP system "goes-live", is also carried out during this phase. This task is usually carried out by a vendor or consulting company, and can be done via various implementation methodologies. This exemplifies how the term 'implementation' can be used both to denote the 'complete' process of the first five phases in the framework, and a limited part of this process (phase three in the framework). Unless specifically referring to the implementation phase in the Esteves and Pastor framework, we hereafter use the term to refer to the full ERP life-cycle.

After going live, the system needs to be maintained, malfunctions need to be corrected, and special optimization requests need to be met. The use and maintenance phase includes issues like system utilization, user acceptance and satisfaction, and benefits realization.

The evolution phase involves extensions of the ERP system through integration of additional applications (e.g., CRM, Business Intelligence, etc.). Finally, the retirement phase is defined as the stage when an ERP system is substituted by a new ERP system or other IS approach.

3 Research methodology

As the purpose of this study is to identify new insights within the SME context, an exploratory qualitative research approach employing a multiple case study design is applied. Case studies allow collection of rich data and are appropriate to study a contemporary phenomenon within its natural setting (Yin 2009).

In total, four organizations were studied. All of them are SMEs operating in the private sector in the Czech Republic. The Czech economy has undergone significant changes over the last two decades. Being a former Eastern Bloc country, the economy went through the transition from a centrally planned economic system to a market driven system (Roztocki and Weistroffer, 2008). Due to substantial economic success and participation in global institutions such as the EU, several former communist European countries including the Czech Republic have been proclaimed to have completed the transition (Roztocki and Weistroffer, 2011). As a member of the EU since 2004, and according to the International Monetary Fund (IMF, 2011) and World Bank (World Bank, 2011), the Czech Republic is now classified as a developed country. Therefore, findings from our current study of Czech companies are regarded to be relevant for other developed European countries.

To maximize the variety between the cases, the organizations differ in terms of organizational characteristics (e.g., size, business type, industry) as well as ERP project characteristics (e.g., brand of ERP system, number of implemented modules). The case selection was based on a mixture of opportunistic, stratified purposeful, snowball, and theory based sampling strategies (Miles and Huberman 1994). Access to the first case organization played an important role. This was a manufacturing company, and the findings from the first case showed how the production strategy can be a significant factor affecting ERP implementation. To enable comparison between the cases, the selection of the three subsequent cases followed the stratified purposeful sampling strategy. As the second case was

selected another manufacturing company, while the third case was a non-manufacturing organization. And in contrast to the first company operating under the make-to-order production strategy, as the fourth case we selected a manufacturing organization operating under a make-to-stock production strategy. To ensure anonymity, the organizations are labeled as CompA, CompB, CompC, and CompD. More details about the cases are provided in the following chapter.

Personal interviews were used as the primary data collection technique. The interviews were conducted with multiple stakeholders involved in the ERP implementation projects. The respondents represented different positions in each organization, including top and middle management, end users, IT responsible persons, etc. Vendors or consultants involved in the ERP implementation were also interviewed. In total, 34 interviews were conducted. The data collection was carried out from February to October 2010. Apart from two telephone interviews with the vendors in CompA and CompD, all interviews were conducted face-to-face at the companies' locations (usually in meeting rooms). The interviews lasted from 20 to 100 minutes, with an average of one hour. Table 2 provides an overview of the interviews.

[Table 2 here]

The interviews were semi-structured, following the guidelines by Myers and Newman (2007). The questions covered various issues of ERP system implementation through the entire ERP life-cycle (Esteves and Pastor 1999), including issues such as ERP implementation motivation, selection process, implementation team activities, critical success factors, user training, ERP system usage, ERP outcomes, maintenance, system development, etc. In addition, e-mail and telephone communication were used for clarification of some issues. The

case material was further supplemented by documents provided by the organizations, company presentations, company web pages, and web pages of the vendors. Thus, data triangulation was assured by utilizing various data sources (interviews, documents, emails) and also by comparing data provided by different interviewees.

The interviews were recorded, transcribed in the original language (Czech), and relevant parts were translated into English. The transcribed material was analyzed through a coding process in the NVivo9 software. The data analysis concentrated on identifying influences of the SME characteristics emerging from the interview data. First, within-case analysis was conducted in order to gain a comprehensive understanding of the individual cases (Eisenhardt 1989). Then, a cross-case analysis was conducted, looking for similarities and differences between the cases. The codes represented particular SME characteristics emerging from the data. While the identified list of SME characteristics was applied, the analysis was open for identifying additional characteristics specific for SMEs. The data were further analyzed along the ERP life-cycle framework, with the identified activities being assigned to the particular phases.

4 Case overview

Table 3 lists key characteristics of the ERP implementation projects in the four cases. The case companies represent different phases in the ERP-life cycle, varying from 11 months (CompA) up to 5,5 years (CompD) of experience with the ERP system at the time of data collection. According to the life-cycle stages modelled by Esteves and Pastor (1999), three of the companies (CompA, CompB, and CompC) were in the “use and maintenance” phase, while CompD was in the “evolution” phase, as they had extended the ERP system with a Business Intelligence module in 2010.

All the implementation projects were reported as successful, but the companies' perceptions of success differed. Success was most often reported as the fact that the business activities were not interrupted by the ERP implementation. Another often cited success measure was user acceptance, as the users accepted the new systems without any major problems. Lastly, the implementation projects were also expressed to be successful in terms of meeting the allocated budget and time line. None of the companies applied more objective measures of the ERP implementation success to assess Return On Investment (ROI).

The case SMEs are continuously growing and agile organizations, experiencing many changes over time. This is also closely related to the age of the companies. All of them are quite young organizations with only 9 to 19 years of existence, and compared to more mature and larger enterprises their business processes can be characterized as more dynamic. The following section provides a brief presentation of the cases, as a basis for a more in-depth comparison of the cases in section 6.

[Table 3 here]

4.1 CompA

CompA, is a manufacturing SME engaged in production of fiber optic components. Since the startup in 1994, the company has substantially broadened the assortment of manufactured products and started offering its products and services to customers worldwide. The company operates on a single site, situated in a small city in the Czech Republic, and consists of six product divisions. The company also has a technological center providing development and design of new products and production technologies. In 2007, CompA decided to invest in a new ERP system to replace the obsolete legacy systems. The CEO appointed a team responsible for the system selection. After a thorough selection process, the ERP system

Helios Green was selected in 2008. A small local IT company operating as a certified agent of the biggest domestic ERP vendor was selected as an implementation partner. However, right after the system selection, the implementation project was discontinued by top management, due tothe market uncertainty resulting from the financial crisis in 2008. The project was restarted 4 months later, only one and half month before the planned start of the system. As a consequence the system was launched in a reduced version compared to the original implementation scope. An accounting module was implemented in the beginning of January 2009 and the full system was launched by mid-April.

CompA successfully utilized the ERP system and continues to develop it further. For example, a new production division of optoelectronic components started three months after the ERP system “going-live”. This required substantial modifications of the ERP system and development of a new module for production rendering. Interestingly, the company gained access to the system source code and develops the ERP system internally.

4.2 CompB

CompB, founded in 1991, is a distributor and manufacturer of electronic components for demanding applications in the areas of aerospace, military, transport, and telecommunications. Over the years, the company has established a credible reputation and has become a reliable partner for aerospace and military projects, mostly in the Czech Republic and Slovakia. The company operated on two sites within a small city in the Czech Republic. In October 2006, the company implemented ABRA G4. The ERP system was implemented by the vendor, while a local consultant was also involved in the project from the company’s side. The implementation project took more time than was planned because of the high level of ERP system customization required by the company. In addition, the CEO required all historical data to be transformed from the legacy system, which also complicated

the project. All modules were implemented at once, except for a financial module which was implemented one year later. The system is further developed through cooperation with the consultant and the company plans its extension towards the manufacturing area.

4.3 CompC

CompC, founded in 2001, is engaged in selling perfumes and cosmetics through the internet. The company is privately owned by two owners, who are also the company CEOs. CompC operates on a single site situated in a small city in the Czech Republic. In the end of 2006 the company decided to replace their legacy IS solution, which was restricted to the accounting function. The ERP system requirements were specific mainly in the emphasis on maximal automation of processes, possibility of extensive program modifications, and system openness for add-on extensions. In August 2007, the company implemented ABRA G3. The ERP system implementation has been carried out by a local agent.. The implementation team consisted of two internal employees, while the CEOs were also actively involved in the whole implementation process. CompC has expanded significantly in the last decade. With its fast growth, the company has widened its operation from the local level to entire Czech Republic. The growth of the company causes new requirements which have radical influence on the behavior of the system. The number of user licenses increased almost ten times during three years since 2007.

4.4 CompD

CompD produces and distributes agriculture machinery. The company operates on a single site, situated in a small city in the Czech Republic. Since being founded in 1992, the company has transformed from a small workshop to a modern company with 200 employees, attaining a leading position in its field. The legacy IS solution became insufficient as the company

expanded, and the need arose for a more sophisticated system. In January 2005, the company implemented ALTEC Aplikace, an ERP system developed by a small Czech vendor. The implementation project has been carried out by the vendor. All modules were implemented at once but with considerable further development over time, as some modules were immature and did not offer the required functionality. CompD collaborated intensively with the vendor on further development of the system and even became a testing partner of the ERP system. The ERP system was extended with a business intelligence module in 2010.

5 Analysis and Findings

This section presents the findings from our data analysis. The analysis of the cases concentrated on exploring the effects of the SME context on the ERP system implementation. The findings are presented according to the SME characteristics presented in Table 1.

5.1 Resources

Financial resources played an important role in the case implementation projects. The costs of the ERP system implementation was one of the selection criteria in all four case organizations. The companies selected inexpensive ERP systems, and in three cases (CompA, CompC, CompD) a local and inexpensive implementation partner was selected. The funding allocated was particularly limited in CompA due to the finance crisis. The project was continued only in a limited version and the costs were reduced by two thirds from the original plan. As the vendor stated: *"The scale of implemented modules was relatively small compared to the usual practice."* The limited funding also influenced user training considerably in CompA. The training was limited to the key users only. The interviewees in both CompA and CompB expressed that it would have been beneficial to repeat the training again after some

time of working with the system. However, it was difficult to find resources for repeating the training.

Limited financial resources also influenced the strategy for further system development in the case organizations. While CompC and CompD utilized the implementing partners also for further system development, CompB decided to use a local certified agent instead. The main reasons were price and proximity of the partner. *"Work of the local agent is much cheaper and I think also faster since they are local."* (Technology manager, CompB). CompA decided to develop the system internally to cut the costs of further system development. As the programmer stated: *"We try to substitute the vendor because the system development is not cheap."* (Programmer, CompA). Limited human resources negatively influenced the work of the implementation team, as all implementation team members had to deal with the ERP system implementations in addition to their regular work duties. The project leader from CompD mentioned that this was the biggest problem in the implementation work. *"If there was more time, or if there was somebody who was engaged only in this* [the implementation]*, it could have been different."* (Project leader, CompD).

Even though the ERP system implementation projects in all the four organizations were considered successful, no evaluation of the ERP outcomes has been conducted by any of the companies. This might be due to limited resources, in terms of both money and human resources. ERP outcome evaluation was not included in any of the implementation projects, and it would have required additional resources.

5.2 Ownership type, management and decision making

The owners in the case organization have substantial decision power, and significantly influenced the ERP system implementation projects. In all four cases the main owner is also the CEO (in CompC there are two CEOs). As one of the interviewees characterized CompD,

"it is a company of more or less one man." The owners were characterized as very active and overseeing many aspects of the business activities. In all four case organizations, the main motivation for implementing the ERP systems was to replace the legacy systems which had become functionally unsatisfactory. As the companies had expanded over time, the situation forced the owners to invest in the new ERP systems. Thus, the CEOs recognized the need for change. However, the perceived importance of the implementation projects varied across the cases. The implementation project was not prioritized by the CEO of CompA. In contrast, the CEOs in CompC recognized the potential for gaining competitive advantage, and put high emphasis on the implementation project.

The owners were not willing to fit their processes to the ERP system. All four companies stressed the need for customizing the ERP systems. For example, the vendor from CompC reported, *"I think it is very strict here, there was zero tolerance and willingness for any kind of adaptation to anything."* (Implementation partner's CEO, CompC). The owners posed their requirements on the system and therefore influenced the selection of the systems and implementation partners. The costs and potential for customization were the two main selection criteria invoked by the owners. Yet, the level of the owners' involvement in the selection process differed among the cases. In CompC and CompD the CEOs actively took charge in the ERP system selection. On the other hand, in CompA and CompB the CEOs were not that actively involved in the selection process, and instead they appointed selection teams responsible for the ERP system and vendor selection. In general, the interviewees reported that top management supported the implementation team effort. The support of the implementation team was also perceived in the level of responsibility left to the teams. *"The owners gave a freedom to the implementation team."* (Key user for production, CompA).

By their decisions, the CEOs also influenced the business process analysis in the case organizations. Especially in CompD, the CEO's decision to implement a new ERP system

was sudden, and he wanted it implemented as fast as possible. The time from the system selection to its implementation was short and it affected the business process analysis. *"It was so fast and sudden that there was no time for a proper analysis."* (Sales manager, CompD). The business process analysis was also constrained in CompA. Because of the top management decision to stop the project, there was only about 1,5 months left for the project completion after its restart. In CompA, the CEO preferred to do all things internally. *"He says that he pays [internal] specialists to have them here and does not need anybody external."* (Project leader, CompA). This corporate philosophy is apparent from the fact that the company has a technological center providing development and design of new products and production technologies. This approach also influenced the approach for further development of the ERP system, as the company decided to develop the ERP system internally after "going-live".

The lack of a perceived need for identifying and evaluating outcomes to justify the ERP system success can also be explained by the ownership. The CEOs were actively involved in the business operation and were in contact with the system on a daily basis. They were therefore able to perceive the effect of the ERP system and recognize ERP outcomes based on practice, and did not see the need for formal evaluations.

5.3 Structure

Organizational structure influenced the case ERP implementation projects in a number of ways. It was noted that it was easier to agree on the system requirements since the case organizations were relatively small and uncomplicated. *"We are not that big a firm, […], and since we have less people it was easier to agree upon a unified way of how the system should look."* (Key user for production, CompA). The interviewees across all case organizations reported that the cooperation of the people involved was very important. The simple structure

in the case organizations also facilitated cooperation between various departments. The companies are family owned, and everybody knows each other. Thus, the simple structures facilitated communication processes and this in turn facilitated the ERP system requirements specification.

Yet, CompA has a more complicated structure than the other companies. It consists of several production divisions which differ in terms of the manufactured product as well as the employed technologies. This specific organizational structure was reported to be one of the reasons for the ERP system customization required by the company.

Enterprise localization is another important issue. In CompA, CompC and CompD it was important that the firms are situated in one location, facilitating the technical installation of the systems. On the other hand, CompB has its production at different locations in the city. This caused some problems during the ERP system implementation due to internet connection problems between the two locations. The legacy internet connection was not sufficient for the new ERP system and had to be upgraded. This required a considerable investment in a microwave internet connection.

5.4 Culture

The data did not provide sufficient detail about organizational culture in the case SMEs. Nevertheless, there are indications of a unified culture in the case SMEs which shaped two of the issues in the ERP life-cycle, implementation team work and user acceptance. The implementation team collaboration and collective work was reported to be crucial for successful completion of the projects. The implementation team task was demanding in terms of both energy and time. *"Sometimes it was so hectic and the people were so exhausted, that I would not have been surprised if they had left the team."* (Project leader assistant, CompA). However, there was a shared feeling that the system innovation was needed, team members

perceived it as necessary and were willing to participate. An important aspect was a strong team cohesion. *"There was a common interest."* (IS administrator, CompA). The work of the implementation team members seemed to be facilitated by the unified corporate culture observed in the case organizations, as the employees understood the importance of the ERP system implementation projects.

Even though some problems regarding user acceptance were recognized in the beginning of the ERP systems usage, in general the users accepted the system and started using it in their daily routine without any major resistance. The fact that people started using the ERP systems quite fast and without any serious trouble has been stated as one aspect of the implementation projects' perceived success. A unified culture in the case organizations may potentially influence the user acceptance. Interviewees in all companies reported that employees saw it as an opportunity to improve the business operations and their work. On the other hand, as typical for ERP systems, the systems are mandatory to use in the case companies. *"If somebody has a problem with the system, it is not a big deal since it has been decided and it works fine."* (Wholesale manager, CompC). Thus, we cannot conclude with certainty to what extent the high user acceptance in the case companies has been influenced by a unified corporate culture.

5.5 Processes and Procedures

As mentioned, the case organizations prioritized ERP system customization over organizational change. This requirement significantly influenced the system requirements' specification. The companies perceived their core business processes to be unique, and did not want to change these. Keeping the idiosyncratic processes was reported as critical for the further functioning of the business: *"we knew that our processes are not standard and the system had to be customized a lot to suit our processes."[…]"It was one of our initial*

requirements during the selection process that we did not want a software or vendor which would force us into their standardized solution. That would ruin us." (Project leader, CompA). A similar situation was also observed in the other cases. The unique business characteristics caused a functional misfit between the ERP systems and established business processes which in turn required ERP system customization.

CompC and CompD did not report any problems regarding the business process analysis, as the processes were small and uncomplicated. On the other hand, the cases in CompA and CompB indicated that the business process analysis was hindered by insufficient mapping of the business processes. This was reported to be related to imprecise definition of employees' roles and responsibilities. *"We had to agree among each other on who should do what, and how."* (Project leader, CompA). In addition, business process analysis in CompA was also complicated by the complexity of the business processes.

5.6 Organizational maturity (Stage of growth)

We also identified organizational maturity level (stage of growth) as an aspect influencing the ERP system implementation projects in the case companies. The business in all the case organizations were dynamic and growing, with a need for flexibility in the business processes. This aspect influenced their requirements for ERP system customization. As the organizations were continuously growing and experienced many changes over time, the ERP systems needed to be modified to accommodate these changes. However, this does not refer to changing the core business processes. It denotes to adding new ERP functionality as the companies grow and develop new business processes.

In addition, the dynamic character of the case businesses has been noted as the main constraint for the evaluation of ERP system impact. A number of interviewees expressed that the value of general evaluation measures would be limited. Significant business changes such

as widening assortment and opening a new division, were perceived to have more significant influence on the overall business measures than the ERP system implementation.

5.7 Market, customers

All case organizations have a wide customer base. Their customers vary in terms of size from individual persons in CompC and CompD up to large corporations from automotive industry in CompA and military industry in CompB. All the case organizations operate on an international range. For example, CompD exports about 80 % of its production abroad. Similarly, CompA and CompB have close collaboration with their international partners. The ERP systems were not connected with customers' or suppliers' systems. Thus, there were no examples of a stronger partner having forced the case SMEs to implement a system compatible with their extant solution. Only CompC was obliged to implement EDI for document exchange with large international wholesale partners. This, to some extent, affected the ERP system as it had to be integrated with EDI.

The international partners of CompA influenced their motivation for implementing a new ERP system. The partners queried about the company's IS and its support of the firm's processes. "*However, outputs from the DOS-based system were not very representative.*" (Project leader, CompA). The new ERP system improved the graphical design of the product documentation and thus the company's perceived quality in communication with partners.

5.8 Uncertainty

Only CompA reported problems related to uncertainty in the business environment. The implementation project in CompA coincided with the financial crisis in 2008. The CEO therefore decided to stop the project after the acquisition phase. It was later refreshed in a reduced version, 1.5 months before the planned system start. This led to insufficient time for

the business process analysis, which also influenced the implementation team work. Thereby, the environmental uncertainty significantly influenced the ERP system implementation in CompA.

5.9 IS knowledge

Overall, the case SMEs possessed adequate IS knowledge. The implementation partners described the case companies as knowledgeable and engaged in the implementation project. For example, the vendor for CompD expressed that *"the customer was professional."* The vendor for CompA even stated that "*the users excelled with some features which exceed the average."* (Vendor's CEO, CompA). CompC has been characterized by a high level of systematic thinking and the vendor expressed that the company knew very well what they wanted from the system. The project leader in CompB had professional experience with ERP system implementations from his previous job as a consultant. Still, the interview data indicated some aspects of limited IS knowledge which influenced the implementation projects. First, the case SMEs were characterized by a high tendency to keep the conceptualizations from the old systems. This shaped the system requirements specification, as ERP system customization was required from the very beginning of the projects. In particular the interviews in CompB indicated that the level of customization might be affected by lack of knowledge about the ERP system. The users who imposed requirements for the system customization were not familiar with the possibilities of the new system prior to implementation. The consultant reported that the users' requirements for ERP system customization were too extensive and difficult to accomplish. Later on it appeared that due to the new possibilities of the ERP system, the business processes can be done differently and in a more efficient way. The consultant further expressed: *"In some cases an EPR system implementation can fix wrong business processes."* (Consultant, CompB). Thus, the lack of

knowledge about the ERP system functionality affected the level of ERP system customization applied in CompB.

The implementation projects in all four cases were mainly technically motivated. This may be related to the lack of IT strategy. In fact, only CompC had a partial IT strategy, as the ERP system was seen as a solution enabling further growth for the firm. Otherwise, the ERP system implementations were not associated with the companies' overall business strategy plans. This could be caused by limited IS knowledge. The lack of IT strategy had implications for the ERP outcomes evaluation practice. Since the companies did not intend to improve their business as such through ERP system implementations, they do not seek for the effect of ERP systems on their operations.

5.10 IT technical expertise

All case organizations except CompA possessed limited internal IT technical expertise. The IT staff was mainly responsible for hardware and network maintenance, and were not experienced in ERP system implementations. Thus, the companies were fully dependent on the vendors. In contrast, CompA had a highly skilled programmer who was instrumental in the ERP system implementation. *"Such a skilled and active person is not standard at all."* (Vendor, CompA). He was involved in the ERP system customization and is responsible for the further internal development of the system. In addition, the company got access to the system development software. This enabled CompA to develop the ERP system internally according to their specific needs. However, the development demanded more programming work than was expected and they had to hire an additional programmer to handle this task.

5.11 IS function, IS complexity

In all four case organizations the main motivation for implementing the ERP systems was to replace the legacy systems, as these systems were not able to support the business activities of the growing companies. The legacy systems mainly focused on the accounting function and production control. Moreover, the DOS-based technical solution was obsolete and inadequate. In addition, the companies were using several separate systems which were not integrated. The unsatisfactory situation with the legacy systems also influenced the implementation team work, as the employees had a strong motivation for the change. They knew that the old system could not work any more. *"The people literally craved for a new system."* (Project leader, CompA). The willingness of the implementation team members to realize the project was noted as one of the critical factors for the project success. The status of the legacy systems also influenced the evaluation of ERP system outcomes in the case SMEs. Since the legacy systems were functionally limited and insufficient, many aspects have improved by implementing an ERP system. As stated by the wholesale manager from CompC: *"It is not comparable with the old system, […]. The improvement is in everything."* Thus, since the ERP outcomes were perceived obvious and apparent, there was no need for their evaluation.

5.12 SME influences on the ERP life-cycle

Table 4 maps the identified effects of the SME characteristics (Table 1) on the activities in the phases in the ERP life-cycle (Figure 1), using letters to represent the four case companies. The phases of evolution and retirement are excluded in the table, because the cases did not yet cover these. The nature of the effects can vary between the cases and is described in the previous sub-sections. The activities across the ERP life-cycle are interrelated, as the activities in early phases influence subsequent activities. The analysis therefore concentrated

on identifying direct effects of the SME characteristics grounded in the data. Hence, table 4 only includes influences explicitly mentioned by the case informants.

Table 4 shows that a majority of the contextual influences were experienced across all four SMEs, potentially resulting from similar conditions and features of the organizations and the ERP implementation projects. However, there are also several examples of characteristics that were only reported to influence one or two companies. Especially CompA seemed to be influenced by more contextual aspects than the other cases. First, CompA was the only case reported to be constrained by environmental uncertainty, in this case by the financial crisis in 2008. In addition, the relative size of the company might provide a potential explanation for the observed divergence. With about 220 employees, CompA is close to the defined border between SMEs and large enterprises. The results show that the company embodies some aspects of a large enterprise, which resulted in the differences compared to other cases. For example, the organizational structure and processes in CompA were more complex, influencing several activities during the ERP system implementation. CompA also had a higher level of IT technical expertise, more often seen in larger enterprises.

Table 4 further shows, that “Ownership type, management and decision making” was identified as the most influential SME characteristic, being the only characteristic exerting influence on all four life-cycle phases. Another influential factor was “resources”, with resource limitations affecting activities across three phases (especially the acquisition phase). Further, also “organizational maturity”, “IS knowledge” and “IS function, IS complexity” influenced various activities in three phases of the ERP life-cycle.

Comparing the distribution of influences across the ERP life-cycle phases, the “implementation phase” in the Esteves and Pastor framework was affected most by the SME context, with all the SME characteristics affecting the activities in this phase to some extent. Also the activities in the “adoption decision” and “use and maintenance” phases were

considerably influenced by the SME characteristics. In contrast, according to the data analysis the “acquisition” phase was only affected by two aspects of the SME context.

[Table 4 here]

6 Discussion

The purpose of this study is to investigate how the SME context affects the phases in the ERP life-cycle. We first discuss how well the case companies fit with the SME characteristics identified from our literature review. Then we discuss the contextual influences on the ERP life-cycle phases.

The four case SMEs displayed many of the same characteristics as identified in the literature review on IT and SMEs (summarized in Table 1). All case organizations had limited resources for the ERP system implementation project, in terms of money as well as human capital. Also ownership type, management and decision making, IS function and IS complexity were consistent with the characteristics identified in Table 1. However, we also observed some differences from the characteristics generally associated with SMEs. While the organizational structure and business processes in companies B, C and D were relatively simple, the organizational structure and processes in CompA were more complex.

Three of the case SMEs operate on a single site (CompA, CompC and CompD), while CompB operates on two sites. According to former studies, SMEs in general serve local markets (Wong and Aspinwall 2004), and have small customer bases (Ghobadian and Gallear 1997). The case SMEs were atypical in this sense, as all case organizations had a large and international customer base. Also, unlike SMEs in general, we did not see evidence that that major customers or suppliers forced the case SMEs to adopt a system compatible with their

extant solution. Yet, some minor issues indicating influence of the major customers were identified.

Only CompA reported to be constrained by environmental uncertainty, in this case by the financial crisis in 2008. The financial crisis was global and one could argue it affected most enterprises worldwide. SMEs in general will be more vulnerable to market fluctuations than larger enterprises due to less resources and fewer customers. We argue that similar circumstances could have severe impacts on ERP implementation projects in other SMEs.

SMEs generally lack knowledge and experience with ERP systems, and we suspected that it could have constrained the ERP system implementation in the case organizations. This was not supported by our results, as the case organizations demonstrated relevant IS knowledge to manage ERP system implementation. Thus, the case SMEs seemed not to be significantly constrained by lack of knowledge or limited experience with ERP systems. While the SME literature characterizes SMEs as having limited IS knowledge, the findings from this study illustrate that many SMEs are quite competent in this respect. We may also expect that SMEs in general are gradually advancing in their IS knowledge, and thus are now more capable of IS implementations than a decade ago (e.g., Blili and Raymond 1993, Cragg and Zinatelli 1995, Levy and Powell 2000). However, this does not imply that the case organizations were able to implement the ERP systems on their own. The IS knowledge here relates to the managerial expertise to plan, organize, and direct the use of information systems in general. The case SMEs still relied on implementation partners as they did not have sufficient IT technical expertise to manage the implementations independently. In this respect, CompA differed from the other cases, as they had a higher level of IT technical expertise. Yet, they still used an implementation partner for the ERP implementation.

In contrast to acquired IS knowledge, the level of strategic planning was limited in the case SMEs, with the companies preferring to keep with the concepts of the old systems. This

may be caused by insufficient attention by management to IS (Levy and Powell 2000, Levy *et al.* 2001). Better strategic planning of IS might potentially help companies see the benefits of adopting new functional possibilities offered by ERP systems.

The analysis showed that the SME context influenced the ERP implementation projects in the case organizations. As summarized in table 4, some of the SME characteristics had a considerable impact, while others had more limited influence.

Limited resources affected various issues in the ERP implementations. Limited financial resources affected mainly the acquisition phase, as the ERP system price was one of the major selection criteria. The data further indicated that in two cases limited financial resources influenced end user training, as well as the system development approach utilized. In particular, CompA decided to develop the system internally to cut the costs of further system development. However, the development demanded more programming work than was expected and an additional programmer had to be hired to handle this task. One may question whether this approach really reduces costs. It could be argued that it would be better to purchase a more complex system without the need for such extensive further development.

The projects were constrained by limited human resources, as none of the implementation team members were dedicated to work full-time on the projects. This illustrates how SMEs with a limited number of employees may find it hard to assign dedicated staff to an ERP implementation project. ERP system outcomes evaluation was also restricted by limited resources, and no financial or human resources were allocated for such activity.

The owner-managers significantly influenced almost all issues across the ERP life-cycle, such as ERP system selection, implementation team work and system customization. Even though the CEOs justified the ERP system implementation, their motivation was limited to replacing the obsolete legacy systems. This shows that the lack of strategic perspective in SMEs might limit the ability to acknowledge the potential of an ERP implementation. This is

also consistent with the fact that SMEs generally have few personnel available with the necessary competence (Gable and Stewart 1999). On the other hand, once the need was recognized, the decision was made fast. This shows that if the need for an ERP system is recognized and supported by the SME's CEO, then it can be attained quickly.

The fast decision making process may be due to a flat organizational structure with few layers of management and decision makers, as in three of the case organizations (CompB, CompC and CompD). The findings indicated that the simple structure might facilitate ERP system implementation, as there is less need to overcome the complex hierarchical structures typical for large enterprises. Furthermore, the simpler structure might facilitate the requirements specification through simplifying the internal communication processes.

SMEs generally have less complex business processes than large enterprises (Wong and Aspinwall 2004). One may expect that the business process analysis therefore would be easier to conduct in SMEs, as it was observed in companies C and D. In contrast, the business processes as well as organizational structure in CompA were more complicated, and hindered the business process analysis. Moreover, business process analysis in companies A and B was also constrained by insufficiently mapped business processes, resulting from imprecise definition of employees' roles and responsibilities. This is consistent with the fact that most of the activities in SMEs are governed by informal rules and procedures, with low degree of standardization and formalization (Wong and Aspinwall 2004, Ghobadian and Gallear 1997).

Although business process reengineering (BPR) is often seen important while implementing the ERP system (Loh and Koh 2004, Nah *et al.* 2001), it was not employed by the case organizations. While there were some minor changes in the business processes, the case organizations chose to customize the ERP systems, and not adapt the organizations to the systems. This finding is in contrast to former literature recognizing minimal customization as a critical factor for successful ERP system implementation in large enterprises (Nah *et al.*

2001, Somers and Nelson 2001), as well as in SMEs (Loh and Koh 2004). Moreover, the SME processes are expected to be more flexible and adaptable to changes taking place around them (Ghobadian and Gallear 1997). The main reason for ERP system customization was to preserve existing core business processes, which were perceived as unique and providing competitive advantage. This can be perceived as typical for some SMEs which usually gain their competitive advantage by excellence within a niche market.

The data analysis identified organizational maturity level (or stage of growth) as an influential characteristic, which is not covered in the former literature on IT and SMEs. Here we refer to the maturity of the organization, and not the maturity of ERP systems use or the stage in the ERP life-cyle. We argue that it is likely that different levels of organizational maturity reflect different business imperatives and thus different needs whilst implementing ERP systems. Limited attention has been given to the importance of the stages of growth among studies on ERP implementation, with companies usually being treated as equal without attention to their maturity level (Liang and Xue 2004). This may be because most of the past ERP studies were based on cases of large enterprises, usually in a mature and stable stage (Liang and Xue 2004). However, the businesses in the case organizations were characterized as continuously growing, making many changes in their business processes over time. These changes needed to be captured in the ERP system and caused a need for system customization after “going-live”. This indicates that SMEs in an immature stage may have special requirements for ERP system customization. The findings also showed that the dynamic character of the case businesses may impede evaluation of ERP system organizational impact.

This does not imply that large enterprises do not continuously grow and that they have no need for system customization. Yet, we argue that the character of SMEs’ businesses is often more dynamic, as changes occur more frequently and faster compared to large enterprises. In contrast to the setting of the case organizations, there also exist more stable

SMEs without a need for further expansion, working with established business processes. Therefore, further research should consider the organizational maturity level of the studied organization to investigate the applicability of our findings.

7 Conclusion

This exploratory study has demonstrated how different characteristics of the SME context may influence ERP implementation activities. By relating the identified influences to the different phases and activities in the ERP life-cycle, the study contributes a more complete picture of the implementation process compared to former studies usually focusing only on one particular phase.

The study provides several implications for research. In general, the findings demonstrate that the SME context influences ERP system implementation and thus should be taken into consideration by future research. In particular, the influence of organizational maturity needs to be focused more. Furthermore, the ownership type was identified among the most influential characteristics of the SME context. Certainly, the role of the owner-managers is unique compared to the large enterprises. Also limited resources, low organizational maturity and obsolete legacy systems influenced several phases. Among the ERP life-cycle phases, activities within the implementation phase were affected most by the SME context.

The number of cases in our study is limited and there is a need to investigate the applicability of our findings in other SMEs, representing other sectors and industries. Moreover, since all the case companies are from one country, the relevance of the findings for other counties needs be investigated. However, this is an exploratory qualitative study aimed at investigating potential influences from the SME context in depth. The findings are thus intended to form the basis for further studies of the influences of the SME context, based either on more case studies or a quantitative approach. Further research may also investigate

influences of the SME context in the last two phases of the Esteves and Pastor's framework, not covered in this study.

Furthermore, our analysis of the case companies in this study illustrates the need for a more nuanced view on what is presented as 'general' SME characteristics in former literature, e.g. regarding IS knowledge, business processes and market characteristics. This should be taken into account in future research on contextual influences on ERP implementation in SMEs.

The study also provides several implications for practice. The findings are valuable for SMEs considering ERP system implementation, as well as for ERP vendors and consultants. Due to limited resources or low organizational maturity, SMEs may be more vulnerable to project failure than larger companies. A proper understanding of the contextual issues may lead to a better comprehension of ERP system implementation and thereby contribute to successful ERP implementation.

The study showed that the role of the owner-manager is essential in SMEs. Therefore, vendors and/or consultants need to assure that the owner-manager(s) takes a strong role in the implementation. The vendors and consultants should also consider the level of organizational maturity as an important factor, with particular influence on further system development after "going-live".

SMEs need to improve their strategic planning of IS utilization, and the motivation for the ERP implementation should not be technology-driven and based only on the concepts of legacy systems. Better strategic planning of IS will help SMEs to recognize the potential benefits offered by ERP systems.

Furthermore, SMEs should put emphasis on a thorough business process analysis. This analysis may eliminate the need for heavy ERP system customization, as the companies

may acknowledge the potential of the business processes embedded in the ERP systems, and facilitate a more continuous business process management practice.

Finally, SMEs may increase their attention towards outcome evaluation of the ERP system, as recognition of the ERP outcomes could improve further utilization of the system. Also, assessment of ROI may provide figures justifying the ERP implementation and facilitate potential further system enhancements and development.

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Appendix A

Interview guide
General information
What is your role in the ERP system?
How do you use the ERP system?
What is your opinion about the ERP system?
Are you satisfied with the ERP system?
What were your expectations from the ERP system?
How are your expectations fulfilled?
What were the main reasons/motivation for the ERP system implementation?
ERP implementation project details
Were you involved in the system implementation?
What problems/complications did you experience during the ERP system implementation?
Was the implementation project according to plan?
Organizational context
Which characteristics/features of the company do you consider unique/specific?
Which characteristics/features of the company do you consider influential for the ERP system implementation?
How did these characteristics affect the implementation?
How did these characteristics affect the different phases/activities of the implementation project?
Do you think that the fact that the company is a SME has affected the implementation?
In your opinion, how did the production strategy (MTO/MTS) affect the ERP implementation?
ERP implementation success
What is your opinion about the implementation project?
Do you perceive the project as a success? (your personal opinion)
How do you define the success of ERP system implementation?
What is a success for you in this context?
Is the implementation considered as a success by the company?
ERP evaluation/outcomes
Was the system implementation evaluated in the company?
What are the outcomes of the ERP system?
Acceptance, usage
To what extent has the system been accepted by the users so far?
What have been the barriers to acceptance? (if any)
Training
What kind of user training was applied?
How many hours of user training were provided?
Was the training sufficient?
Critical Success Factors
Which factors do you consider the most important for the success of the ERP system implementation?
Overall evaluation

What are the limitations of the current ERP system?
What problems / complications do you face now (if any)?
What could be done to overcome these problems?

Table 1- SME characteristics

SME characteristics	Selected references
Organizational characteristics	
Resources • Modest financial resources • Limited human capital • Limited resources for employees' training	Blili and Raymond 1993, Cragg and King 1993, Ghobadian and Gallear 1997, Gable and Stewart 1999, Bernroider and Koch 2000, Levy and Powell 2000, van Everdingen *et al.* 2000, Thong 2001, Wong and Aspinwall 2004, Buonanno *et al.* 2005, Raymond and Uwizeyemungu 2007, Seethamraju and Seethamraju 2008
Ownership, management, and decision making • Owner is the CEO • Time constraints of owner-managers • Top management highly visible and active • Few layers of management • Centralized decision-making • Short-term decision-making cycle • Intuitive decision process	Blili and Raymond 1993, Ghobadian and Gallear 1997, Gable and Stewart 1999, Wong and Aspinwall 2004
Structure • Simple, flatter, and less complex structure • Flexible structure and information flows • Single-sited • Organic structure • Limited and unclear division of activities • Low degree of employees' specialization	Blili and Raymond 1993, Ghobadian and Gallear 1997, Gable and Stewart 1999, Wong and Aspinwall 2004
Culture • Unified culture • Few interest groups • Common corporate mindset • Low resistance to change • Organic and fluid culture • Influenced by owner-managers	Ghobadian and Gallear 1997, Wong and Aspinwall 2004
Processes and procedures • Smaller and less complicated processes • More flexible and adaptable processes • Informal rules and procedures • Low degree of standardization and formalization	Ghobadian and Gallear 1997, Wong and Aspinwall 2004
Environmental characteristics	
Market, customers • Mostly local and regional market • Normally dependent on a small customer base • Affected by powerful partners in their supply chain	Blili and Raymond 1993, Ghobadian and Gallear 1997, Wong and Aspinwall 2004, Seethamraju and Seethamraju 2008
Uncertainty • High level of environmental uncertainty • Uncertain and unstable environment	Blili and Raymond 1993, Gable and Stewart 1999, Seethamraju and Seethamraju 2008
Information Systems characteristics	
IS knowledge • Limited knowledge of IS • Modest managerial expertise • Limited management attention to IS • Lack of strategic planning of IS	Blili and Raymond 1993, Cragg and King 1993, Cragg and Zinatelli 1995, Levy and Powell 2000, Levy *et al.* 2001, Shiau *et al.* 2009, Chang and Hung 2010
IT technical expertise • Limited IT in-house technical expertise • Emphasis on packaged applications	Raymond 1985, Blili and Raymond 1993, Cragg and King 1993, Cragg and Zinatelli 1995, Iacovou *et al.* 1995, Fink 1998, Gable and Stewart 1999,

• Greater reliance on third party	Levy and Powell 2000, Thong 2001, Shiau *et al.* 2009, Chang and Hung 2010
IS function, IS complexity • IS function in its earlier stages • Subordinated to the accounting function	Blili and Raymond 1993, Gable and Stewart 1999

Table 2. Overview of interviews in the four cases

	CompA	**CompB**	**CompC**	**CompD**
# of interviews	14	7	4	9
Participants	Project leader (production manager), project leader assistant, CEO, financial/technology managers, IT/IS administrators, key users, end user, vendor's CEO.	Project leader assistant, financial/technology/ sales managers, IT/IS administrator, end user, consultant.	Sales manager (responsible for the IS), wholesale manager, end user, vendor.	Project leader (purchasing manager), IT/IS administrator, economic/warehouse/ technology/ production managers, payroll clerk, end user, vendor.

Table 3. Characteristics of the case companies and ERP implementation projects

	CompA	**CompB**	**CompC**	**CompD**
Industry	Fiber optic components	Electronic components	Cosmetics	Agriculture machinery
Business type	Manufacturer	Distributor/ Manufacturer	E-shop	Manufacturer
# of employees	220	100	50	200
Time of ERP implementation	April 2009	October 2006	August 2007	January 2005
Time since "going-live"	11 months	3,5 years	3 years	5,5 years
ERP system	Helios Green	ABRA G4	ABRA G3	ALTEC Aplikace
Implemented modules	Finance, Commerce, Logistics, Production Control	Finance, Commerce, Logistics, Production Control, Asset Management, Human Resources	Finance, Commerce, Logistics, Asset Management, Human Resources, CRM (limited)	Finance, Commerce, Logistics, Production Control, Asset Management, Human Resources, Material Requirements Planning, Production Planning, Business Intelligence (extension in 2010)
Legacy information systems	4 separate DOS-based systems (accounting, production control, payroll system, attendance system)	2 separate DOS-based systems (accounting, production control)	DOS-based accounting system	2 separate DOS-based systems (accounting, production control)
Implementation partner	Certified agent	Vendor	Certified agent	Vendor
Implementation team	10 internal employees	4 internal employees + consultant	2 internal employees	6 internal employees

Table 4. Influence of contextual characteristics on the ERP life-cycle in the four cases

Contextual characteristics		ERP life-cycle												
		Adoption decision		Acquisition			Implementation					Use and Maintenance		
		Needs recognition, motivation	System requirements specification	ERP system selection	Implementation partner selection	Selection criteria	Implementation team work	Business process analysis	System customization	Users training	Technical installation	Use of the system, user acceptance	System development	ERP outcomes, evaluation
Organizational characteristics	Resources			ABCD	ABCD	ABCD	ABCD			AB			AB	ABCD
	Ownership type, management and decision making	ABCD	ABCD	ABCD	ABCD	ABCD	ABCD	AD	ABCD				A	ABCD
	Structure		ABCD					A	A		B			
	Culture						ABCD					ABCD		
	Processes and procedures		ABCD					AB	ABCD					
	Organizational maturity		ABCD						ABCD			ABCD		ABCD
Environmental characteristics	Market, Customers	A									C			
	Uncertainty						A	A					A	
IS characteristics	IS knowledge		ABCD						B					ABCD
	IT technical expertise								A				A	
	IS function, IS complexity	ABCD					ABCD							ABCD

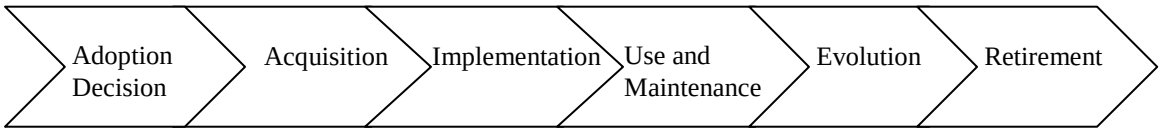

Figure 1. ERP life-cycle framework (adapted from Esteves and Pastor, 1999)