

Rescuing Small and Medium-sized Enterprises from Inefficient Information Systems – a Multi-disciplinary Method for ERP System Requirements Engineering

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Abstract

Enterprise resource planning (ERP) systems integrate companies' multiple information systems and help adapt best practices for business processes. ERP systems are in most cases off-the-shelf software packages and large by their size and complex by their structure. Small and medium-sized enterprises (SMEs) require flexibility of the ERP system because of their individual operational processes. Therefore it is crucial to select and implement an ERP system that fits the requirements of the intended target processes. To support the requirements engineering of ERP systems, we have developed Customer-Centered ERP Implementation (C-CEI) method. The method introduces a multi-disciplinary approach to the ERP project, and provides in-depth understanding of the company's processes and context of use. Using C-CEI method decreases the risk of SMEs to select an inappropriate system, and improves the system acceptance by the customer company's employees. In this paper we present the method and illustrate it by three SME case studies.

1. Introduction

Enterprise resource planning (ERP) systems are mostly commercial-off-the-shelf (COTS) products [5]. Companies implement ERP systems in order to integrate their information systems, to enhance their processes, and to develop their competitive advantages. Implementation of an ERP system is a risky project that binds the company resources, for example, information systems and production

management personnel, for months. The efficiency of company operations is in danger when the organization adapts to changes that the new ERP system brings. As apart of the transition, business processes are usually aligned simultaneously with the ERP system implementation.

Recently, the ERP market has expanded towards small and medium-sized companies (SMEs). SMEs have special challenges such as the adequacy of resources in ERP selection and implementation. The selection of ERP software is done mainly on the basis of the adaptability of the software, length of implementation time, and vendor support [2]. SMEs have, in many cases, company-specific needs for the ERP software, but in most cases they have to adapt to the processes and information structures the ERP systems offer. SMEs do not have the resources to create tailor-made ERP software to cover all their requirements, and thus they have to limit the software tailoring to the most crucial areas.

Van Stijn and Wensley [16] note that the need for company changes in ERP implementation is greatly underestimated. The ERP selection is nearly always a compromise between the needs of the company and the characteristics of the ERP software. In order to select an ERP system that best supports the business processes of an SME, an in-depth analysis of company's processes and requirements is needed. The analysis must support both the ERP system implementation process planning and process change management.

To improve the requirement engineering process in SMEs, we have developed a vendor-independent *Customer-Centered ERP Implementation method (C-CEI)*. The novelty of C-CEI is to combine two

requirement engineering approaches. One of them focuses the company operations and processes, and the other focuses on users and their tasks in the context of use. C-CEI provides multi-disciplinary and holistic, but still company-specific initiation for the ERP project.

C-CEI focuses on defining the most important ERP system requirements and process change areas by an extensive process analysis. C-CEI method is based on analysis of human factors and organizational needs of the customer company. Thus the method is *customer-centered*. In C-CEI, the organizational requirements are identified by analyzing the details of company *context of use*, i.e., system users, their tasks, used equipment, and the physical and social environments [8]. The context analysis is based on principles and activities of user-centered design [8]. The company achieves increased understanding of the broad requirements of their ERP project to the company personnel and management. The strategy and goal of the ERP investment are also clarified, thus giving a sound basis for the ERP project.

In this paper we first give the motivation for the development of C-CEI method. We then introduce the method step by step. To illustrate C-CEI method we present three SME case studies, in which C-CEI has been applied. Finally we discuss the lessons learned of C-CEI method.

2. Motivation for Customer-centered ERP implementation method

The ERP projects should have clear strategic and operational goals. To get the system to work is not an adequate goal; instead companies should focus more on business goals [6]. The approach to an ERP system implementation can be *technical*, *operational* or *strategic* [12]. However, many *critical success factors* in ERP implementations refer to human factors like involvement of key players and ERP system context of use [14, 18]. Therefore, to take care of the human factors in ERP implementation a new *customer-centered approach* is needed. C-CEI method adapts principles and activities from user-centered design (UCD) process [8], which aims at, for instance, improving productivity of users, and operational efficiency of the organization. These principles are in line with the objectives of an ERP project. However, user-centeredness has not been the primary focus in ERP projects.

Once initiated, the ERP project should be managed by a person who is expert in both technical and business management [6]. SMEs might run into trouble

with ERP project management and when the business processes of the company have to be re-engineered. C-CEI method helps the company to set goals for their ERP project. The strategic goals are described and agreed by the company board of executive officers (BEO), before detailed ERP requirements and organizational goals are defined.

An ERP system that perfectly fits all the business processes of a company does not exist [6]. Instead, nearly all the ERP system products include the most common processes such as accounting, order processing, inventory management, production planning and control. The differences that make some of these ready-made software packages fit better than the others emerge from the company-specific requirements. Those requirements are based on company's own business processes or information management needs that are not met by standard ERP system. Such examples are the mixed batch and line production model, or the sub-module based parts' serial numbering system.

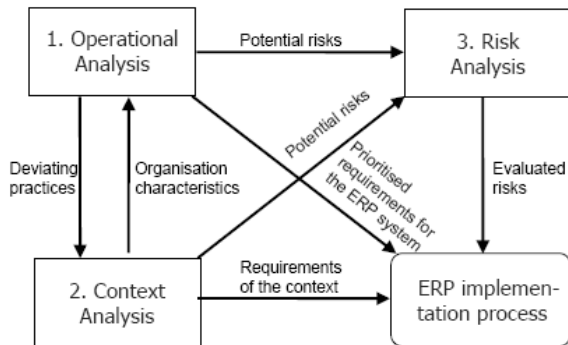
The companies should first analyze what is their main source of profit [6]. Then they should decide which of the deviating processes from the ERP system's point of view should remain, and which are changed according to the ERP system's logic. Only then will the companies be able to select an ERP system that supports their strategic success factors and business processes. C-CEI method focuses on the company's exceptional practices and information management need. The ERP requirements, defined by C-CEI method, are based on the company's conscious decision whether to change their practices or leave them intact.

An ERP project has several key players like company's ERP project manager, project champion and steering committee members in addition to company's top management and executives [15, 9]. They all have varying objectives in the ERP project. In an SME, the key players may not be able to work full time for the ERP project. This forces an SME to focus their small resources on only the most critical business needs. C-CEI includes tools for identifying only necessary changes in the organization and its operations. C-CEI gives a multi-disciplinary point of view for the decisions to be made before the implementation. C-CEI method also prepares the upper management for the upcoming implementation.

3. C-CEI method

C-CEI method is based on the combination of operational, contextual and risk analyses (Fig. 1). First

the company's critical business processes and special information management needs are defined. Second the context of use is analyzed. As a result of the preceding analyses the potential risks in the implementation are also revealed. C-CEI method helps a company to identify the company-specific requirements and design how the business processes are carried out in the new ERP system. A company needs to decide whether it aligns its processes to the ERP system or requires ERP to operate according the



current processes of the company.

Figure 1. Phases of C-CEI method

C-CEI includes three major phases (analyses), and each of them produces a document to be exploited when an ERP system is selected, implemented and used. In Figure 1 relationship of different phases and each phase's contribution to ERP implementation process is described as arrows. *Operational analysis* seeks the most critical requirements for the ERP software to be purchased. The future business needs and company operations developments are taken into account when defining the ERP system requirements. *Contextual analysis* focuses the current sequences of tasks, the personnel culture and interaction, and how the resources are allocated. *Risk analysis* defines the most essential risks and their likelihood, as well as defines actions that the company should take to prevent them.

In addition to the results of the analyses, C-CEI method prepares the personnel of the company in many ways for the ERP project. First they are closely involved with the analysis activities; second they describe the current processes and problems, third they participate in the modeling of the context, and fourth they prioritize the risks.

3.1. Operational analysis

ERP implementation project typically begins by requirements engineering, which analyzes the company operations and information processing needs.

Consulting companies and ERP vendors are using, for example, structured questioning methods, process descriptions and function related information input-output analyses. Business process reengineering (BRP) suggests that the company processes should "engineered" before information system implementation [7]. Reengineering is carried out in many cases for aligning the company processes with the ERP system's logic. Reengineering prior ERP system implementation has been reported to lead to a more successful implementation [13].

Different process analysis tools like ARIS, for example, have been developed to help the reengineering projects and information system implementation. However, a full scale reengineering or process descriptions hardly are appropriate for SME's purchasing of COTS type software. The SMEs have to accept in most areas the processes and information processing as they are carried out in the ERP system they have selected [1]. Therefore, it is justified to analyze and possible reengineer the company processes according the common ERP-system logic [17].

Operational analysis describes first the current (As-Is) business processes, and the problems and development needs related to them. The future business processes (To-Be) are defined in co-operation with company representatives based on the current processes. Operational analysis begins with the collection of the background information, including the company strategy, business goals, operations and capability development. The company board of executive officers (BEO) and the company's C-CEI project team are interviewed to get a clear picture of the business needs and operations development targets.

In the second phase the order-delivery process (ODP) and the main support processes are analyzed to obtain knowledge of the current processes and their development needs. Information is gathered at group interviews. The groups are formed for each major sub-process and support process of ODP, and they consist of key personnel of each process.

The basic process information covers quantitative information of the volume and frequency of a process (e.g. personnel, working hours, amount of purchases per period of time, material usage). The process phases, and data and material flows are also charted. Process management principles and goals are defined. Planning and control tasks related to managing are listed. Finally the information management requirements such as need for reports, or need for wireless connection to the ERP system, are queried.

During the interviews, the process descriptions are compared with the ERP logic [20]. The goal is to

reveal the processes and information processing needs that deviate from the standard ERP systems' logic. In most areas the companies have to change their processes according to the ERP system's functionality. On the contrary, those areas where companies want to keep their own practices and processes are the most important for the ERP systems requirement specification. These deviations from the standard processes are usually critical in the ERP system selection and implementation. In the next phase of C-CEI method, *contextual analysis*, the critical points are analyzed in more detail.

After the group interviews the new operational model, the "To-Be" model, is designed. The model is a short process description that includes the most important changes that are to be made in company processes and information management. The findings of operational analysis are presented to company board of executives (BEO) and top management in order to support the decisions of the future management principles and processes. The key question when ERP requirements are created is *whether a company adapts to the requirements caused by the ERP system's operational model, or does a company hold on its current operational model and require an ERP system that fits to it.*

Finally, when the consensus of opinion over the "To-Be" model exists, the requirements for ERP software are prioritized and listed. Requirements are classified as "must have" features, and other classes that vary from important features to less serious features for the operations of the company. Must have features will narrow down the amount of potential ERP systems, and thus guide the selection process. Compromises and trade-offs are negotiated with the

less important features. The software tailoring decisions are based on a comparison between the importance of the requirement and cost of tailoring.

Some features are marked to be tested during the ERP system selection. Typically requirements to be tested are those that relate to routine processing, are operated largely or frequently, or their usability is critical for user acceptance, like in employee reporting. The major outcomes of operational analysis are description of the target operational model and requirements for the ERP system. The document can be send over to potential ERP vendors.

3.2. Contextual analysis

During the interviews of operational analysis, the personnel of the company subjectively describe the company operations. In order to reach thorough understanding how the operational model really works, the personnel needs to be objectively observed while they carry out their normal tasks. Contextual analysis aims at deep understanding of the company's context of use [8], i.e. users, their tasks, devices, and physical and social environment. The company's culture and organization will both have an effect on the ERP implementation, and be affected by it.

Contextual analysis in C-CEI applies the first four stages of the user-centered design method Contextual Design (CD) (Fig. 2) originally introduced by Beyer and Holzblatt [3, 19]. The method includes observation and modeling the work and its context. Via interpretation of consolidated models and special wall technique, the potential problems in work are defined. Thereby the necessary changes in context of use can be planned and put into practice within ERP project.

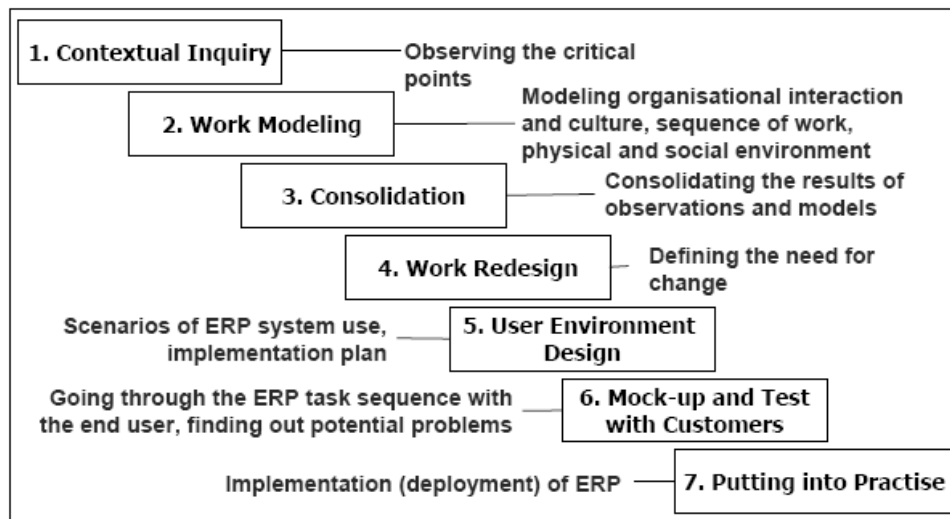


Figure 2. Contextual Design method [4] applied in C-CEI.

The contextual analysis starts by making a decision on the focus. Usually it is the key process, the order-delivery process, but it may vary according to the company's strategy for the ERP project. The focus is also affected by the results of the operational analysis, because there may be found unusual sequences of work or centralized information management that should be investigated more deeply with contextual analysis.

When the focus is clear the CD process can be started by collecting information on target users. To find out the real task flows in the company, the CD starts with *Contextual Inquiry (CI)* (Fig.2.) that is a mixture of observation and interview. In the CI the focused task, sequence or process is observed in the real work place. The person carrying out the focused task is asked to do the job in a normal way ignoring the observers. Afterwards the observations and interpretations are checked by interview in order to avoid any misunderstandings. [3]

The data collected by CIs is analyzed further by *modeling* it with five different visual models: *flow*, *cultural*, *sequence*, *physical* and *artefact* model [4]. The flow model describes how the user interacts with other persons, divisions and systems. Cultural model illustrates the user's position, influence, attitude in the organization, and the dominant culture that influence the user. Sequence model specifies triggers, intentions and pathway for conducting a task. Physical model maps the workplace, the devices and furniture where the action takes place, and the artefact model is based on forms and prints used in carrying out the task.

The models need to be *consolidated* in order to transfer the understanding from the individual level to the organizational level. One type of model is consolidated at a time. The purpose is to find common features of the work or process without losing individual variation [4]. In C-CEI method the consolidation follows the CD in cases of flow, cultural and physical model. Sequence models are an exception, because originally they are all supposed to describe the same task. In C-CEI method, however, the observations are from different phases of the process so that the individual models cannot be consolidated. Instead, individual sequence models can be used as use cases in an ERP selection or training. The same applies for artefact models, which can be used as models for reports and forms of the new ERP system.

All the data from the observations cannot be modeled. Instead, the single notices are written down in separate post-it notes, which are then grouped at the wall as *Affinity Diagram* [4]. The Affinity Diagram is built together with the multi-disciplinary team in order to share different points of view. In C-CEI method the

Affinity Diagram includes organizational issues and issues relating to information systems. The Affinity Diagram shows the areas where the company can improve its operations, and challenges to be overcome during their ERP project. These areas can relate to, for example, time management or multiple information systems in current production data management. The contextual analysis results requirements of the context for ERP system implementation process, and development ideas that organization should implement already for their current practices.

3.3 Risk analysis

Risk analysis consolidates all the information gathered from the ERP literature, project risk listings, and interviews concerning previous implementations, the operational analysis and the contextual analysis. The challenge is to make the analysis complete enough without losing the company-specific details. Furthermore, the risk analysis document should be readable in a way that the analysis could easily be evaluated at every stage of the implementation.

In C-CEI method the risks are divided according to ERP project phases: *selection*, *implementation* and *usage* [11]. The risks are analyzed systematically starting from the description of the potential cause and occurrence. Then the consequences of a risk are illustrated and proposals for action are listed. Finally the effectiveness and probability of the risks are evaluated. In SMEs, top management's awareness of the risks of their ERP projects is critical for the implementation success. Therefore, the company board is closely involved in the evaluation of the risks, and thus committed to an ERP project risk management.

3.4 Summary

The three phases of C-CEI method together give complete requirements for a new ERP system, its implementation and context of use. Operational analysis produces a thorough description of how the company will operate with the new ERP system. Contextual analysis elucidates the characteristics in the organization, and proposes changes for enhancing operations. Risk analysis results checklist for every step in ERP project reminding what the major challenges are in each phase.

4. Case studies

During 2005, C-CEI method was developed and applied in three small and medium-sized enterprise's

ERP requirements engineering process (Table 1). The activities of C-CEI method were carried out by the multi-disciplinary research team. First, in this chapter the case companies and their ERP investment motivation are introduced. Second, the how C-CEI method is applied is described from a methodological point of view. Third, the major results of C-CEI method for the companies are presented.

4.1 Case companies

The case companies presented different type of organizations; a product development organization, a manufacturing organization and a project organization (Table 1). The common feature of the companies was that they all had their previous ERP systems that were utilized only partly in their business processes.

Company A is an expert organization, which has autonomous expert-driven divisions. Company A is providing its customers with a product and solutions that are totally tailored according to customers' needs. This had led to situations where every product is a unique prototype, and production development costs are hardly paid back. Now Company A aims at a more standardized and modular product. The changes should increase the efficiency of operations, shorten the through-put time, and improve forecasting and profits.

Company B is a manufacturing organization, which has complicated and multi-staged manufacturing process. Manufacturing operations are scattered over a large area and many buildings for safety reasons. The company has long customer relations and demand is quite predictable. Because of the dangerous product, explosives, Company B has an extensive and strict quality control process that gives the production process a license to progress depending on laboratory test results. Company B aims at production process management with a real-time information system.

Company C is a projecting organization which operates in construction sites that are located in miles apart from the head office. Company C operations consist of project activities such as quotation calculation, project timetable management, and project

based cost accounting. A great number of the personnel work at construction sites in different projects. Company C wants to monitor the progress of projects in real time by developing the site reporting.

4.2 Analyzing case companies' ERP system requirements by C-CEI method

The cases described in this paper, are the first application tests of C-CEI method. Therefore the needed human resourcing has been monitored. C-CEI method took 490, 650 and 350 hours in companies A, B and C respectively. The companies share of hours were 27%, 58% and 45%. Company A was pilot case, and thus took a relatively great amount of resources compared for example with Company C.

In every case, applying C-CEI began by operational analysis and discussion with the company board of executive officers (BEO). The scope, tasks and schedule of C-CEI project were planned. The company project team was formed of manager level representatives. In all three cases the company project team included at least a Chief executive officer (CEO) and financial manager. Depending on company branch and size other managers joined the team of 4, 8 and 5 managers from companies A, B and C respectively.

Order delivery process was divided into sub-processes. Each of them was then analyzed by group interviews. Group members were employees and executives who planned and managed the sub-process. The interviews took 2-4 hours per sub-process. The process related volume information, e.g. the number and frequency of tasks, bills, purchases, and products, were defined. The sub-process was gone through step by step in order to achieve deep understanding of the current operations of the process. Different reports and documents were also collected during interviews to gain understanding of the information flows and management and planning practices.

After the interviews, C-CEI method continued by contextual analysis. It focused the order-delivery process, because it was the key process, and thus prone to changes within ERP system implementation. The

Table 1. Details of case companies and their ERP system usage before applying C-CEI

Companies/Features	Company A	Company B	Company C
Branch	Measurement devices and services	Explosives	Construction projects
Turnover	8 M€ (2003)	14 M€ (2004)	7 M€ (2004)
Personnel	40	150	109
Usage of current ERP system	Accounting	Accounting, production management	Accounting
Problems in current ERP system usage	ERP does not fit in business process	ERP does not support production and information management	No on-time information about projects, character-based system

number of contextual inquiries was six companies A and B and five in company C five. Target users of the observations were workers, e.g. managers, designers, foremen, a fabricator and a programmer, from various levels of organization. Contextual inquiries were carried out by 2-3 researchers. The conversation was recorded and observations were documented briefly after each session into models and post-it notes. Models were consolidated as a research group activity.

The contextual analysis concluded in intensive day when research group worked together with the company's ERP project management. First, the Contextual Design method was introduced, then the Affinity Diagram was built, and last the consolidated models were analyzed. Four to five key persons from the company participate these activities, including at least chief executive, financial and information officers. This day resulted for the companies the changes needed in organization, its culture and infrastructure. The results also revealed problematic issues that cannot be affected by ERP system, and thus must or could be changed before the implementation.

Risk analysis was going on simultaneously with the operational and contextual analyses. It focused the changes in processes, information management, and organization. The other possible sources of risk found in operation and contextual analysis were further examined. The risks were introduced to the company's top management in order to define the probability and effectiveness of each risk. The risks in each phase of the ERP project could then be prioritized and the main risk management principles defined.

5 Main results of applying C-CEI method in case companies

The results of cases where C-CEI method has been applied in the ERP requirement engineering processes are presented here. The outcome of each analysis phase of C-CEI is illustrated.

5.1 Company A

The strategy of Company A is to change their product structure and streamline the order delivery process. In order to have more effective production, the company is planning to change from unique to more standardized and modular products. With the ERP project the aim is to develop management processes, for example, inventory management, product data management (PDM) and customer relationship management (CRM). Improved

management will also support the order delivery process.

The special information needs of Company A focus on the serial number system for different product modules. Currently each department uses its own serial numbering system, making product data management very difficult and inconsistent. The must requirements of the company for the ERP system are, CRM supporting their customer relations management practices and consistent order information management throughout the production process.

In the contextual analysis of Company A, the consolidated flow model shows that informal communication is the primary mean for production data management. Production planning and notification of changes rely on a person circulating physically from one department to another many times a day. The cultural model strengthens the sense that the company is an expert organization, which has partially encouraged the departments to act individually. The heavy boundaries between departments have prevented the order delivery process from working efficiently. Contextual analysis showed very similar sequences in every department of the company. The same type of problems occurred; lacking input information for production, synchronization with other departments, and no notification of progress. The physical model reveals physical obstacles between the key person coordinating the production and others. The obstacle reduces the oral communication and forces the person to physically check the status of orders in the production places. When the Affinity Diagram, built by the multi-disciplinary team, was analyzed the board of executives was slightly surprised as to how many issues could be taken care of even without ERP system.

The risk analysis of Company A resulted the most serious risk in the ERP system selection to be ERP system incapable for product data management. The risk includes both options that the company either enters too detailed or too loose a product structure in the ERP system. The first case causes every product to be, despite the company strategy, unique and the second case prevents data search and the sorting option to be used efficiently. The most serious ERP implementation risks of Company A include e.g. the ERP project manager working only part time.

5.2 Company B

The strategy of Company B is to make their operation routines more systematic. This includes centralizing the all the process data into the ERP system apart from currently used files and notebooks.

Part of this strategy is to have the real time process data available in the ERP system. This requires the shop floor workers to enter production data more frequently into the ERP system. The company has also decided to implement the master production schedule (MPS) system to assist the production management. One of the must-be requirements is a batch numbering system that supports the production methods, and traceability of material, equipment and final products.

In the contextual analysis the flow model indicates that production progress information is transferred via various paper notes, reports, and phone calls even via personal communication. They all end centralized to one person only. This person, heavily relied on in the organization, has served the company for decades as can be seen in the culture model. The strong effort put on the information management could be reduced, and at the same time the production information could be spread through the organization by an ERP system.

In the future, the responsibility has to be delegated for production workers. The information input for the system can be efficiently decentralized if workers report manufacturing activities, working hours, quality measurements directly into the ERP system. The order delivery process sequence of Company B is highly complicated, but it cannot be easily re-engineered because of the quality requirements of the product. Producing explosives has its own special requirements for production environment (physically separated production phases as was seen in the physical model) and quality assurance seen in the sequence model. The contextual analysis of the company produced a sequence model that can be exploited in the ERP system selection or training processes.

The ERP selection risks of Company B included that the system will not be able to handle the exceptional conditions in production, for example, mixed batch and line type production processes or mixing different production batches to form a new product. The risk of selecting a system with too narrow a scope can limit the future changes in company operations, customer relations development and strategic co-operation. In the case of Company B, the risks related to the systematic and disciplinary use of the system are predictable and, when occurred, have a strong impact on company operations. If e.g. the production data is only partly entered into the ERP system, it becomes unreliable and useless.

5.3 Company C

The main strategy of Company C is to develop real time monitoring of their on-going projects. This could be realized if project sites were connected online to the

ERP system. The main focus should be on the systematic reporting of project schedules, progress, materials and resources. The company aims to standardize their offering and project price calculation processes. Also changes in purchasing and inventory management practices are needed. The must-be requirements for company's ERP system are project management, including sub-project management support, project budgeting and project site wireless connections to ERP system.

In the contextual analysis of Company C the consolidated flow model shows much of communication of the project information between different stakeholders, i.e. customer who orders the construction project, the raw material supplier, project managers and chief executives. The cultural model describes how well Company C conforms to the rules of construction work. On the contrary, the cultural model reveals that different persons, who were responsible of the same kind of task, have different ways to conducting their work. Consolidated sequence model of company C describes extensive amount of work related to offer preparation and price calculations. In addition inventory and purchasing management has problems because of inventory records are inaccurate.

ERP selection risks in company C relate to the project type operations, and the low level of usage of current ERP system. The company must invest heavily in technology, consultation and education if the construction sites are to be connected real-time to company's ERP system. The implementation risks culminate in bringing construction site foremen as ERP users. They may not be able to see how the ERP system benefits their work, because in the first stage it brings new duties. In the future, the material and human resource allocation in construction projects will heavily rely on the availability of the ERP system in the construction sites. The risk of disconnections has to be considered in ERP system usage of construction site project management.

6 Lessons learned and further work

The customer-centered ERP implementation method C-CEI is a truly multi-disciplinary approach for ERP implementation. It has been carried out by experts in two fields; user-centered design and industrial management. This combination has potential to introduce best practices from user research and operational analysis. For small and medium-sized enterprises (SMEs) the extensiveness of the approach means that they might have to hire external consultants

to help them carry out the activities of C-CEI method. On the other hand, an external point of view is sometimes needed when a company is developing its operations and practices.

This paper has presented novel research on how user-centeredness could be introduced to the ERP system requirements engineering. Ncube and Maiden [10] have implemented a software application for a Commercial-Off-The-Shelf type software selection. Their application compares the requirements and the product, but does not speak out how the requirements are collected and analyzed. The Contextual Design method applied in C-CEI was formerly unknown by the case companies. Even so, the personnel were keen to show their work to the observers, and to see the consolidated models of their company context of use.

In the contextual analysis of C-CEI, some phases required relatively extensive company participation, for example building the Affinity Diagram. Yet the results cannot be easily transformed to requirements of the system. The role of contextual analysis, however, is to make clear the amount and type of changes needed in the organization and context during the ERP project. In the future, other user-centered design methods could be exploited instead of Contextual Design.

Activities of C-CEI method prepare the companies for the trading with ERP system vendors. The board members of companies commented that C-CEI revealed the most important areas influencing their ERP system selection and implementation. They also stated that C-CEI method contributed significantly to their decision making process. For example, the planning process of the future (To-Be) business processes developed the company managers' knowledge of how ERP systems contribute to their business and management processes.

A small enterprise can be incapable of handling an ERP project on its own. At the same time, the methods used by large ERP system providers may appear too heavy and expensive to be used in an SME environment. Besides, these methods most often are vendor-dependent. C-CEI aims at enhancing customer company's operations also outside the ERP project.

The case companies have used in their earlier ERP projects consulting services or have done the selection and implementation planning by themselves. They judged C-CEI method clearly better than their earlier approaches. They considered C-CEI as diverse and inspiring, although demanding method

To support the application of C-CEI method, practical instructions, checklists and templates should be provided. The method will be developed towards a toolbox which could be adapted to be used by the vendors, consultants and the customers companies.

The results of C-CEI method can be exploited in different phases of company's ERP project. In the selection phase, C-CEI can be used for ERP system requirements engineering, and in the implementation phase the method can bring input to the planning of the implementation activities, e.g. testing and training. Even when the ERP system is in use, the results of C-CEI method can be used for rationalizing the production and enhancing the operational model of a company.

In the future research and development of C-CEI method the efficiency of the method will be investigated further. This includes the studying of how ERP system vendors exploit the results of C-CEI method. The usefulness of C-CEI method can be considered by the way how the implementation partners utilize the results of the contextual analysis.

Although there has not yet been a final measurement of the success of the ERP implementations of the case companies, it is already clear that these companies have put effort into their ERP projects and are more aware of the restrictions and possibilities of the ERP systems.

7 Conclusion

Small and medium-sized companies are implementing ERP systems to increase their competitiveness. The challenge is to find the best fit between target business process and ERP system logic. Another demanding task is to manage the organizational changes in order to improve efficiency on every level of the company. C-CEI method is developed to help companies, especially SMEs, in their ERP projects. In this paper, we have presented the method and three case studies where it is applied.

The contribution of C-CEI method is that first, it focuses on company-specific critical operations, such as operations under change, instead modeling standard business processes, such as paying the bills. Second, C-CEI exploits a user-centered design method Contextual Design, by which the company context of use is modeled and analyzed, and improvements identified. C-CEI results an ERP requirements document, which can be attached to the request for quotations from ERP vendors. Other results are the contextual and risk analysis documents to be used in planning and managing the ERP implementation project and process successfully.

Initial feedback from the case companies has been that C-CEI has succeeded in exposing the details of how the company actually operates, and in clarifying the role of ERP system in their future operational

model. Even though the method requires resources from the company, the impact of C-CEI method on company's ERP project is broad. Part of the effectiveness of C-CEI method relies on multi-disciplinary activities in which the key persons of a company's ERP project participate. C-CEI reveals potential pitfalls in ERP projects and increases SMEs' knowledge of ERP systems' limitations. Therefore, SMEs are able to avoid investments in inappropriate information systems. Finally, this will contribute to their ERP project success.

8. References

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