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Inka Vilpola

# Applying User-Centred Design in ERP Implementation Requirements Analysis



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## **Applying User-Centred Design in ERP Implementation Requirements Analysis**

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## Abstract

Companies adopt Enterprise Resource Planning (ERP) systems in order to streamline their business processes and to integrate their information systems. ERP implementations have reported failures e.g. because of a lack of integration into existing legacy systems or insufficient training and support for the business processes. User-Centred Design (UCD) aims at improving the effectiveness, efficiency, and user satisfaction of the system to be designed. In a Commercial-Off-The-Shelf (COTS) -type ERP system implementation, the user requirements are not used for designing an ERP system. Instead, the existing functionality of an ERP system is matched with the user requirements. Either the organisation adapts to the ERP system functionality or the ERP system is modified according to organisational requirements. UCD has been utilised in ERP system feature development, but it has not been systematically applied in COTS-type ERP system implementation. This dissertation provides a model of how UCD can be applied in the ERP implementation process. The focus is on how UCD can be applied in ERP implementation requirements analysis, with the aim to improve the success of ERP implementation.

In this research, a Customer-Centred ERP Implementation (C-CEI) method has been developed adapting action research approach. The C-CEI method attempts to develop an ERP implementation into a more holistic and multidisciplinary process by its three analyses: *operational*, *contextual*, and *risk analysis*. Operational analysis produces the requirements for an ERP system, and risk analysis considers the company-specific risks of an ERP implementation. The novelty of the C-CEI method is the adoption of UCD principles. For example C-CEI promotes user involvement in various levels of the company, as opposed to those analyses that focus on the management level. Furthermore, C-CEI requires a multidisciplinary design team, iteration of design results, i.e. requirements, and allocation of users' and an ERP system's function. The second novelty of the C-CEI method is the contextual analysis that applies a UCD method called *Contextual Design* in analysing the context of use. The results of this analysis reveal the need for changes in the organisation and its workers' processes. In addition, the method is vendor-independent and thus focuses on customer needs without the limitations of a specific COTS product.

The C-CEI method has been developed in cooperation with four companies. Even though not all the companies involved have yet selected an ERP system, the effect of the development of the C-CEI method has been studied from various perspectives. Content analysis of the documents produced during the development process reveals that the C-CEI method supports the identification and prioritisation of a company's requirements for the system, requirements for organisational change, and requirements for risk management during the implementation of ERP. Interviews with staff members from the participating companies highlight the benefits and challenges of the C-CEI method from the organisational perspective. The study of how C-CEI had affected the ERP implementation critical success factors in an organisation provided promising results. Overall, the positive responses (38) exceeded the negative ones (4) by far. In particular, C-CEI was commented on as having positive effects on top management support for the implementation of ERP and on the careful selection of an ERP system. Furthermore, interviews with ERP system vendors revealed that the results of C-CEI were supportive for their role in preparing the proposal for the customer. In summary, the results show that UCD has the potential to be included as a part of the ERP implementation process in order to support the achievement of ERP implementation objectives. This research has opened a new dialogue between UCD and ERP research communities.

## List of original publications

This dissertation includes the following original publications:

- I. Vilpola, I. and Väänänen-Vainio-Mattila, K., (2005), Evaluating Human Factors in ERP Implementations. Proceedings of the 12th European Conference on Information Technology Evaluation (ECITE2005), Edited by Dan Remenyi, Academic Conferences Limited Reading, UK, pp. 511-520.
- II. Vilpola, I. and Kouri, I., (2006), Improving ERP Requirement Specification Process of SMEs with a Customer-Centered Analysis Method. Proceedings of the Frontiers of e-Business Research (FeBR) 2005, Eds Seppä et al. Tampere University of Technology (TUT) and University of Tampere (UTA), pp.140-151.
- III. Vilpola, I., Väänänen-Vainio-Mattila, K. and Salmimaa, T., (2006), Applying Contextual Design to ERP System Implementation. Conference on Human Factors in Computing Systems (CHI), Extended abstracts on Human factors in computing systems, ACM Press, NY, USA, pp. 147-152.
- IV. Ojala, M, Vilpola, I. and Kouri, I., (2006), Risks in ERP project – a case study of IS/ICT management capability maturity level and risk assessment. Frontiers of e-Business Research, Maula, M., Hannula, M., Seppä, M., and Tommila, J. (Eds.), Tampere University of Technology (TUT) and University of Tampere (UTA), Tampere.
- V. Vilpola, I., Kouri, I. and Väänänen-Vainio-Mattila, K., (2007), Rescuing Small and Medium-sized Enterprises from Inefficient Information Systems – a Multi-disciplinary Method for ERP System Requirements Engineering. Proceedings of the 40th Annual Hawaii International Conference on System Sciences (HICSS), IEEE Computer Society, p. 242b.
- VI. Vilpola, I., (2008), A method for improving ERP implementation success by the principles and process of user-centered design. Enterprise Information Systems (EIS), Vol. 2, Issue 1, Taylor & Francis, pp. 47 – 76.
- VII. Vilpola I., (2008), Development and Evaluation of Customer-Centered ERP Implementation Method. To appear in Journal of Information Technology Theory and Application (JITTA), Ken Peffers, 9:4.

The author of this thesis is the sole author of Papers VI and VII. She is the main author of Papers I, III, and V. In Paper I the author was responsible for conducting the three post-implementation case studies and analysing the human factors in ERP implementations. In Paper III the author illustrated the cases, but Taru Salmimaa provided the visual models. In Paper V the author was fully responsible for the article, but Ilkka Kouri contributed to the section ‘Operational analysis’ and provided comments which led to improvements in other sections. Kaisa Väänänen-Vainio-Mattila played an advisory role in Papers I, III, and V.

In Papers II and IV the author shared the writing with the co-authors. In Paper II the author was responsible for the article, but Ilkka Kouri contributed to the sections ‘Proposed method for SMEs’ ERP requirement specification’, ‘Operational analysis’, and the description of operational analysis

in the 'Case study' section. In Paper IV the author was responsible for analysing the IS/ICT capability maturity of the companies. The author also compiled the results of the article. Mika Ojala was responsible for analysing the company-specific risks of the companies and comparing them to a common risk list. Ilkka Kouri edited the 'Introduction' section. All the papers describe the results of research projects in which the author was in charge of the research activities, except Paper VI, which is theoretical. The author and Ilkka Kouri are together responsible for initiating and organising this research.

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# 1. Introduction

ERP systems are large and modular information systems that cover companies' business processes, such as sales, production or logistics, or financials. According to the Finnish market intelligent service provider Aara Finland Oy, 66% of all the organisations and 82% of companies have ERP systems in use (Digitoday 2007). The principle of an ERP system is to collect and share the company data, e.g. orders or inventory, in such a way that redundancy is avoided. An ERP system can be connected, i.e. integrated, with other information systems, such as CAD systems. An ERP implementation is considered to include e.g. the process of ERP system acquisition, modification, training, and putting the system into use (Figure 1). The implementation process is challenging for companies, because the activities require the allocation of special competences and a number of human resources. The implementation is usually carried out concurrently with the daily business, which already ties up the available resources. The implementation process may last from a minimum of six months up to several years, and eventually it will affect everyone in the company. For example, top management make decisions on the basis of the information in the ERP system, middle management plan operations within the ERP system, and shop floor workers' tasks are assigned according to the information in the ERP system.

An organisation may confront difficulties in an ERP implementation. The time, resources and effort needed for the implementation is often underestimated. The changes required to business processes typically exceed the level that is expected, and therefore the scope of the implementation is difficult to manage. In the modification phase (Figure 1) the resourcing from both the business and IT is usually higher than anticipated, likewise the level of outside expertise needed. The difficulties in the modification phase are affected already in the evaluation stage (Figure 1). For example, the ERP system selection criteria are difficult to specify because of the competing needs of different units of the company. Additionally, the changes needed in the organisation can be challenging to identify in advance. The problems may appear when the new system is taken into use. For example, the city of Tampere implemented an SAP ERP system in 2006, but at the end of 2007 it was claimed that the system is still not working as it should (Aamulehti 30.11.2007). Stakeholders such as the service production manager and the manager of the Tampere group argued whether the blame lies with the system or the management. However, there were incompatibilities between different systems used by the City of Tampere, and therefore the information was not integrated, causing inconvenience to the end users. Even though an ERP project deals with workflow, i.e. process, it does not consider people and their job descriptions in practise (Besson and Rowe 2001).

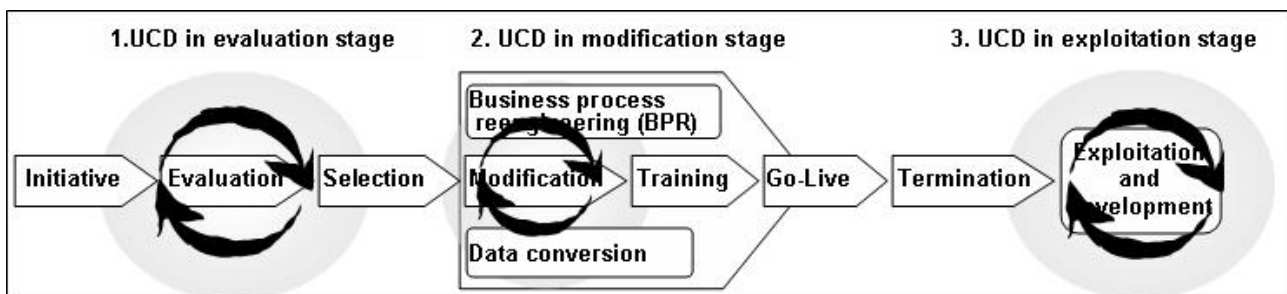


Figure 1. The method that combines three user-centred design (UCD) iterations in the ERP implementation process (Paper VI).

ERP vendors may provide an implementation template, which can, for example, describe the milestones or the documents that are produced during the implementation. Implementation services are part of the vendors' and consultants' businesses, and therefore are seldom scientifically



published. The major lifecycle of an ERP system in a company can be up to 15-20 years (if updates and extensions are excluded). Because adoptions take place rarely, the companies adopting the system are not intently developing the implementation process. Therefore the implementation needs to be developed in a vendor-independent manner so that the results are applicable for both the vendors and their customers. A more proactive approach needs to be considered and field experiments conducted to find out how the implementation could be improved. Improvements in the implementation of the ERP system affect the result, i.e. ERP system usage.

### **1.1 User-centred design approach to an ERP implementation**

User-centred design (UCD) has a focus on the design process of interactive systems. It has also been applied in the development of an ERP system's functionality. However, the objective and principles of UCD could also be applied in an ERP system implementation process. The combination of UCD and ERP implementation processes (Figure 1) is unexplored, although some examples of adapting a principle of UCD have been presented before. UCD may have minor or indirect affect to the costs or the schedule of implementation, but a major effect on the specification of ERP selection criteria and on identifying the changes needed in business processes. UCD also provides means to manage expectations.

The aim of this research, in general, is to introduce user-centredness in ERP implementation, and specifically to apply usability methods to the specification of ERP requirements. By user-centred methods, the organisational requirements can be identified and defined for the ERP system and its implementation and usage. A theoretical model of combining a user-centred design (UCD) process and an ERP implementation process is presented in Paper VI. In this model the UCD iterations are illustrated with the ERP implementation model of Mäkipää (2003) (Figure 1). The model includes three iterative UCD cycles: *UCD in the evaluation stage*; *UCD in the modification stage*, and *UCD in the exploitation stage*. All three UCD cycles are based on the UCD process and its four stages: (1) *specifying the context of use*; (2) *specifying the user and organisational requirements*; (3) *producing design solutions*, and (4) *evaluating the designed solutions against the user and organisational requirements*.

This research focuses on UCD in the evaluation stage, and other UCD cycles are discussed in the future work section (p.77). A novel Customer-Centred ERP Implementation (C-CEI) method was developed and evaluated within this research. The term 'customer' is used to emphasise that the activities of C-CEI are carried out in a potential ERP customer organization. The C-CEI method is vendor-independent and focuses solely on customers' needs, ignoring the vendors' solutions. The C-CEI method consists of three analyses: operational, contextual, and risk analysis. C-CEI applies the UCD principles and process. However, the term "customer-centered" refers to the focus of the C-CEI method, whereas user-centredness has a special meaning for the human-computer interaction (HCI) research area. Specifically, the UCD method called Contextual Design (Beyer and Holzblatt 1998) is applied in contextual analysis (Paper III).

The C-CEI method aims to capture the company's requirements for an ERP system and its implementation in a holistic manner. In this research, the C-CEI method is applied before the company selects an ERP system. The entire ERP implementation and its success in companies are evaluated from the requirements analysis perspective, because of the restricted focus and limited progress in ERP implementation in the companies that this research has been conducted in.

### **1.2 Research goals and approach**

This research combines user-centred design (UCD) and ERP implementation studies. UCD refers to adoption of UCD principles and processes in an ERP implementation requirements analysis, i.e.

adoption of the whole C-CEI method that enable critical success factors (CSFs) in its part. Some of the CSFs are affected by UCD more than others. The CSFs help an organisation to overcome the introduced challenges of ERP implementation, In brief, C-CEI supports usability, i.e. effectiveness, efficiency and satisfaction of ERP implementation, because of relevant requirements, managed expectations and managed risks in the early stages of implementation. The main research goal of this thesis is:

- to study the applicability of the UCD principles and process in ERP system implementation requirements analysis.

The supplementary goals of this research are:

- to develop a method that enables the critical success factors of ERP implementation in its part, and
- to gather real-world experience of the iterations of the C-CEI method within target organisations.

As the C-CEI is a new method, experience of its trials should be gathered. In this context, experience means resources needed, material produced and participants' impressions of the C-CEI method. Those are covered in Chapter 7 as results.

The research approach is action research, where the researcher cooperates with the subject of the study. The difference between action research and consultancy is narrow, but clear. An action researcher works closely together with the organisation, delivers and receives information, and learns within the research. In contrast to consultancy, in action research the scientific results are emphasised, in addition to the perceived useful results for the company. An action researcher plans and clearly communicates the objectives and activities in advance and then iteratively discusses the lessons learned together with the organisation.

Action research on the development of the C-CEI method includes: (1) evolution of the C-CEI method; (2) the method and its analyses; (3) content analysis of documents that each of the four companies involved produced; (4) interviews with the company staff members that participated in the development of C-CEI, and (5) interviews with ERP vendors that received the requirements document of C-CEI. The results indicate that C-CEI affects critical success factors positively, and facilitates the vendor-customer relationship, which affects the ERP system selection process. The principles and process of UCD are applicable in ERP implementation requirements analysis.

### **1.3 Contributions of the papers**

**Table 1. Relationship between research goals and the papers.**

Research goal	Papers
Applicability of the UCD	III, V, VI, VII
Development of the C-CEI method	II, VII
Real world experience of C-CEI	IV, V, VII

The papers present a path of how the Customer-Centred ERP Implementation (C-CEI) method is initiated, developed, and evolved. Relations of the research goals and the papers are presented in Table 1. In this research it was first shown by post-implementation case studies and by related research that most of the critical success factors relate to human factors (Paper I). Thus it was concluded that the context of use should be analysed at the beginning of an ERP implementation to support the organisational aspects of implementation. Moreover, the key players should be involved

in the implementation, and usability principles and processes should be applied in ERP implementation activities.

Then a holistic and multidisciplinary approach to ERP requirements specification, i.e. the C-CEI method, was introduced in Paper II. Paper II described the challenges of ERP implementation, especially for small and medium-sized organisations. As a conclusion the practical relevance of the results for the ERP system selection and implementation process of a company was emphasised.

The analyses of the C-CEI method were studied in detail; contextual analysis in Paper III and risk analysis in Paper IV. Since C-CEI applies the Contextual Design (CD) method (Beyer and Holzblatt 1998), Paper III presents the key modifications to CD. The paper also contributes to UCD practitioners and academics a novel application of CD in ERP implementation. Paper IV expands the risk analysis by analysing companies' IS/ICT capability maturity (Renken 2004) and comparing the effect of maturity to the company-specific risks identified and assessed. The paper further compares the company-specific risks to a common risk list (Sumner 2000). As a conclusion, company-specific risk analysis is recommended, especially for companies with low IS/ICT capability maturity. Paper IV applies the case study approach, because the focus is on company-specific risks instead of evolution of risks analysis.

The C-CEI method and how it can be applied are presented from companies' point of view in Paper V, whereas the development and iteration of the C-CEI method is presented in Paper VII. Paper V emphasises the practical arrangements, participants, resourcing, and phases of the C-CEI method. Paper VII, on the other hand, focuses on how the method has evolved during the development process from one company to another, and analyses the results from various perspectives. Staff members from the companies that participated in the development of C-CEI are interviewed, and the resulting company-specific documents of C-CEI are analysed.

The theoretical framework for combining UCD and ERP implementation processes is presented and discussed in Paper VI. The framework describes three target UCD processes within ERP implementation (Figure 1). This research is an example of the first of them. However, future work should explore the other UCD processes and evaluate the overall impact of UCD in ERP implementation.

## ***1.4 Organisation of the thesis***

This introductory part is organised as follows. Chapter 2 presents ERP implementation from various perspectives. The reasons why companies invest in an ERP system and how they measure its achievements are discussed. ERP implementation models are presented in order to give a range of phases and activities related to ERP projects. Implementation stakeholders, risks, and critical success factors are then introduced. Some issues related to COTS-type ERP implementation and business process reengineering, which is often concurrent with an ERP implementation, are illustrated. Chapter 3 presents the user-centred design (UCD) approach with its principles and processes. A few methods that relate to the empirical aspects of this dissertation are also presented. Chapter 4 concludes the related research conducted on combinations of ERP implementation and UCD. Other angles are the implementation of COTS-type ERP systems and the UCD of COTS type ERP systems. Chapter 5 briefly illustrates the research approach, methods, and process. Chapter 6 presents the development of the C-CEI method and its evolution. Chapter 7 presents an evaluation of the C-CEI method. Chapter 8 discusses and concludes the results and their implications for academics and practitioners. Chapter 9 summarises this research and presents topics for future work.

## 2. ERP Implementation

Enterprise Resource Planning (ERP) systems are integrated software systems that have functions to manage different business processes, such as material management, sales and operations planning, or order processing. The entire system can be built as tailored software, but that is seldom a realistic option, e.g. because of extensive costs. Instead, ERP systems are mostly commercial-off-the-shelf products (COTS) that are bought as a package and then modified or tailored according to business needs. The package can be one entity, provided by one vendor, or sometimes companies will have “best of breed” systems, in which their ERP system is built up from different ERP products. The best of breed solution has almost vanished, as it makes for extra costs because of interfaces between different software and difficulties related to the asynchrony of updates.

ERP implementation is a multidimensional process that includes various *stakeholders* in several *stages or phases*, which include many activities, such as defining key performance indicators and the process of measurement, or planning how the system will be rolled out. ERP implementations are modelled in order to understand the process. With the implementation models, researchers are able to study the causes and consequences, i.e. the relationships between different factors related to implementation. Moreover, practitioners, for example vendors and customers, are able to communicate, plan, and agree the stages and activities across the implementation. In their comparative case study Motwani et al. (2002) conclude that “*a cautious, evolutionary, bureaucratic implementation process backed with careful change management, network relationships, and cultural readiness can lead to successful ERP implementations*”. Having said this, however, they state that organisational readiness and proper change management are needed to support ERP implementation. The critical success factors (CSFs) of ERP implementation are a widely explored topic in ERP-related research. The CSFs can be used as guidelines for planning e.g. an ERP implementation strategy and activities. In this chapter these topics, implementation models (2.2), and stakeholders (2.3) are presented, as well as the risks and critical success factors (2.4) concerning the implementation project. COTS-type ERP systems and their implementation (2.5) are introduced before the need for business process reengineering (BPR) in most ERP implementation projects is discussed (2.6).

### 2.1 Motivation and Measurements

ERP implementation motivations can be categorised as *strategic*, *operational*, and *technical* (Parr and Shanks 2000b), or *organisational* instead the operational (Shehab et al. 2004). Strategic motivation covers issues such as system integration, multi-site standardisation, and improving customer service. Operational motivation covers process improvement, data visibility, and reducing operating costs. Technical motivation is about the renewal of the technical infrastructure. Organizational motivation links to business process reengineering and adapting the ERP package processes into an organisation. These motivations are on a somewhat abstract level, and need to be further divided into more concrete and measurable objectives. However, the categorisation helps practitioners to justify the implementation motives and academics to categorise e.g. implementation cases.

In more concrete level, the ERP implementation motivations can be either technical or business reasons (Markus and Tanis 2000). The technical reasons include e.g. replacing hard-to-maintain interfaces, eliminating redundant data entries and errors caused by them, and improving IT architecture. The business reasons relate to business objectives, such as improving business

processes, reducing business operating costs, reducing inventory, and reducing stock-outs. Even though measurement of the project and business should be carried out, the success of the implementation is a relative concept (Markus and Tanis 2000). An implementation project can be successful in terms of its scope, schedule, and budget, but still the business objectives may not be achieved. This can be caused, for example, by the failure to utilise the new system or simply because of changes in the market.

One of the key motivations to implement an ERP system is to *manage and connect the information flows* across organisations (Davenport et al. 2004). Therefore the managers are able to make their decisions on the basis of real-time data on the current state of their business. The information may need to flow between internal and external supply chain processes (Shehab et al. 2004). The information supports real-time management of plans and services, and therefore facilitates the competitiveness and customer-orientation towards business partners.

One of the concerns is how the data is entered into the ERP system in the first place. To collect the data accurately and efficiently, the transactions can be *automated* and thus there is a potential to *reduce the costs* (Davenport et al. 2004). Integration of business processes and the information systems support the automation of transactions across functions and locations (Shehab et al. 2004). Cost reduction is supported e.g. when a single data is entered only once into a system, and then it is accessible throughout the system. Another example of cost reduction is to automatically trigger purchase functionality based on material consumption. In a long run the sharing of common data and practises will reduce errors and enhance the productivity within an organisation (Shehab et al. 2004).

In order to *increase the business value* realised from the ERP system, companies should first prioritise the benefits and then create an action plan of how to achieve those benefits (Davenport et al. 2004). For example a company may improve the performance level of a supply chain network by reducing cycle times (Shehab et al. 2004). These objectives, however, require the ERP system to be fully integrated with all the existing systems of the enterprise, and the organisation to adapt to the processes and practises provided by the ERP system. In addition, the implementation scope has to be enterprise-wide; otherwise, the sharing of data and practises suffers.

The scope of an ERP implementation can be used for categorising implementations. Parr and Shanks (2000b) categorised ERP implementations into Vanilla, Middle-road, and Comprehensive according to their *physical scope*, *business process reengineering (BPR) scope*, *technical scope*, *module integration strategy*, and *resource allocation*. The physical scope includes both the geographical scope and number of users. The BPR scope has options (1) alignment to ERP, (2) global BPR, or (3) local BPR. The technical scope may vary from no modifications to major modifications. Module implementation strategy involves two phases. First, it needs to be decided whether only skeletal or full ERP functionality is to be implemented. Second, the integration approach is chosen, either module by module or all the modules are first implemented and then integrated. Resource allocation is expressed in scales of time (6 months to 6 years) and budget (\$A1.3M-\$A70M).

The ERP implementation motivations and categories can be used in planning or analysing implementations. However, a company needs to measure the results of an implementation. Metrics can be based on objectives derived from motivations, for example increasing profitability, lowering costs, and reducing cycle times. Some expected results, however, are difficult to measure, such as the level of competitiveness and automation. Measuring the effects of the implementation should not be different from the everyday monitoring of the business. This can be the reason why the

measuring of achievements has not been largely covered in ERP research. Operational metrics that are available for various business areas can be utilised in the measurement. For example, the Supply-Chain Operations Reference (SCOR) model has SCORCard metrics for customer-oriented metrics, e.g. supply chain reliability, flexibility, and reactivity, and internal metrics, e.g. costs and restricted capital. SCOR does not cover business areas such as sales and marketing, product development, research, or after-sales (Supply-Chain Council 2007).

The measurement should take place in different phases of implementation, and, furthermore, it should cover financial, technical, and human issues (Markus and Tanis 2000). As a minimum set *project metrics*, *early operational metrics*, and *longer-term business results* are offered. Project metrics include comparing project team performance against the planned schedule, budget, and functional scope. Early operational metrics cover the business performance measurement before the operations are normalised. These include e.g. customer calls missed, labour costs, order fulfilment cycle time, and error rates. Longer-term results are more qualitative than other metrics, and may include e.g. the continuous improvement of business performance metrics, maintenance of internal ERP competence, and upgradeability of the ERP system.

## **2.2 Implementation Models**

ERP implementations are modelled in order to structure such a large entity into pieces capable of being handled, i.e. stages or phases. A similar approach has been used in modelling e.g. software engineering projects. The phases can then be described by the objectives, activities, and stakeholders involved. The implementation models serve, for instance, managerial, planning, educational, and research purposes. They also facilitate communication about ERP implementation topics. Various models of ERP implementation exist, and they vary according to e.g. the number of phases (Table 2). For example, the model of Umble et al. (2003) includes 11 phases and it gives practical checklist-type guidance for an ERP implementation. On the other hand, the models of Markus and Tanis (2000) or Parr and Shanks (2000a) are very general, and are merely used for analysing ERP implementation projects. The models are useful in studying, analysing, or planning ERP implementations.

Generally, the phases before the acquisition of an ERP system are emphasised, as well as the phases after the ERP system has started to be used. A broad concept of an ERP implementation also covers these after and before phases. The preliminary phases are, for example, initiation and requirements definition (Kurupparachchi et al. 2002), project chartering (Markus and Tanis 2000), and initiative and selection (Mäkipää 2003). Verville and Haltingen (2003) even present a Model of the ERP Acquisition Process (MERPAP). The phases after the ERP system is put into use are described as termination (Kurupparachchi et al. 2002, Mäkipää 2003), onward and upward (Markus and Tanis 2000), exploitation and development (Mäkipää 2003), enhancement (Parr and Shanks 2000a), acceptance, routinisation, and infusion (Rajagopal 2002), and stabilisation, continuous improvement and transformation (Ross 1999).

In some cases an ERP implementation concept may cover only the phases between the acquisition and beginning of usage of a system, i.e. 'go-live'. The parallel activities of business process reengineering and system modification have been illustrated e.g. by Mäkipää (2003), whereas Parr and Shanks (2000a) emphasise technical issues such as configuration, testing, and installation. More detailed models of ERP adoption activities are provided by e.g. Umble et al. (2003).

**Table 2. ERP implementation models.**

<b>Author(s)</b>	<b>ERP implementation model</b>	<b>Notes</b>
Bancroft et al. (1998)	(1) Focus, (2) Creating As-Is picture, (3) Creating of the To-Be design, (4) Construction and testing, and (5) Actual Implementation	
Kurupparachchi et al. (2002)	(1) Initiation, (2) Requirement definition, (3) Acquisition/development, (4) Implementation, and (5) Termination	A model of IT projects
Markus and Tanis (2000)	(1) Project chartering, (2) The project, (3) Shakedown, and (4) Onward and upward	
Mäkipää (2003)	(1) Initiative, (2) Evaluation, (3) Selection, (4) Modification, Business Process Reengineering, and Conversion of Data, (5) Training, (6) Go-Live, (7) Termination, and (8) Exploitation and Development	Three parallel phases in phase number 4.
Parr and Shanks (2000a)	(1) Planning, (2) Project: a. setup, b. reengineer, c. design, d. configuration & testing, e. installation, (3) Enhancement	
Rajagopal (2002)	(1) Initiation, (2) Adoption, (3) Adaptation, (4) Acceptance, (5) Routinisation, and (6) Infusion	Applied from Kwon and Zmud's (1987) model of IT implementation
Ross (1999)	(1) Design, (2) Implementation, (3) Stabilisation, (4) Continuous improvement, and (5) Transformation.	
Shields (2001)	Rapid implementation model of three phases and 12 major activities	
Umble et al. (2003)	(1) Review the pre-implementation process to date, (2) Install and test any new hardware (3) Install the software and perform the computer room pilot, (4) Attend system training, (5) Train on the conference room pilot, (6) Establish security and necessary permissions, (7) Ensure that all data bridges are sufficiently robust and the data are sufficiently accurate, (8) Document policies and procedures, (9) Bring the entire organisation on-line, either in a total cutover or in a phased approach, (10) Celebrate, and (11) Improve continually.	
Verville and Haltingen (2003)	(1) Planning, (2) Information search, (3) Selection, (4) Evaluations, and (5) Negotiation	Model of the ERP Acquisition Process (MERPAP)

In order to have an insight into the possible depth of a phase description, the *Enterprise System Experience Success Model* of Markus and Tanis (2000) is taken as an example. The model could easily be used as a template in ERP project planning activity. Markus and Tanis (2000) adapted their model from the framework of Soh and Markus (1995), which describes how IT investment turns into business value. In order to match the enterprise systems implementation, Markus and Tanis changed the outcomes from business value to success, and added an initialising phase. Even though the model has only four coarse phases, (1) *project chartering*, (2) *the project*, (3) *shakedown*, and (4) *onward and upward*, they describe the ERP implementation project in detail. The abstract objective of each phase is described as:

1. Project chartering = “Ideas to dollars”: decisions defining the business case and solution constraints
2. The project (configure and rollout) = “Dollars to assets”: getting system and end users up and running
3. Shakedown = “Assets to impacts”: stabilising, eliminating bugs, getting to normal operations
4. Onward and upward = “Impacts on performance”: maintaining system, supporting users, getting improved results, upgrading technology

In addition, Markus and Tanis (2000) specify each phase in detail: *description*, *key actors*, *common errors or problems*, *typical performance metrics*, and *possible outcomes*. Furthermore, they define, for each of the four phases, *a successful outcome*, *necessary conditions*, *probabilistic processes*, and *recipe for success*. For example, the “Project chartering” phase is described in detail in Table 3.

**Table 3. Detailed description of the first phase “Project chartering” from the Enterprise System Experience Success Model of Markus and Tanis (2000).**

Phase name	Project chartering
Description	Making decision on project approval and funding.
Key Actors	Executives, IT specialists, enterprise systems vendor, and consultants
Typical activities	Developing business case for investment, defining key performance indicators, analysing current state of performance, selecting a system, selecting an implementation partner, assigning project manager, making an initial plan of system implementation, communicating the organisation, defining the organisational changes and incentives related to performance improvement, making decision to proceed, and approving the project plan.
Common errors or problems	Vendors and consultants oversell the system, failure in linking the technology and business strategy plans, business case and project plan are unrealistic, performance indicators and process owners are not defined, software, hardware, integrator, or project manager are inappropriate, contracts are inadequate, long-term support and migration plans are lacking, need for business change and change management are underestimated, and organisational requirements are misunderstood.
Typical performance metrics	Not usually measured. Possible metrics include: quality of business case, business strategy alignment, relevance of performance metrics, and soundness of project parameters such as schedule and budget.
Possible outcomes	Either abandonment of enterprise systems integration idea because of insufficient business benefits, or deciding to proceed with the project according to the plan.
Successful outcome	Proceeding with decision on an enterprise system project with sufficient chartering and a sound business case.
Necessary conditions	Executive participation, assessment of business conditions and needs, understanding characteristics of enterprise systems, well defined and communicated business case shared with relevant parties.
Probabilistic processes	Managerial decision-making, environment and technology information distribution, availability of competent people for challenging untested assumptions, communication gaps of humans, acceptance of changes needed, and volatile business conditions.
Recipe for success	Executives make sound decision on enterprise system investment, and align organisation with the decision.



ERP implementation models help practitioners and academics see the wide range of alternatives in ERP implementation projects. Following a model reduces the risk of ignoring an important event or aspect of implementation. These models also provide a common language for an organisation to use during the implementation project. Without these models it would be impossible to manage an implementation project and to decide how to set milestones without dividing the project into chunks first. In addition, the models provide a framework for ERP-related research to further deepen and explore the understanding of ERP implementation projects.

### 2.3 Implementation

ERP implementation stakeholders are those who facilitate the change, put the implementation into practise, and eventually either directly use the system or indirectly use the results of the use of the system. Their motivation concerning the ERP implementation varies according to their role. The personal work history and organisational status are also factors that affect personal motivation (Abdinnour-Helm et al. 2003). ERP system implementation includes several stakeholders from various organisations; Figure 2 presents, for example, an ERP system vendor, an implementation consultant company, and a customer company that is putting the ERP system into use. In the company that is putting the ERP system into use there are several stakeholders. For example, Skok and Legge (2002) consider an ERP project to have four key parties: management, users, developers, and consultants, of whom only consultants are considered to be external to the organisation.

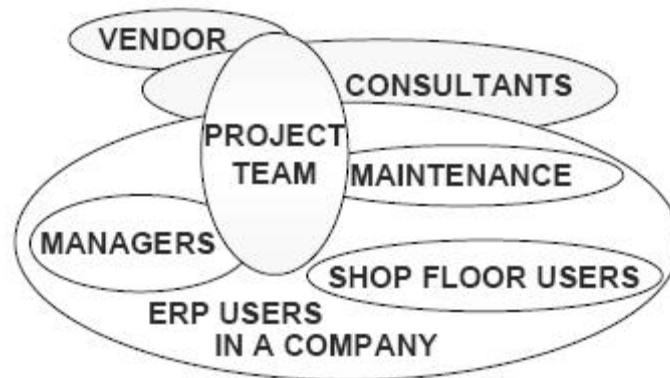


Figure 2. Stakeholders in ERP Implementation.

Somers and Nelson (2004) call them key players. From the research literature they identified eight key players: (1) top management; (2) project champion; (3) steering committee; (4) implementation consultants; (5) project team; (6) vendor-customer partnerships; (7) vendor's tools, and (8) vendor support. If only persons or parties are considered as the key players, then the last three can be considered as one key player, i.e. the vendor. Surprisingly, the project manager is not mentioned alone in the list of Somers and Nelson (2004), even though it is in their top ten list of critical success factors (Somers and Nelson 2001): project management. Markus and Tanis (2000) state that in the project chartering phase the key players also include company executives and IT specialists. Their participation depends on whether the ERP project is business- or IT-driven. Markus and Tanis (2000) also note that when the ERP system starts to be used, control is passed over to the operational managers and end users. The most extensive scope for the term 'key player' is provided by Skok and Legge (2002). They show how two companies in their study treated all the staff as key players, and paid loyalty bonuses for everyone as an incentive for the implementation.

Top management support is agreed to be most important to ERP implementation (Somers and Nelson 2001). Grabski and Leech (2007) state that a steering committee enables senior management to be directly involved in the implementation project. Committing senior executives to the steering

committee also increases the project's importance within the organisation. Verville and Halington (2002) present the formation of a steering group. In their study the steering group of a company was composed of officials right across the functions of the company. The steering group participated in the acquisition process, which they directed and on which they finally approved the decision. Chien et al. (2006) state that decision-making can be centralised to a project manager or to a steering committee. Centralising can improve the consistency of an ERP implementation with company goals, but it may reduce the motivation of the implementation team.

Boonstra (2006) suggests that the project manager should be aware of the diverse opinions of the stakeholders. Then the project manager is able to take them into account and try to affect them in a manner that benefits the implementation. Al-Mudimigh et al. (2001) state that the project manager and steering committee together select the project team.

In ERP vendor companies, stakeholders include e.g. a salesperson, and usually another person who assists with the technical details. Then an ERP vendor's project manager can be a third person representing the vendor in the implementation. In later phases, for example in the training, testing, or go-live phases, the vendor's personnel can be in a supportive role. The implementation consultant can be vendor-independent, but nowadays they have references from certain ERP system(s). A customer company may hire the consultant before or after the system selection. Umble et al. (2003) state that ERP system vendors make assumptions about management and business processes. Therefore the acquisition of an ERP system is more than buying software. At the same time the vendor's opinion about best practises in business processes is also bought. Alleman (2002) recommends that ERP vendor and integrator payments should be tied to the accomplishment of real tasks instead of payments being tied to an implementation schedule.

End users are seldom mentioned among the key players in ERP implementation. Naturally, the implementation team is crucial for the planning and execution of the implementation activities, but from the business process perspective, the end users are the most critical players in ERP system implementation. Without their acceptance, the system is a waste of money. However, their ERP competence, commitment, expectations, and acceptance might already be affected in the implementation. Other end users include the group leaders, who have an effect on others in their group. Baskerville et al. (2000) describe them as power users, and describe them as follows: "Power users are self-starting leaders with a quasi-formal role as internal consultants among the users". It is group leaders that are able to convince colleagues that it is beneficial to use the ERP system. These group leaders should be taken along effectively in the implementation in order to ensure their commitment (Aladwani 2001). Their advantage is that they know more about using the system than the IT technicians do, and more about the business context than external consultants (Baskerville et al. 2000). In some cases these users can be called project champions or key users as well.

The roles of stakeholders can be temporary or relatively permanent regarding their tasks. For example, the project manager of a customer company is temporary and valid for the implementation project only, whereas the project manager of a vendor company is more permanent, because their work remains the same from one customer to another. Power users ought to be temporary only for the time of the implementation project, but often the role is continued and they are responsible for further developing the system in their area of their business. However, dedication and motivation suffer the most if a role, but not the time and other resources required by the role, is given to a person. As in other project practises, in an ERP implementation project too, the roles should be explicitly expressed in terms of the persons allocated to a role, responsibilities included in the role, and resources, e.g. time, needed in the role. Defining the roles in the early phases will help in the further planning and execution of the activities of the ERP implementation project.

## 2.4 Critical success factors and risks

The consensus concerning ERP implementation is that multiple factors affect success. Pinto and Slevin (1987) have defined implementation project success as a function of critical success factors (CSFs). ERP implementation research has widely tried to specify the CSFs of ERP implementation projects. Somers et al. (2000) conducted an extensive literature review on CSFs, and surveyed their importance for ERP implementation (Somers and Nelson 2001). As a result of 86 responses, they presented a ranking list of 22 CSFs (Table 4). The list is utilised in related studies e.g. by Akkermans and Helden (2002).

**Table 4. Mean rankings of CSFs by degree of importance in ERP implementation (Somers and Nelson 2001)**

Critical success factor	Mean	Std. Dev
1. Top management support	4.29	1.16
2. Project team competence	4.20	1.07
3. Interdepartmental cooperation	4.19	1.20
4. Clear goals and objectives	4.15	1.14
5. Project management	4.13	0.96
6. Interdepartmental communication	4.09	1.33
7. Management of expectations	4.06	1.37
8. Project champion	4.03	1.58
9. Vendor support	4.03	1.60
10. Careful package selection	3.89	1.06
11. Data analysis & conversion	3.83	1.27
12. Dedicated resources	3.81	1.25
13. Use of steering committee	3.79	1.95
14. User software training	3.79	1.16
15. Education in new business processes	3.76	1.18
16. Business Process Reengineering, BPR	3.68	1.26
17. Minimal customisation	3.68	1.45
18. Architecture choices	3.44	1.19
19. Change management	3.43	1.34
20. Partnership with vendor	3.39	1.21
21. Use of vendors' tools	3.15	1.57
22. Use of consultants	2.90	1.20

Somers and Nelson (2001) use a reference model which has the same phases as in Rajagopal's (2002) ERP implementation model, in order also to prioritise the CSFs in different phases of the implementation. Similarly, Nah et al. (2001) found 11 CSFs through a comprehensive literature review and mapped them to the four phases of the reference model of Markus and Tanis (2000). The advances represented by these mappings are that in such a large-scale project it is challenging to focus on everything at once. Instead, for each implementation phase CSFs can be identified that are more important than the others. Besson and Rowe (2001) have also used the ERP implementation model of Markus and Tanis (2000) as a reference model in order to interpret ERP project dynamics, such as problems occurred in the chartering phase. In one of their examples the IT and the finance departments argued about ERP project leadership, which indicate failure in the CSF of interdepartmental cooperation. Then the executive committee recruited somebody outside,

but unfortunately the recruit had any managerial expertise. Thereby also the CSF of project management was now at risk.

Hong and Kim (2002) used a survey as a tool to identify how the ERP system and process adaptation affect the success of an ERP system implementation. They defined the variables as:

**Implementation success:** the degree of deviation from project goal in terms of expected cost, time, system performance, and benefits

**Organisational fit of ERP:** the degree of alignment between ERP model and organisational needs in terms of data, process, and user interface

**ERP adaptation:** the amount of effort and time spent on ERP alteration to align with organisational process needs except for ERP customisation

**Process adaptation:** the amount of effort and time spent on process change to align with ERP

**Organisational resistance:** the strength of negative organisational response to ERP implementation

As a result of the survey of 34 firms and a total of a hundred and five questionnaires, it came out that organisational fit is critical in explaining the success of an ERP implementation. ERP adaptation showed a significant negative correlation with implementation success, implying that if the organisational fit is estimated to be low, then it would be safer to adapt the process rather than the ERP system. The result could be interpreted as meaning that in most cases external expertise is needed in adapting the ERP system according to the customer's needs. However, the external actors, such as consultants, can be more difficult to manage than the internal actors that are needed if the process is adapted instead the ERP system.

The CSFs presented above are mostly collected from cases where a new system is implemented. However, ERP implementation can be seen as on-going activity, because the ERP system is constantly being updated and maintained and some new modules can be attached to it. Davenport et al. (2004) found that none of the 191 companies in their study reported their implementation as completed. Beatty and Williams (2006) collected recommendations from firms that had completed their ERP system upgrade projects. The recommendations are:

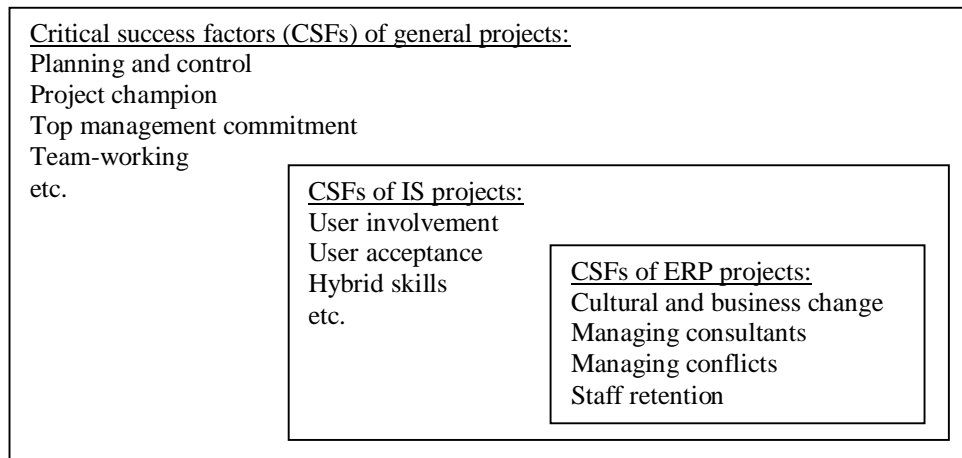
1. Build your business case on a new functionality
2. Treat the upgrade like a new project in order to avoid underestimating the resources needed
3. Continue with the same team as in the initial ERP project to save the orientation effort
4. Treat the project as business, not an IT project
5. Beware of the hidden infrastructure costs caused by the upgrading of the technology needed
6. Un-customise customisations in order to save on maintenance costs
7. Test carefully, because upgrades may affect existing systems and processes
8. Provide sufficient training for the users, because the utilisation of the system depends on the organisation's ability to use the system.

These guidelines mostly apply to a first-time ERP implementation project as well, but it is still relevant to discuss the upgrade projects separately. After a large-scale ERP implementation project the organisation may consider upgrading as a minor effort and an easy task. However, the upgrade affects parts of the organisation and has similar phases to a first-time ERP project. Therefore the critical success factors, as well as the ERP implementation risks, should be considered together with management activities.

### **Categorisation of critical success factors**

Long lists of CSFs can be difficult to adapt to an ERP implementation project. Therefore various categorisations try to structure these lists by dividing the CSFs into groups. Skok and Legge (2002) created a hierarchy of CSFs on the basis of their interviews in case companies (Figure 3). The

interviews were based on nine CSFs presented originally by Bancroft et al. (1998), but then it was noticed that some CSFs are more specific to ERP projects than others.



**Figure 3. Hierarchy of CSFs or priority areas adapted from Skok and Legge (2002).**

The authors suggest that especially the CSFs of ERP projects are paid high-priority attention in ERP projects. Holland and Light (1999) divided the CSFs identified from the literature and experiences of the organisations into the categories of *strategic* and *tactical* CSFs. Esteves-Sousa and Pastor-Collado (2000) divided CSFs found from the literature (10 articles from the years 1997-1999) into *organisational* and *technical* CSFs, and furthermore into *strategic* and *tactical* CSFs, as did Holland and Light (1999). In the matrix, it was clearly shown that the organisational CSFs predominated over the technical ones. Tossavainen (2005) divides the CSFs from the literature (15 articles from the years 1998-2003) into four categories: (1) management; (2) project team/structure; (3) methods and tools, and (4) technology. Tossavainen stated that methods and tools were posited and noted as contributing most to the work, but the other categories should be examined further.

A large and complicated set of ERP implementation CSFs is presented by Al-Mashari et al. (2003). Their taxonomy relates the activities of ERP project phases, ERP success, and ERP benefits. The actual CSFs are presented via ERP implementation phases:

- Setting-up
  - Management and leadership, Visioning and planning
- Implementation
  - ERP package selection, Communication, Process management, Training and education, Project management, Legacy systems management, Systems integration, Systems testing, Cultural and structural changes
- Evaluation
  - Performance evaluation and management

ERP success is defined by *correspondence success*, i.e. the match between it and the planned objectives, *process success*, i.e. the project is completed in time and within the budget, *interaction success*, i.e. users' attitudes towards IT are positive, and *expectation success*, i.e. the system matches users' expectations. ERP benefits in turn are divided into groups of *operational*, *managerial*, *strategic*, *IT infrastructure*, and *organisational benefits*. The taxonomy proposes a tight link between the ERP implementation approach and business process performance measures.

## **Risks and Risk Management**

The CSFs are gathered and analysed in order to improve the success rate of ERP system implementations. The other purpose is to avoid the pitfalls, i.e. risks, of ERP implementation. ERP project failures can be divided into four categories: (1) process failure, i.e. the project is not completed within the schedule or budget; (2) expectation failure, i.e. the IT system does not match the users' expectations; (3) interaction failure, i.e. the users have a negative attitude towards the system, and (4) correspondence failure, i.e. the system does not meet the planned objectives (Aloini et al. 2007). The failures mirror the ERP success factors of Al-Mashari et al. (2003).

As ERP project-specific risks, in contrast to IS projects risks, are identified: (1) failure to redesign business projects; (2) failure to follow enterprise-wide design that supports data integration; (3) insufficient training and reskilling; (4) insufficient internal expertise; (5) lack of business analysts with business and technology knowledge; (6) failure to mix internal and external expertise effectively; (7) failure to adhere to standardised specifications which the software supports; (8) lack of integration, and (9) attempting to build bridges to legacy applications.(Sumner 2000) In order to manage the risks they should be divided according to the implementation phases and related, for example, to CSFs. A planned and systematically adopted risk management procedure throughout the implementation project reduces the possibility of risks occurring. As a result of an extensive literature review on risk management in ERP implementation projects, Aloini et al. (2007) suggests following as the main phases of risk management:

1. Context analysis;
2. Risk identification;
3. Risk analysis;
4. Risk evaluation;
5. Risk treatment;
6. Monitoring and review;
7. Communication and consulting.

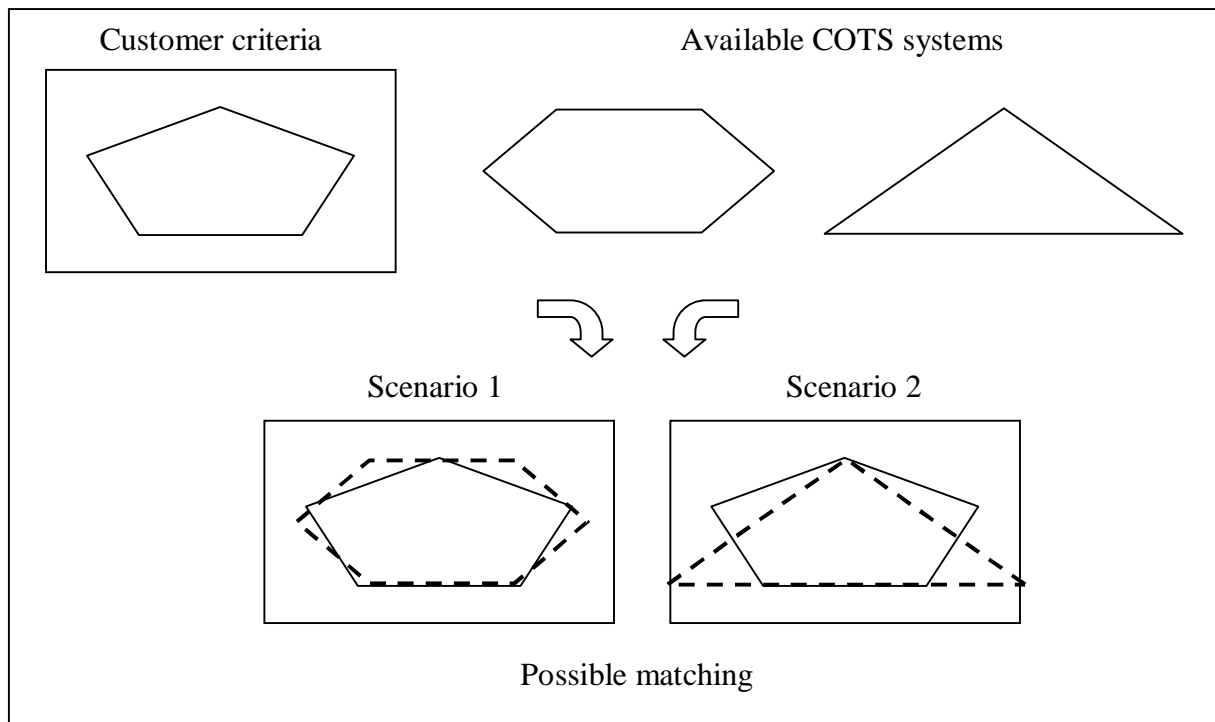
Instead of using ready-made risks lists, a company might consider identifying their own, company-specific, ERP implementation risks. These risks could then be complemented by common risk lists, such as Sumner's (2000). The risk management supports this by proposing the context to be analysed first in order to identify the risks.

## **2.5 COTS-type ERP systems and their implementation**

Commercial-off-the-shelf (COTS)-type ERP systems are commonly used as they are already-tested software products and save in-house development effort. Therefore the approach of using COTS products can be called a procurement-centric rather than a development-centric approach (Alves and Finkelstein 2002). The challenge of COTS-type ERP systems is their selection, which is often based on subjective evaluations, current partnerships, and vendor marketing. Demonstrations are the best way to understand the available products, but they offer a limited chance to verify whether the requirements of the customer company can be met.

As many of today's ERP systems are available as commercial-off-the-shelf (COTS) products, the requirements engineering (RE) in these cases is different from traditional IS requirements engineering. IS development requirements are supposed to be complete, whereas COTS requirements are incomplete in their nature. The COTS requirements merely limit the number of products to be considered, which can then be evaluated in more detail. This incompleteness can be

described humorously as IKIWISI ('I know it when I see it') (Soffer et al. 2001). Most often, none of the COTS-type ERP systems available totally fulfils the customer criteria (Figure 4), but then the customer needs to decide the areas for trade-off.



**Figure 4. Matching between customer criteria and properties of available COTS systems (Alves and Finkelstein 2002, adapted).**

The ERP implementation market is covered by product and service providers. Some of the service providers have their own (COTS-type) product that they sell and implement for customer companies. Other service providers offer integration services and they help customer companies to select and implement an (COTS-type) ERP system available on the market. Another segment of service providers is the information system developers, who tailor the system exactly as the customer company will have it. These systems are not considered to be COTS. According to Aara Finland Oy, the ERP market in Finland is divided into at least three markets, according to the size of companies, and several different industries, such as retail and manufacturing (SWbusiness.fi 2007). For example Lean System, provided by TietoEnator Oyj, is an ERP software application for industrial environments and project control (VTT 2002). It has been adapted by several manufacturing companies in Finland, such as ABB, Neste Oil, and Sinebrychoff (TietoEnator 2007).

Globally, the playground of service providers is heavily competitive. In 2004 the top five ERP vendors, SAP, PeopleSoft, Oracle, Sage Group, and Microsoft Business Solutions, accounted for 72% of the global revenue (AMR Research 2005). The revenue of SAP was 9.372 \$ M in 2004, and its share was 40% of the market. Vendors have used different tactics. Some players place great emphasis on building the brand. For example, SAP has reached a nearly unbeatable position in the market, in which only Oracle is seriously competing with it. The position may indicate for a customer company that e.g. the failure of an SAP implementation can be considered more acceptable than a failure in another, smaller, ERP system implementation. Because of its large amount of references, long lifecycle, and reputation as a massive information system, the failure is more easily considered as the user's own inexperience than in the case of another ERP system implementation.

If an ERP product gains enough references from one industry, it may become a *de facto* ERP system in that particular type of company. Some ERP products are used and marketed more in certain parts of the world, but this may decrease as a result of the globalisation of both vendor and customer companies. On the one hand, an ERP system vendor may argue for their own product that ERP systems overlap, i.e. they all have basically the same functionality (Akkermans and Helden 2002). On the other hand vendors deliberately differentiate their products in order to improve their competitiveness (Alves and Finkelstein 2002). Standardising ERP products would help the matching of ERP customer requirements and COTS products.

The benefits of COTS-type ERP systems are that they can be considered as ‘best practises’. This means that if a company adapts its business processes according to the ERP system, then the processes should be improved. Adopting COTS systems without modifications saves implementation costs and improves the upgradeability of the system. However, adopting a COTS system forces the organisation to align its processes according to the system. Changing workflows and tasks affect workers on different levels of the organisation, and therefore, it requires managerial competence and top management support in order to succeed.

## 2.6 Business Process Reengineering

Business process reengineering, BPR, is an organisational development activity that aims at more efficient and effective operations in a company. Hammer and Champy (1993) state that “Reengineering is the fundamental rethinking and radical redesign of business processes to achieve dramatic improvements in critical, contemporary measures of performance, such as cost, quality, service, and speed.” Zhang and Cao (2002) have compared BPR and continuous improvement (CI). BPR means radical changes in workflows, whereas CI is the incremental improvement of business processes. The same authors also consider the dimension of organisational change in BPR (Table 5). Functional improvement is closer to continuous improvement. Process redesign is what is considered by BPR in ERP implementation, whereas business rethinking is more challenging to manage concurrently with an ERP system implementation.

**Table 5. Dimensions of organisational change with BPR, adapted from Zhang and Cao (2002).**

	Functional improvement	Process redesign	Business rethinking
Objective	Incremental improvement in productivity	Order of magnitude improvement in process performance	New level of process innovation measured by the value set of costs, quality, lead time, delivery reliability and product function
Scale	Departmental/ Functional orientation	Cross-functional participation including customer	Redefining the business mission and vision
Focus	Reducing unnecessary tasks and streamlining workload	Redesigning workflow, technology and people components of processes	Dramatic change in products, services, channels, markets
Time	Three to six months	Six to twelve months	One to three years

BPR originally refers to designing new processes on a “clean sheet of paper”, i.e. without constraints. The idea is to discard all the existing processes and replace them with totally new ones. However, one of the objectives of an ERP implementation is “to create process-oriented information systems and information-oriented processes” (Davenport 2000, p. 142). The key to this



kind of effective implementation is *ES-enabled reengineering* (Davenport 2000, p. 147), in which ES (Enterprise systems) refers to ERP systems. In ES-enabled reengineering a company first decides whether to use an ERP system to support the new processes and quickly analyses its existing business processes. If the ERP system is not to be used, then a conventional BPR can be conducted. Otherwise a company needs to reconcile its processes with the properties of an ERP system. The reconciling consists of developing process design principles, i.e. objectives, and then configuring the ERP system to meet the design. Configuring is about deciding thousands of parameters that affect data management inside an ERP system. Because of the number of parameters, some industry-specific preconfigured systems are available in the market. Es-enabled reengineering is very system-focused and the organisation adapts to the processes supported by the system. On the positive side, using this approach, the ERP system will fit the processes of the company, but on the negative side these processes may not be the most competitive for the company.

## 2.7 Requirement Analysis Methods

ERP implementations have been mostly studied analysing the activities taken without attempt to affect to the studied implementations directly. Esteves and Pastor (2001) in their annotated bibliography on enterprise resource planning research found ERP implementation methodologies pointed out as a critical success factor. However, they also denote a lack of studies about definition and usage of these methodologies. Shehab et al. (2004) in their integrative review on ERP presented any ERP implementation methodologies. Instead they suggest that “Further research is necessary to develop a new technique for adopting the ERP system to overcome the shortcomings of the current approaches [BPR and ERP system modification]. The new implementation model should take the SMEs into consideration.” In order to review existing methods or methodologies a search on titles of articles was conducted to following large scale scientific article libraries (Table 6):

- [www.emeraldinsight.com](http://www.emeraldinsight.com) the world’s leading publisher of management research
- [www.Sciencedirect.com](http://www.Sciencedirect.com) is Elsevier’s database of over 2500 journals and 6000 books.
- The ACM Portal is published by the Association for Computing Machinery.
- IEEEExplore

**Table 6. Article review about ERP implementation requirements analysis methods.**

Library / words in title	Emerald	Elsevier	ACM	IEEE
ERP implementation + method	0	0	0	1
ERP + requirements engineering	0	0	0	7
ERP + requirements	1	2	1	11

ERP implementation requirements analysis method should propose a procedure how implementation stakeholders identify the company-specific requirements for an ERP system selection and implementation. The methods are not been widely published (Table 6). The reason for shortage of method articles may be caused by current practises in ERP business. To day the ERP system vendors and consultant have their own procedures and templates developed for ERP implementation requirements analysis. Those are part of their competitive advance and therefore usually not published. Besides they usually refer to the ERP system that the vendor provides, and therefore are not available before a system is selected.

Few suggestions for the ERP requirements engineering however exist. A Map representation system is ERP requirements driven approach introduced by Rolland and Prakash (2001). Within the Map,

an Object-Process Methodology (OPM) can be used for modelling for both the ERP system and the enterprise requirements (Soffer et al. 2005). In the Map approach, the system is supposed to be already selected and the gap analysis using the MAP supports the alignment of ERP system functionality to customer requirements. How the customer requirements are exactly gathered and analysed is not introduced. Instead both sources refer to reuse of the ERP selection criteria. Reuse of requirements is the objective for applying the Map for domain-level requirements before enterprise-level requirements (Salinesi et al. 2007). The advantage is that domain-level Maps could be reusable for other enterprises to facilitate the matching between ERP functionalities and their needs.

Another approach for gap analysis is “meet-in-the-middle” methodology that tries to solve terminological incompatibilities by measuring semantic similarities between ERP and enterprise process models (Gao et al. 2007). The method relies that as-is business models of the enterprise are sufficient for the gap analysis. This approach is rather technical solution for gap analysis, and for the ERP implementation requirements analysis the focus is too narrow. The gap analysis presumes that as-is model is a relevant reference as a business model for an enterprise. However, the ERP implementation is usually conducted also for business process improvement purpose. Therefore the improvement potential is ignored at least those parts of processes that meet the equivalent ERP system processes. Rather the gap analysis should compare a target business model (to-be) and a process model of an ERP system.

Finally Araujo and Araujo (2006) propose a process for preparation of an ERP request for proposal (RFP). They suggest that preparation of RFP should continuously involve end-users, business owners and senior management. Furthermore they specify that requirements can be elicited using focus groups and facilitated sessions. For requirements representation methods like Data flow diagrams, use cases, activity diagrams and business scenarios should be combined in order to achieve common understanding between a vendor and the customer. They also suggest the vendors apply the methods in their bid to the customer. The article by Araujo and Araujo (2006) gives practical guideline about the content of RFP, although the process is based on study of a single organisation. This approach could be further developed by adding activities that would support the forthcoming implementation. The elements could include for example ERP implementation risk analysis and analysis of needed changes within the organisational context.

## **2.8 Summary**

ERP implementation is a multi-phase process including several stakeholders, e.g. the personnel of the customer organisation, the ERP system vendor, and the consultant(s). ERP implementation models are useful for studying, analysing, or planning implementation projects. ERP implementation has its risks and critical success factors as well. The most agreed CSF is top management support, which is needed in order for the implementation to succeed. A key question is whether a company adopts a commercial-off-the-shelf (COTS)-type ERP system and adapts its business processes according to the system, or whether the ERP system is modified according to the target business processes of the company. The decision should not be based solely on the costs of the solution, but also on the effects on the work flows, i.e. the tasks of the personnel. Therefore the personnel should be involved when these decisions are being designed and evaluated. Despite the amount of research related to ERP implementations, the proposed ERP implementation methods are only few in numbers. The focus is rather on the gap analysis between the processes in ERP system and in enterprise than how the requirements are gathered, described and prioritized. The lack of published methods calls for more holistic, vendor-independent and experienced methods for ERP implementation requirements analysis.

### 3. User-Centred Design

User-centred design (UCD) is “a philosophy based on the needs and interests of the user, with an emphasis on making products usable and understandable” (Norman 1988, p. 187). Karat (1997) associates UCD as an approach with the general field of human-computer interaction (HCI). HCI, on the other hand, has its roots in e.g. studies of human performance in factories at the beginning of the 20<sup>th</sup> century (Dix et al. 2004). The Second World War motivated studies of the interaction between humans and machines in order to develop more effective weapons systems. This led to the establishment of ergonomics research (UK) and human factors research (English-speaking parts of North America) (Dix et al. 2004). Both disciplines represent a socio-technical approach and are concerned with user performance in the context of computer, mechanical, or manual systems. Other approaches, e.g. prototyping and evolutionary approaches, such as Joint Application Design (JAD) and participative design, have also affected UCD (Isomäki and Pekkola 2005). Other interdisciplinary fields related to UCD are e.g. Computer-Supported Cooperative Work (CSCW), Information Systems, and Cognitive Engineering (Preece et al. 2002).

The main objective of UCD is to increase the usability of the designed system. The aspects of usability, such as effectiveness and efficiency, have been proposed as metrics of performance (ISO 9241-11 1998, Macleod et al. 1997). Relative user efficiency, which compares others to expert users, and productivity, i.e. the proportion of usage time without problems, as well as snag, search, and help times, have also been proposed as measurement aids (Macleod et al. 1997). Principles and process of the UCD has been established in the ISO standard for Human-Centred Design Processes for Interactive Systems (ISO 13407:1999). The standard introduces four principles of UCD and an iterative process model including four phases. The most common application of UCD relates to product development, and specifically to software product development. For example, when the Disneyworld.com was redesigned with UCD, the results were, e.g. increased bookings and high user satisfaction (Sood et al. 2004). Furthermore, they also established a multidisciplinary experience design group, and reported improved cooperation with multiple business partners in form of a common business vision. Recently, usage of UCD has broadened to other areas, such as services (e.g. Singh 2006) or work processes, as described in Paper VI. In this chapter, the focus is on the purpose and implementation of the principles and process of UCD.

#### 3.1 Principles

According to the standard ISO 13407 (1999), User-Centred Design (UCD) adapts four main principles: (1) *the active involvement of users and a clear understanding of user and task requirements*; (2) *an appropriate allocation of function between users and technology*; (3) *the iteration of design solutions*, and (4) *multi-disciplinary design*. The principles can be used, for example, as evaluation criteria for the user-centredness of a design process. Gulliksen et al. (2003) have later extended the UCD principles as 12 key principles that support the adoption of a UCD process. The list includes practical advices such as use of simple design representations, conducting explicit and conscious design activities, including a usability champion, and an establishing user-centred attitude. The principles are appropriate for usability-oriented design of an interactive system. For example UCD in an ERP implementation requirements analysis aims at usability of the implementation process, and therefore the principles of ISO 13407 standard (1999) are in appropriate level of detail. However, the biggest ERP system provider, SAP, also promotes four principles of UCD (Detweiler 2007). Compared to the principles of ISO 13407 (1999), the principles are much more user- and UI-focused. For example, the composition of the design team is not covered. A design process of an ERP system functionality may as well follow the 12 principles

of Gulliksen et al. (2003). In this thesis the principles of ISO 13407 (1999) standard are used as a reference, and therefore the principles are introduced in this sub-chapter.

User involvement in the system design process means obtaining valuable first-hand knowledge of the context of use and about the actual usage of the system. In her review Kujala (2003) divides user involvement research into three different research streams: field studies, qualitative research, and quantitative research. All of the research streams offer evidence of the expected benefits of user involvement: (1) more accurate user requirements; (2) avoiding costly system features that the user did not want or cannot use, and (3) improved levels of acceptance of the system. In addition, the qualitative user involvement research stream offers evidence of (4) increased participation in decision-making in the organisation. Only (5) increased understanding of the system by the user was not studied in the research streams reviewed. The nature of the user involvement depends on whether the objective is a custom-made or generic consumer product (ISO 13407 1999). In custom-made product design, the organisation and its users can be more directly involved in the design activities, whereas in the case of general consumer products the users are merely testers of different design solutions. Damodaran (1996) presents a continuum of forms of user involvement. The categories are *informative*, *consultative*, and *participative* involvement, and users' influence on design increases from informative to participative involvement. In UCD the aim is to actively involve the users in the earliest possible phases of the design process. Therefore the objective is to have participative user involvement, i.e. users have the opportunity to influence the design process and results in UCD.

The allocation of functions determines which of the tasks should be carried out by the users and which are implemented with technology (ISO 13407 1999). Multiple factors, e.g. reliability, accuracy, flexibility of response, and financial cost, affect the allocation. Rather than the capability of technology, the rationale for the allocation of functions is to have a meaningful set of tasks for the user. Dearden et al. (2000) developed a scenario-based approach to the allocation of functions. The method considers the relative costs and relative benefits of each allocation, and therefore it should lead to a well-reasoned cost-justifying allocation of functions. The method is thorough, and a minimum requirement is that every function identified in the original requirement specification is presented with at least one scenario. The method is further evaluated in the military aircraft domain, which partly explains the level of detail of the method. Dearden et al. (2000), however, elicit the available alternatives of allocation by reframing the function allocation question as: "*To which functions, required of this system in this context, should we allocate the limited resources of this agent, human, or development organisation?*" The question is more relevant than a simplistic man-or-machine division.

Iterating design solutions is a way to ensure that designers are doing the right thing. There is always a possibility of the requirements being miscommunicated. However, as in trading, the customer is always right. Regardless of whether the design fulfils the requirements and the solution is error-free, the user may not want to use it, and the design is useless. Part of the iteration is the management of expectations. The other part is testing early and often. Both lead to reducing costs caused by unnecessary features or unexpected usage. By combining iteration and user involvement, the risk of the design not meeting the user and organisational requirements can be effectively reduced (ISO 13407 1999).

A multidisciplinary team is needed in order to make appropriate design trade-off decisions (ISO 13407 1999). The team can be small and dynamic, as long as sufficient diversity exists. The design team can consist of e.g. marketing, production, information systems, usability, and ergonomics experts. Peeters et al. (2007) have developed an instrument for measuring behaviour that is crucial

to successful design task completion. The instrument is the Design Behaviour Questionnaire for Teams (DBQT) and it consists of 55 items divided into three main categories (design creations, design planning, and design cooperation) and 12 subcategories. The DBQT is a quantitative tool for scoring and comparing design team members, or studying the relationship between design behaviour and the outcome of the design. When a multidisciplinary team is built up for conducting UCD activities, it could be useful to direct the team's behaviour with the DBQT.

Occasionally, not all the principles are applicable, even though the aim is to carry out a user-centred design process. The purpose to increase the usability of the design does not automatically imply that the design process is user-centred. For example, if a usable product is designed far away from the users, and the users therefore are not involved in the design, the design is merely usability-focused design. Otherwise, the term 'user-centredness' will become overloaded, as has happened with the term 'customer-oriented'. Today, when a company claims to be customer-oriented, this may stand for selling or marketing products to the customer. However, 'customer-oriented' should indicate that customers are actively studied and they may be involved in the product development process. The principle of iteration, on the other hand, is somehow more interpretative. A once-conducted cycle of the UCD process can be considered as the first cycle, which can then be continued iteratively in later phases.

### 3.2 Process

The user-centred design process (or human-centred design process in ISO 13407 1999) has four major design activities (Figure 5): (1) *understand and specify the context of use*; (2) *specify the user and organisational requirements*; (3) *produce design solutions*, and (4) *evaluate the design against the requirements*. The process is general and should guide the planning of the overall design process. The four activities in the UCD process should be further expanded into a more detailed plan consisting of subtasks, usability methods, techniques, progress reporting, and findings (ISO 13407 1999). The methods and techniques depend on the available resources and objectives of the design. The UCD process should start at the beginning of the process and continue until the system satisfies the user and organisational requirements.

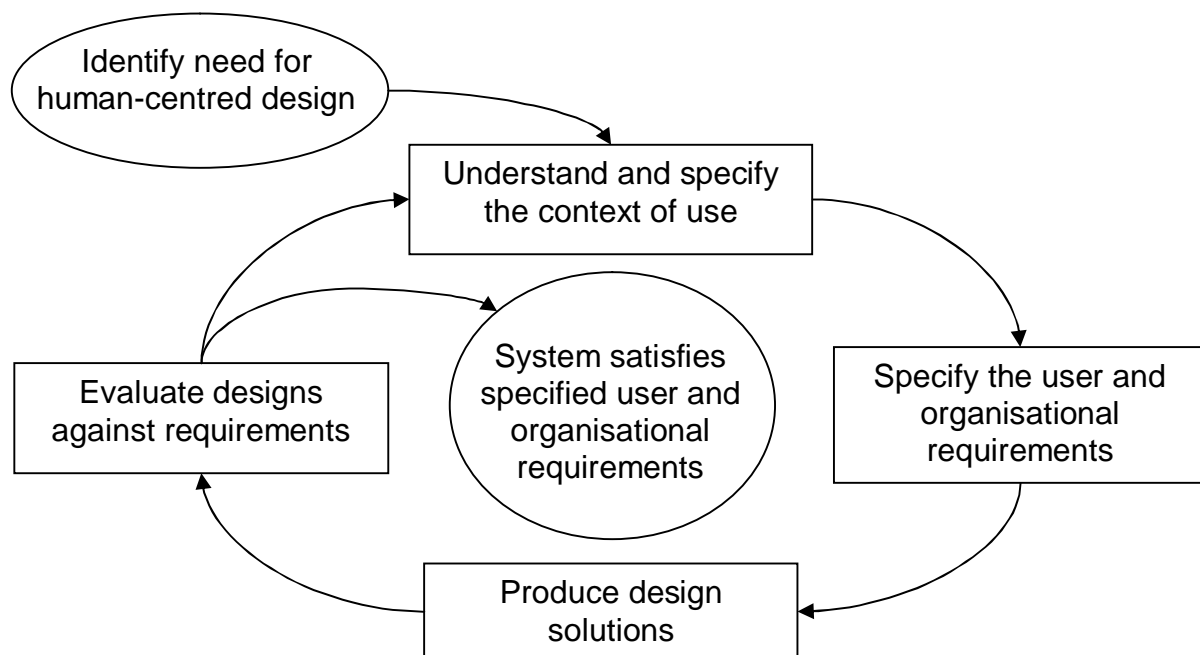


Figure 5. Iterative user-centred design process (ISO 13407 1999).

The context of use should be specified in terms of users, tasks, devices, and the physical and social environment. This knowledge serves as the basis for early design decisions and later serves as evaluation criteria. The data should be available for the design team for reiteration. Specifying the user and organisational requirements extends the activity of specifying functional and other requirements. It focuses on the user and the usage of the system. The objective is to explicitly express the measurable objectives of UCD in a prioritised order. Thus the requirements can be used as evaluation criteria for design solutions. Producing design solutions is already relevant in the early phases of the design process. They can be presented as scenarios, simulations, models, mock-ups, etc. The aim is to have feedback and modify the design before the actual implementation. This helps to e.g. improve the quality and completeness of the functional specification. Explicit designs also assist in the internal communication within the design team. Evaluation has a different scope, depending on the phase of the process. On a small scale evaluation is an expert evaluation of a particular design solution. On a large scale evaluation is conducted in field validation and even long-term monitoring can be used for collecting evaluation data. However, the aim is to evaluate the design against user and organisational requirements, although new requirements may arise during evaluation (ISO 13407 1999).

Jokela (2002a, 2002b) presents an outcome-driven UCD process model that includes six identified UCD processes (Figure 6). The reference model is ISO 18529 Human-centred Lifecycle Process Descriptions (2000), which was developed from the UCD process presented in ISO 13407 (1999) for evaluation purposes. The UCD process in ISO 18529 has the same four phases as the UCD process in ISO 13407 has. First, the original process was assessed by representatives of two organisations. The UCD process was found to be not precise enough and it was difficult to interpret. In the first iteration step phases were defined through outcomes, e.g. usability requirements and UI design requirements, and one more phase was added by splitting the *produce design solutions* phase into (1) produce user task designs and (2) produce user interaction designs (Figure 6). The new UCD process model, which included five phases, was then assessed by those who had participated in the previous iteration, and also by usability specialists. The comments were encouraging, but still the model was developed further by widening the specification of the context of use to cover all user groups, and adding more outcome definitions. As a result the process was developed into a UCD process model of a total of six UCD processes defined by their outcomes (Figure 6).

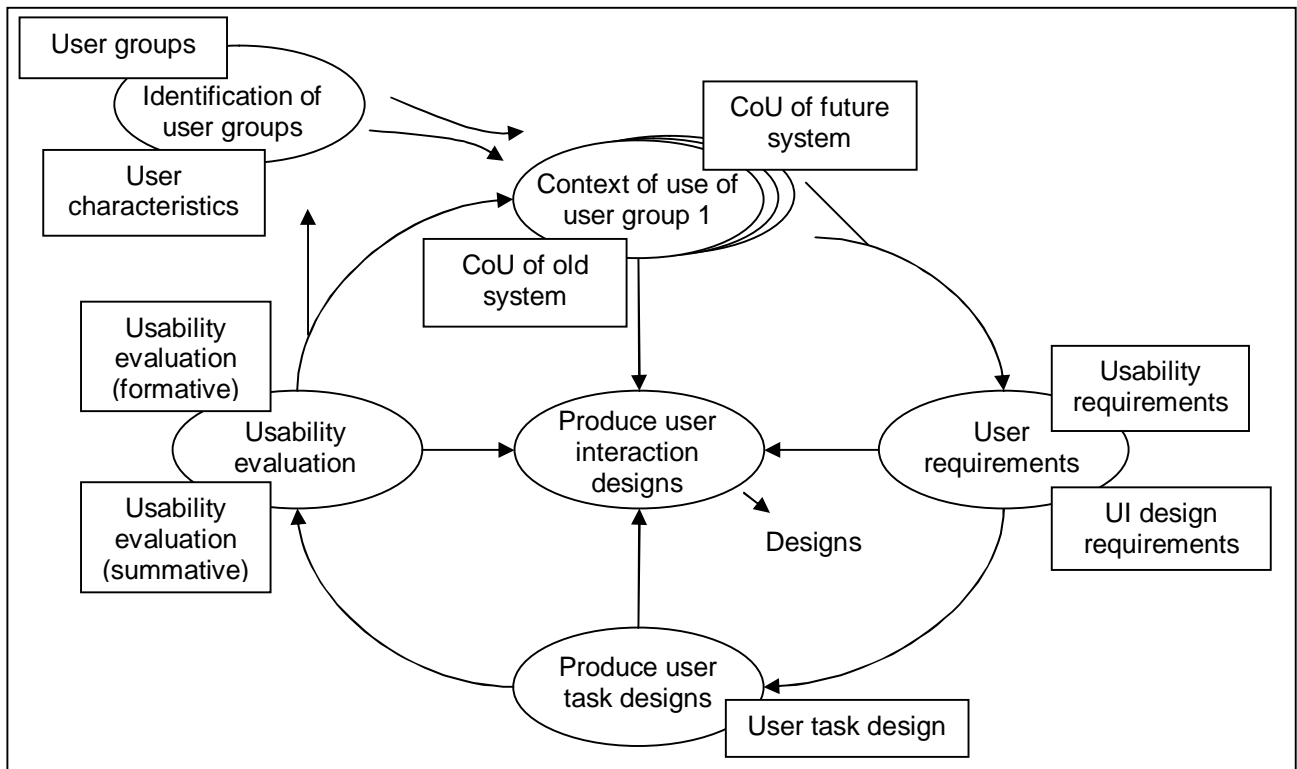


Figure 6. UCD process model with six UCD processes (Jokela 2002a).

For fast-phased projects, a more agile version of UCD (Detweiler 2007) can be applied. The three iterative phases of UCD are: (1) *understanding users*; (2) *defining interaction*, and (3) *designing UI*. In order to understand the users, they are interviewed and observed and focus groups can be arranged, for instance. The results are detailed user profiles, descriptions of task flows, and identified problems. The interaction is then defined via use cases that serve as the basis for UI development. UI development requires the iterative development of prototypes and their evaluation. This process is suitable for information system development, but process improvement, for example, requires alternative activities after the first phase. For example, in the next phase the problems could be investigated more thoroughly, and in the third phase alternative processes could be designed, illustrated, and evaluated. Detweiler (2007) emphasises that the role of the user experience expert in an agile project team is more active and managerial than in a traditional UCD process team. From these UCD processes, the outcome-driven (Jokela 2000a, 2000b) and agile version (Detweiler 2007) emphasize user interfaces and their design-evaluation cycle. However in ERP implementation requirements analysis, the focus is on more abstract level, e.g. on processes and organisation. Therefore, the process in standard ISO 13407 (1999) is in appropriate level of detail for this research.

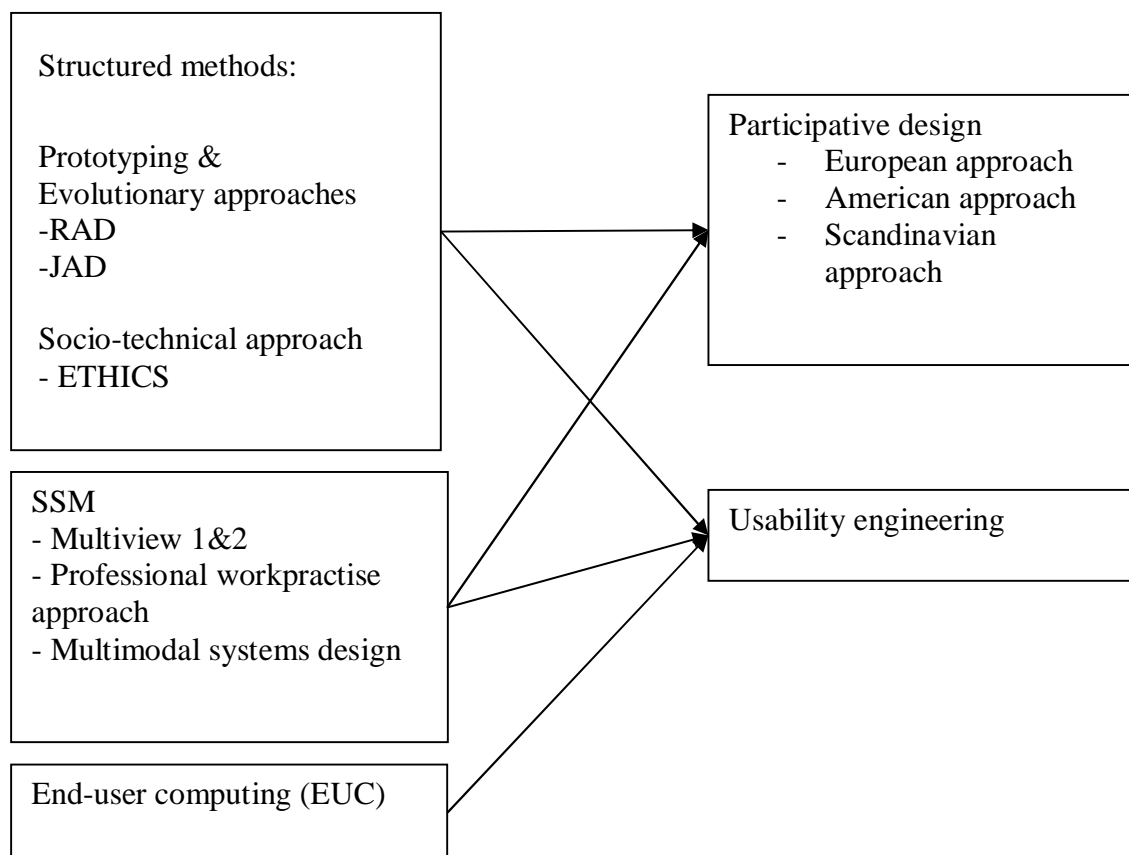
### 3.3 Approaches and Methods

The principles and process give phases and objectives for conducting UCD on an abstract level. Approaches and methods are needed in order to realise a UCD process. The terms ‘approach’ and ‘method’ are used inconsistently in the literature, but in this section the approach is a wider concept in which various methods can be applied. The approaches discussed in the next section relate to IS development, and include for example socio-technical modelling, Soft Systems Methodology (SSM), and Participatory Design (PD). Ethnographic methods are only mentioned. The Methods section describes the categorisation of methods rather than presenting any methods in detail. The

purpose of this section is to introduce approaches and methods that could be utilised in e.g. UCD related to a working context.

### 3.3.1 Approaches

Variety of approaches and methodologies have contributed to human-centred view of IS development (ISD) (Figure 7). Isomäki and Pekkola (2005) refer the 1990's as an era of human-centred focus in ISD. The trend brought HCI and computer-supported co-operative work (CSCW) methods in the ISD. Methodologies and standards, such as a model for usability engineering (Nielsen 1993), usability engineering life-cycle (Mayhew 1999) and Standard for human-centred design processes for interactive systems (ISO 13407 1999), were referred as human-centred development or usability engineering. Approaches known as co-operative, collaborative, participatory or participative design have origin in socio-technical design and promote for user involvement in ISD (Isomäki and Pekkola 1995). For capturing requirements especially within the working context, Dix et al. (2004, p. 458) propose approaches such as socio-technical modelling, soft systems methodology, participatory design, and ethnographic methods. These approaches aim at understanding the reality of a working context from the perspectives of different stakeholders by utilising UCD methods.



**Figure 7. Accommodation and trajectories of different ideas concerning IS development methodologies and approaches (edited from Isomäki and Pekkola 2005)**

Socio-technical models aim at describing the impact of specific technology on an organisation. The models generally capture elements such as the problem intended to be solved, the stakeholder affected, the workgroups within the organisation, the changes supported, the proposed technology and its functioning, external constraints, and performance measures. To gather information,



methods such as interviews, observation, focus groups, and document analysis can be used. Several socio-technical methods are available, for instance: CUSTOM, which is based on the User Skills and Task Match (USTM), or Open System Task Analysis (OSTA) (Dix et al. 2004, pp. 460-462).

Another approach, the Soft Systems Methodology (SSM), was first introduced by Checkland (1981). The SSM comprises the organisation and technology as components of a system. The SSM does not assume any particular solution, but focuses on understanding the situation. The seven phases of the SSM are divided into real-world (R) and system (S) phases: (1) defining the problem situation (R); (2) describing the problem situation (R); (3) generating root definitions for the system (S); (4) making and testing conceptual models (S); (5) comparing conceptual models and reality (R); (6) identifying feasible and desirable changes (R), and (7) identifying changes needed in order to improve the situation (R). In Phase 2 it is recommended to use a rich picture in describing the situation. The rich picture shows the stakeholders, their tasks, the working groups, the organisational structure, speech balloons for representing stakeholder issues, crossed swords to represent conflicts within the system, and an eye representing an external influencer or observer (See for example Figure 9, p.27). The information for the picture can be gathered using e.g. observation, interviews, questionnaires, workshops, and simulations (Dix et al. 2004, pp. 462-464).

The participatory design (PD) approach aims to specify the systems requirements iteratively in a design process in which the users are actively involved. American, European and Scandinavian approaches of PD can be distinguished (Isomäki and Pekkola 2005). The American approach focuses differences in cognition of users and IS designers, whereas European approach focuses on the level of user involvement and influence on IS design. Inside European approach is the Scandinavian approach (Kygng 1991) that emphasises an active cooperation between users and professional designers. The principles of PD are very much in alignment with those of UCD. However, participatory design is especially intended to improve the work environment and its tasks. The methods used in PD include e.g. brainstorming, storyboarding, workshops, and paper prototyping (Dix et al. 2004, pp. pp. 466-467). In ethnographic methods the interactions between people and the environment are recorded objectively and without interference. The aim is to understand the organisation within its own 'cultural framework'. The difference between PD and ethnography is that in PD the workers come out of the work situation either physically or mentally in order to act as designers, whereas in ethnography the analyst goes to the workplace and maintains a certain objectivity. One of the ethnographic methods applied is *Contextual Inquiry* (CI) (Dix et al. 2004, pp. 470-471).

### 3.3.2 Methods

Various methods to carry out UCD activities exist. Many of them are suitable for both gathering requirements and evaluating design solutions. For example, the *Focus Group*, in which three to ten users participate in a meeting and discuss a predefined topic (Preece et al. 2002, p. 396), can be used either for discussion about user needs or, for example, for discussion about a design prototype. Usability evaluation can be either *formative* or *summative*. Formative evaluation is conducted during the design in order to improve the usability during the design (Preece et al. 2002). Summative evaluation is conducted after the design process to check the usability of an end product. For example, *focus group* and *walkthrough methods* (Dix et al. 2004, pp. 321, 347) are appropriate for formative evaluation, whereas *heuristic evaluation* (Dix et al. 2004, p. 324) and *usability tests* (Preece et al. 2002, p. 346) are suitable for summative evaluation. The International Standards Organisation (ISO) has set a standard for usability methods supporting human-centred design (TR 16982 2001).

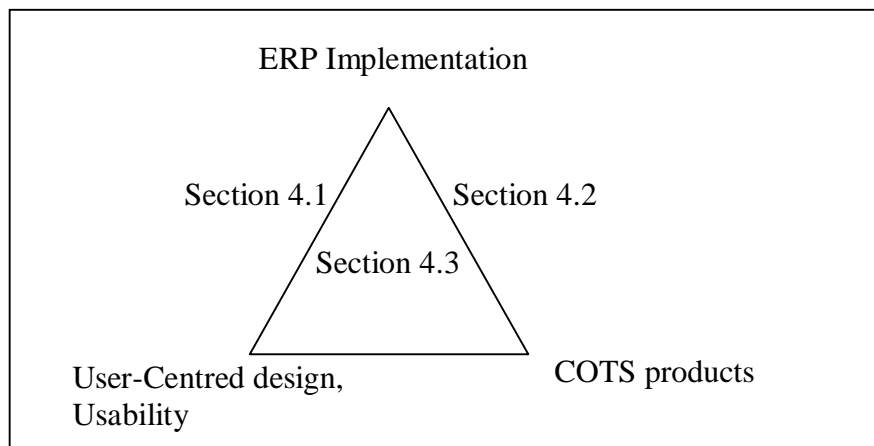
Wixon et al. (2002) present field methods that can be used for studying users and their tasks in their natural context. Field methods differ from usability tests and heuristic evaluations in that the methods can be used without a design prototype and the data are based on how the users currently carry out their tasks. The field methods presented are those related to Contextual Design (Beyer and Holzblatt 1998), task analysis, and a discount user observation (DUO) method. Furthermore, in Contextual Design, methods such as contextual inquiry, work modelling, scenarios, storyboarding, and paper prototyping are used. In task analysis site visits for observing and interviewing users can be used as a basis for e.g. work flow analysis, job analysis, and developing task inventories. The DUO method offers a user observation method that is more easily extracted than traditional audio recordings and video tapes. The roles of observers are clearly defined, and photos are used for supporting the high-order presentation of the user's tasks. DUO produces material that presents task scenarios for development and testing purposes. In the next section the Contextual Design method is described in more detail because of its validity for this thesis.

### ***3.4 Conclusion of User-Centred Design***

User-Centred Design (UCD) originates from the interdisciplinary need to have a methodology to establish and sustain user input into the IS design process. Before the standardisation UCD processes, related approaches, such as socio-technical design, prototyping approaches, participatory design, and soft systems methodology, had already taken the IS design towards the user-centeredness. Today, UCD has been established in the form of principles and various process models for UCD exist. In addition, multiple approaches and methods can be utilised to realise UCD. The approaches, such as ISO 13407 (1999) provide a framework of how to conduct a UCD process with a specified emphasis, e.g. ISO 13407 emphasises active user involvement, iteration of designed solutions, function allocation between the system and users, and a multidisciplinary design team. The UCD methods, such as focus group or walkthrough methods, on the other hand, are practical tools to be used within that process. The standard of UCD refers to designing process of an interactive system. This interactive system can be interpreted broadly, including e.g. work processes as an interactive system of workers and information systems.

## 4. Related research

Enterprise resource planning (ERP) systems and their implementations have been widely studied since the middle 1990's, when companies started to increasingly adopt such systems. The ERP implementation models, key players, critical success factors, risks and ERP products have been covered in Chapter 2. Similarly, usability and user-centred design (UCD) have stabilized the definitions, principles and processes since the late 1990's. Those are covered in Chapter 3. However, these two processes, ERP implementation and UCD, have not been systematically combined in related research. Nevertheless, in some studies, the topics considered together; usability, e.g., is discussed in relation to ERP implementation. Another perspective is the implementation of a commercial-off-the-shelf (COTS) type ERP system that requires also the organization to adapt its business processes according to the ERP system (Figure 8). In the case of COTS-type systems, the UCD also places a different emphasis on the "design" compared to that of the UCD, which was originally intended for designing software. In the case of COTS-type ERP system-requirement analysis, the design refers merely to the design of processes, workflows and ERP implementation activities, rather than to the design of the system itself.



**Figure 8. Focuses of related research and their combination that are covered in corresponding sections 4.1, 4.2 and 4.3.**

In the following sub-sections, the related research on each side of the triangle (Figure 8) is reviewed, firstly from the ERP implementation and user-centred design (UCD) perspective (4.1), secondly from the COTS-type ERP systems implementation perspective (4.2), and finally with all three topics included (4.3). The UCD relating to COTS-type information systems is not covered, because this thesis focuses on UCD related to ERP systems and their implementation. Related research into UCD and COTS products would cover the design of consumer products, web sites, electric voting systems, and mobile games, e.g., which are excluded from this research.

### **4.1 Related research on ERP implementation and user-centred design**

User-centred or human-centred design (ISO 13407 1999) focuses on increasing usability of a system in its design phase. In the comprehensive ERP implementation research reviews (Shehab et al. 2004, Umble et al. 2003, Esteves and Pastor 2001, Møller et al. 2004, Botta-Genoulaz et al. 2005), only Esteves and Pastor (2001) raise the issue of the usability of ERP systems as an important factor. The usability discussion relates to usage and maintenance phases, in which only the status of usability can be verified, but not affect to the system design anymore. The user-

centeredness or usability requirements in early ERP implementation phases, however, are not discussed.

In order to analyze the frequency of studies that combine UCD and ERP implementation, the main ERP journals were systematically reviewed (Table 7). As Webster and Watson (2002) recommend that “major contributions are likely to be in leading journals”. Therefore, the source journals were selected on the basis of the ERP research reviews by Shehab et al. (2004) and Møller et al. (2004) as they were the latest reviews available. Unfortunately Botta-Genoulaz et al. (2005) did not specify the journals they had used. The identified journals included are:

- Business Process Management Journal (BPMJ),
- Journal of Information Technology (JIT),
- Communications of the ACM (CACM), and
- European Journal of Operations Research (EJOR).

The first three journals accounted 48% of the citations in the review by Shehab et al. (2004). Møller et al. (2004) found ERP papers in 212 different journals in which the BPMJ and the EJOR had published the greatest number of articles. In addition, the Proceedings of the Computer-Human Interaction (CHI) were specifically reviewed as it is the main conference in field usability research. The search included any fields of the articles. A basic search of articles including keywords like “ERP implementation” or “ERP” was conducted to indicate the maximum amount of articles that combine UCD and ERP implementation.

**Table 7. Results of the review of selected sources.**

Sources/Keywords	BPMJ	JIT	CACM	EJOR	CHI
ERP implementation	94	5	79	8	7
ERP implementation + UCD	1	0	0	0	2
ERP implementation + Usability	4	0	6	0	6
ERP implementation + User-cent(e)redness	0	0	0	0	0
ERP implementation + User-cent(e)red design	0	0	0	0	1(4)
ERP implementation + User involvement	26	0	11	1	0
ERP implementation + Human-cent(e)red	0	0	0	0	0
ERP	96	13	107	16	16
ERP + UCD	0	0	0	0	2
ERP + Usability	4	0	6	0	9
ERP + User-cent(e)redness	0	0	0	0	0
ERP + User-cent(e)red design	0	0	0	0	1(4)
ERP + User involvement	26	0	12	1	1
ERP + Human-cent(e)red	0	0	0	1	0

The Table 7 shows that the journals that have published many of ERP-related articles may have any of those related to UCD. Among the articles found in CHI is also Paper III related to this research. For example Communications of the ACM prompt 107 ERP-related articles but any of those related to UCD. Instead user involvement is represented among ERP and ERP implementation related studies. However the user involvement may have different appearance depending on the research (Kujala 2003). User involvement and UCD are not interchangeable although the user involvement is one of the four main principles of UCD (ISO 13407 1999). In some cases, the intention of plain user involvement may have been to promote for usability of an ERP system even though UCD is not specifically addressed.

Elsewhere in single related articles, for example Kawalek and Wood-Harper (2002) analysed SAP case in a post-implementation manner. They focused on user participation that was found to be

consultative. It was used to gather local intelligence on deviating practises and possible difficulties. Depending on the information, either configuration requirements were formed or local practises changed. The senior project manager emphasized the importance of user participation. However, user participation is not clearly covered in the description of implementation activities, nor are the users specified. The user participation in this case is for finding particular local difficulties. This is an example of user involvement, but not in an active UCD manner aiming at increased usability.

An ERP project or implementation is “the social activity system, which consists of a variety of stakeholders, e.g. users, developers, managers, suppliers and consultants” (Skok and Legge 2002). The role of different stakeholders, such as users, in an ERP implementation can be analysed using interpretive research. In order to analyse the complex environment, Skok and Legge used an abstract model, a *rich picture* (Figure 9), adapted from Soft Systems Methodology (SSM) (Checkland and Scholes 1990). The rich picture includes symbols, e.g., and sketches, cartoons, keywords and a title to illustrate complicated situations in advance. According to Monk and Howard (1998), an effective rich picture includes elements such as (1) structure, e.g. geographic localities or organizational hierarchy, (2) process, and (3) concerns. In a rich picture, the language should be of the people depicted, but otherwise any appropriate pictorial or textual device is allowed.

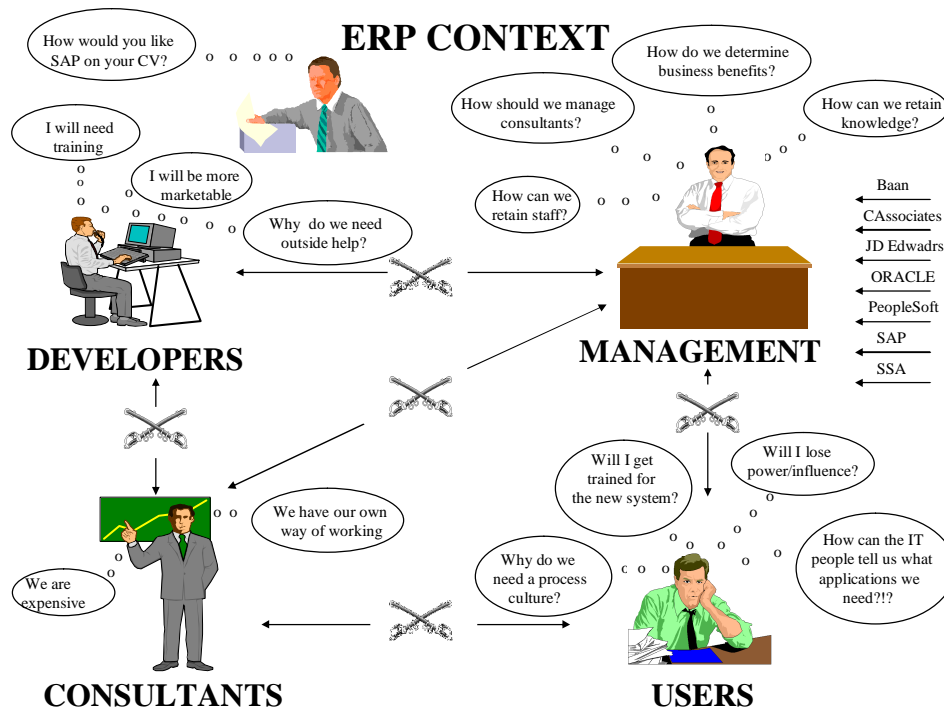


Figure 9. Rich picture depicting ERP project (Skok and Legge 2002; reprinted with the permission of the author).

Figure 9 presents the four key parties, i.e. developers, management, consultants and user. The ‘crossed swords’ symbols between the stakeholders represent possible areas of conflicts, while ‘think bubbles’ represent simplified thoughts and emotions when participating in an ERP project and its activities. During five in-depth case studies, researchers iterated between the rich picture and results of the interviews in order to improve the interpretation of the ERP context. As a result of the research, the authors presented a hierarchy of critical success factors (See 3.2, p.13). The study identified critical success factors that are given priority in ERP projects. The rich picture could be useful in, e.g., clarifying an ERP implementation project for an ERP project team and for the other organization as well. UCD methods are applicable e.g. when the information for the rich picture is

collected. However, identifying and analysing the context does not imply improved usability by default.

A usable ERP system can be described as “*a comprehensive management software package that supports the effective and efficient completion of tasks in a given work context*” (Calisir and Calisir 2004). According to their survey, perceived usefulness has the strongest impact on end-user satisfaction, although learnability is the other determinant. Perceived ease of use affected end-user satisfaction indirectly via perceived usefulness. Other indirect factors were system capability and user guidance. These attributes could be used in, e.g., measuring the success of an ERP project from the perspective of end users. On the opposite, Abdinnour-Helm et al. (2003) in their survey noticed that, instead of high levels of pre-implementation involvement, length of time in the company and position had greater impact on attitudes towards the ERP project. For instance, managers had a more positive attitude towards the system than the other users, and newer employees were more receptive towards new technologies than those who had worked for a longer period in the company. These survey-based findings suggest that more comparative research work, e.g., qualitative case studies, is needed to analyze the role and impact of user participation in ERP-system implementations.

On the basis of their extensive annotated bibliography of ERP systems research, Esteves and Pastor (2001) suggest ERP implementation methodologies should be studied in more detail. Such methodologies should be defined, and their usage, adequacy, and value in ERP projects should be investigated. This research defines such a methodology and evaluates its implications for both the academics and practitioners. The need for understanding the different stakeholders, such as steering committee, project members and vendors, was raised as a topic for further research. Furthermore, they highlighted the point that user involvement and user satisfaction have not been studied in depth. Development and evaluation of the C-CEI method approaches the ERP implementation from various perspectives of different stakeholders. On the basis of the related research presented here, these topics are still valid, and implementation methodologies should still be further developed with focus on stakeholders.

## **4.2 Related research on COTS-type ERP systems implementation**

Multiple methods for selecting Commercial-Off-The-Shelf system exist. For example OTSO (Off-The-Shelf-Option) method (Kontio 1995), STACE (Social-Technical Approach to COTS Evaluation) (Kunda and Brooks 1999), and PORE (Procurement-Oriented Requirements Engineering) method (Ncube and Maiden 1999) are suitable for COTS type system selection. The OTSO is a method for evaluating and selecting software components to be reused in software development (Kontio 1995). STACE is a method that applies the socio-technical approach to COTS software selection. It includes four interrelated processes: (1) requirements analysis, (2) social-technical criteria specification, (3) alternatives identification, and (4) evaluation (Kunda and Brooks 1999). The PORE method encourages simultaneous analysis of customer requirements and candidate COTS software. The method is supported by specially implemented software prototype (Ncube and Maiden 1999). However, these methods are not directly developed for ERP system selection, but could be considered for applying to a selection phase in an ERP implementation also.

In the selection of a COTS type system the requirements are first specified and then prioritised. However, instead of developing a system, the activities focus on matching the requirements to the COTS type software. Alves and Finkelstein (2002) present activities of the COTS selection process (Figure 10). First, the goals are determined iteratively and incrementally. When the goals, i.e.

requirements, are refined, they are prioritized, their modifiability is determined, and they are divided as core and peripheral goals. The core goals help distinguish between the products. “Understanding COTS” refers to becoming acquainted with the product terminology, and delving deeper into functional details rather than the package description provided by the vendor.

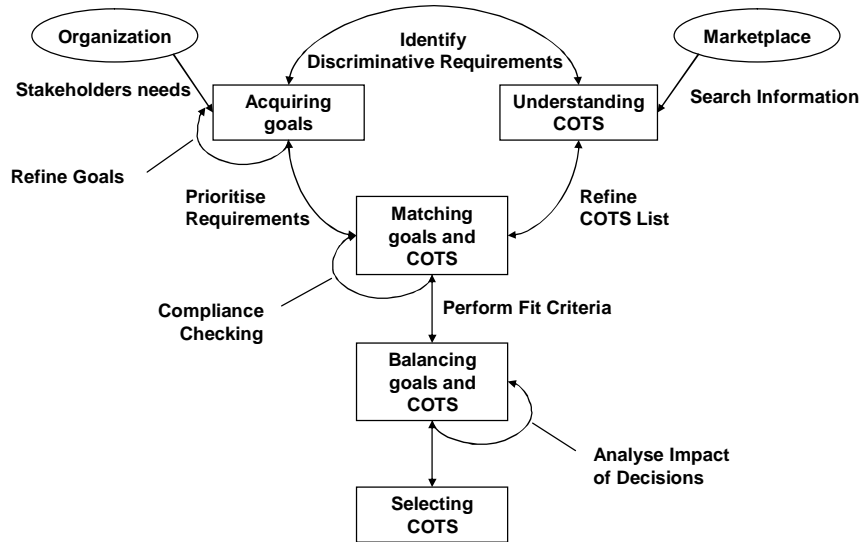


Figure 10. Main activities of COTS selection process (Alves and Finkelstein 2002).

Matching the goals and COTS is incomplete, as any COTS products may fulfil all the requirements of a customer. In some cases, the COTS product needs to be adapted in order to match the goals, while, in other cases, the customer has to modify the goals to meet the Features of the COTS product. Balancing goals and COTS is the aim of the needed analysis of compromises, their effects and cost. In the selection activities, the COTS products are ranked. During the ranking, also other aspects, such as the adaptability and vendor support for the adaptation, need to be considered. This process model could be used as an ERP acquisition model as well. In selecting a COTS-type ERP system, however, the preliminary analysis of company goals and need for business process reengineering should be the basis for defining goals that support target processes in the future.

Alleman (2002) proposes agile project management methods for ERP, and states that agile methods in an ERP context provide increased stakeholder participation, incremental and iterative delivery of business value, and maximum return on assets using a real options decision process. In order to be agile, a process should be incremental, iterative and evolutionary. The process should also be modular and lean, allowing the components of a process to move freely. Moreover, the agile process is time-based and relies on work cycles, checkpoints and feedback loops. These characteristics further guide agile project management, which has several principles. For example, creating immediate benefit for the stakeholders is expressed in four out of a total of ten principles. Two of the principles handle the emphasis on change management, while the other two give guidance towards further considering maintenance and update activities. The latter two principles focus on multidisciplinary projects and rapid feedback. If the activities focus on only those that produce the maximum immediate value to the stakeholder, there will be the risk of short-sightedness that ignores documentation, change-management activities, and data clean up, e.g. However, these are activities that are necessary and deliver value in the long run.

Tools and models have been introduced and utilised in order to improve COTS type ERP systems implementation. For example Arinze and Anandarajan (2003) have developed the Enterprise Object

Model (EOM) that is a mapping method for transferring user requirements into the configuration settings of an ERP system. The aim is to improve the ability of user managers and non-technical users to maintain and configure the ERP system in a vendor-independent manner. The prototype of EOM, built with Java, presents how material and customer discounts are first defined with an easy-to-use interface, and then transferred with the EOM prototype into a text or spreadsheet file. The file can be loaded in, e.g., SAP R/3, which performs input commands with the data. The use of EOM is targeted in the maintenance and development phase that comes after the ERP system is taken into use. The model does not state how the requirements, which are then entered into EOM system, are defined in the first place, or how the requirements for building the EOM model are gathered.

The main focus in COTS-type ERP systems implementation is on the procurement process, on how to match the requirements and features of a COTS product. For example, a quantitative study identifying the extent of ERP system adaptations could be useful to help practitioners decide the desired level of modifications for the product. As current ERP systems are constantly upgraded, the affects of modifications to upgradeability should be qualitatively studied, for product development purposes, for example. Alves and Finkelstein (2002) refer to core goals that distinguish COTS products. As the ERP market evolves so fast, it is not, however, reasonable to undertake a massive comparison of ERP products. Therefore, C-CEI encourages prioritising requirements in order to reduce the amount of potential systems to two to three candidates. Alternatives from the perspective of various industries could be studied also in order to understand how, e.g., a project business model could be supported by an ERP system. Although some compromises need to be made between customer requirements and COTS product features, the system of the COTS type should not affect the measurement of ERP implementation benefits. The C-CEI method aims at holistic development of a company context instead limited focus on functionality of an ERP system.

### **4.3 Related research on usability of COTS-type ERP products**

A report from Forrester Research (Chew et al. 2003) presents an overview of accomplishing three simple tasks with eleven ERP products. The report concludes that, even though the tasks were accomplished, the products suffered usability problems. The customers are also encouraged to require better usability from ERP products, and the vendors are encouraged to use external expertise with regard to usability issues and prioritize the fixes according their importance to users. Botella et al. (2003) adapt the quality standard *ISO/IEC 9126-1* (2001) in their quality model for the selection of ERP systems. In this standard, the usability includes five attributes: (1) understandability, (2) learnability, (3) operability, (4) attractiveness, and (5) usability compliance. Using the quality model in ERP selection ensures that *someone* has considered the usability issues during the selection process. It remains unclear, however, who evaluates the ERP systems, and from whose point of view.

From the ERP business perspective, Oracle, one of the ERP system providers, uses methods such as object/task modelling, flow diagramming, interface prototyping, focus groups, contextual inquiry, group task analysis, and CIF testing for developing and evaluating the usability of their products. In order to work globally, Oracle has a streaming video feed over the Internet to remote development and customer locations (Rosenberg and Gajendar 2004). Detweiler (2007) from SAP proposes observing and interviewing end users and other stakeholders to gain understanding of users. The requirements could be gathered using field studies, for example, as well as focus groups and interviews. In UCD, for agile projects, the interaction is defined with use cases, and then the UI is designed and evaluated iteratively using prototypes.



A consultant in the Tellus Mobility Company has concluded the thirteen ERP projects and presented fourteen lessons learned from these experiences (Daneva 2004). The lessons concern organizational aspects of ERP process support, i.e. stakeholders' participation and knowledge generation. The lessons discuss various perspectives, such as partnership between process owners and consultants, or knowledge transfer to client's IS staff and process owners. The recommendation is to stay with the ERP vendor's architecture to better manage and reuse requirements modelling activity. This approach is appropriate if the system is already selected.

In order to improve the usability of ERP systems, Babaian et al. (2004) suggest that the interaction between a user and ERP system should be more collaborative. The collaborative behaviour between parties is specified by four principles, according to earlier definitions of Bratman (1992), and later by Grotz and Kraus (1996): (1) commitment to joint activity, (2) mutual responsiveness, (3) commitment to mutual support, and (4) meshing subplans. A simple example of the results of a collaborative interface is the highlighting of misspelled words (Babaian et al. 2004). An ERP system is considered as a collaborative party, and therefore the usability of an ERP system cannot refer to local interface design. Instead, the system behaviour and activities should be designed using principles of collaborative behaviour.

Related research into COTS-type ERP system implementation and usability is relatively limited. Most often, *usability* refers to the user interface of the system. Even though the user interface is the contact between the user and the system, the task sequences and support of processes provided by the system are relevant. Before the ERP system is in use, there are several phases that affect the usability of the system. The usability should be the focus in those activities, not as the most important, but merely as important, with reference to price and expected life cycle, for example. If the users refuse to use the system, the ERP system is wasted. Therefore, every possible activity should be used to reduce this risk. One alternative is to use user-centred design (UCD) in the early phases of ERP implementation in order to increase usability, i.e. efficiency, effectiveness, and satisfaction. In this research the C-CEI method combines UCD to the ERP implementation phases before a system is selected. The aim is to eventually increase the usability of the system by e.g. specifying the requirements using user-centred approach and thus also preparing the organisation for the change

#### **4.4 Conclusion**

The complicated nature of ERP implementation projects involving multiple stakeholders, critical success factors, and risks has been identified and analyzed in depth. The exact matching of the requirements of a customer and properties of a COTS-type ERP system is a challenge for the implementation process. Usability has been recognized as one of the selection criteria of an ERP system. However, related research lacks studies that directly involve an ERP implementation and support the implementation activities with user-centred design (UCD) methods. Mostly, the UCD and usability in these studies relate to user interface or a feature development for an ERP system. However, some methods or processes are developed for COTS-type ERP system implementation, but they do not refer to UCD principles or processes. In this study, the applicability of UCD to the COTS-type ERP system requirements analysis process is studied, and how the UCD could complete the current ERP implementation methods is discussed.

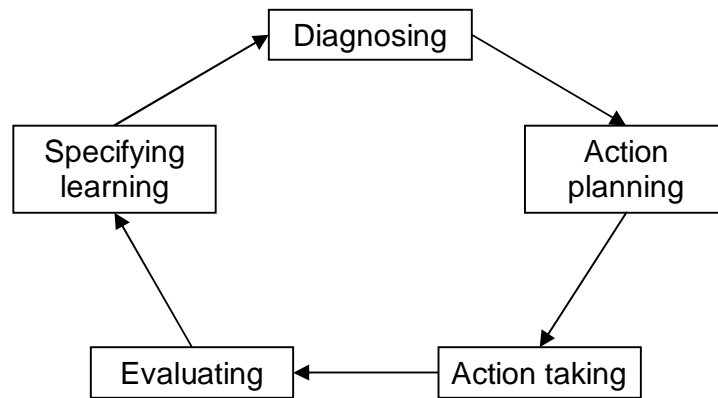
## 5. Research methods and process

ERP implementation is a complex multi-dimensional process, and its success is dependent on many factors, such as stakeholders participating in the process, the activities undertaken, and the realisation of critical success factors. In this research, the aim is to identify and tackle obstacles to ERP system implementation, especially in the requirement analysis phase before a system is selected. Even though the overall focus is on improving the success of ERP implementation, there should be special focus on risk identification and systematically following principles that aim at the realisation of critical success factors. Therefore, a method to support the requirements analysis phase of ERP implementation is developed and evaluated. The development and evaluation of the Customer-Centred ERP Implementation (C-CEI) method form a participative, qualitative, and iterative research process.

This research is conducted with action research approach. The approach is summarised by Hult and Lennung (1980): “*Action research simultaneously assists in practical problem-solving and expands scientific knowledge, as well as enhances the competencies of the respective actors, being performed collaboratively in an immediate situation using data feedback in a cyclical process aiming at an increased understanding of a given social situation, primarily applicable for the understanding of change processes in social systems and undertaken within a mutually acceptable ethical framework*” Development of C-CEI focus on solving the problem at hand and iteratively learning within participative research work. On the other hand, the C-CEI method, as developed serially in a number of companies, is somewhat reminiscent of the case study approach. However, the C-CEI method is constantly being evaluated and further developed from one company to another, and therefore the research process does not fully meet the conditions for a case study (Yin 2002, p. 5). Since the user-centred design (UCD) approach is part of the novelty of the C-CEI method, the UCD methods, principles and process are followed. They are described in Chapter 3 (p.20) in detail. In this section, action research is first introduced. Then the specific methods within action research are described separately, and finally the research process that has been followed is delineated.

### 5.1 Action Research

Action research originated in the social and medical sciences in the 1920s (Baskerville 1999). The method was first formulated officially by Lewin (1951) by means of a model with six phases: (1) analysis; (2) fact-finding; (3) conceptualisation; (4) planning; (5) implementation of action, and (6) evaluation (Baskerville and Wood-Harper 1996). Later, a five-phase model (Figure 11), introduced first by Susman and Evered (1978), became established as a reference model for action research (Baskerville 1999). In the *diagnosing phase* the problem is first identified, and then in the *action planning phase* alternative courses of action are considered in order to solve the problem. A selected course of action is taken in the *action-taking phase*, and the consequences are studied in the *evaluating phase*. In the *specifying learning phase* the findings are generalised.



**Figure 11. The cyclical process of action research (Susman and Evered 1978).**

Susman and Evered (1978) present comparisons between positivist science and action research. For example, methods are considered to be value-neutral in positivist science, whereas in action research methods develop social systems. In positivist science the researchers are detached observers, for whom the members of the client system are objects. In action research the researcher(s) and the client organisation are acting together. Action research is also more future-oriented, and presumes that every action or choice is based on human interest. As regards generalisation, action research is narrower in scope than positivist science, as it is bound by the research context, i.e. the client organisation. In single research cases the case can be a sufficient source of knowledge, and the evaluation is based on whether actions have produced the intended objectives.

### 5.1.1 Applying Action Research

The action research approach has been used, e.g., in applied ethnographic research for using ICTs in reducing poverty in one project, and designing a network of young people connected by the web in another project (Tacchi 2004), in the development and design of a paper-based and orally communicated child health IS (Byrne 2005), and the development of a CRM system in a bank (Reynolds 2005). These three action research studies together with research where MacColl et al. (2005) adapted ethnographic action research (Tacchi 2004) give examples of the content and process of action research.

As an example of content of an action research, Tacchi (2004) describes two projects. The first project was a UNESCO initiative to reduce poverty in nine locations in South Asia. The work consisted of teaching a selected group of locals e.g. how to use the internet, and then the group recruited new members from their neighbourhood. The focus was primarily on how to utilise ICT technology, rather than inventing new technologies. As a first result, spaces for innovation are needed, rather than any properties of new technologies. The other project was developing the Youth Internet Radio Network (YIRN), where an audio streaming website was established first in order to study how young people used it. The research included a couple of workshops during a period of two years, and ethnographic fieldwork. The results will illustrate what kind of content the young people create and consume, and how the network will develop. In another action research study, Reynolds (2005) applied a business process portfolio and platform (BP3) approach (Thorogood and Yetton 2004) in order to reduce the risks related to e.g. marketing and technical complexity. They noticed that the perceptions of risks observed were highly biased, with some risks being over- and some under-emphasised compared to a more traditional risk framework. However, a new risk may

occur if the managers do not utilise the collaboration and joint decision-making tools provided by the new approach, e.g. BP3.

About the action research process, Tacchi (2004) illustrate how action research and ethnographic research are combined into applied ethnographic research. The methodology was developed earlier in a project funded by UNESCO (Tacchi et al. 2003). Byrne (2005) is motivated to describe the action research process, because of the abstractness of other such studies. In general the study concludes that in action research there is a need for a researcher to be explicit in terms of the origin of the research and responsibilities. Building networks of action instead of focusing on a single site or unit is also recommended. Moreover, the participatory approach should be used, and take the form of a longitudinal study. It is suggested that over-generalising the results is inadvisable because of a possible loss of valuable insights into IS development.

Ethical concerns of conducting action research are presented by MacColl et al. (2005). They adapted ethnographic action research (Tacchi 2004) to understand and facilitate communication in the Cooperative Research Centre (TheCRC). The aim was to recruit participant observers from other projects in the CRC, deploy an initial toolkit of collaborative technologies, and then iteratively evolve the toolkit with ethnographic action research. The research raised concern about ethical issues, such as whether participation in the research should be voluntary and the participants be able to interrupt their participation freely. Moreover, participation needs to be based on consent, the risk of harm to participants should be minimised, participants should not be identified, and no confidential data should be disclosed.

These examples show that action research is considered to be a relevant approach to sharing common practises, e.g. facilitating communication, and understanding an organisation more thoroughly, e.g. banking project organisation. The results of action research appear first on the methodological level, i.e. how an action research project should be organised, and second on the content level, i.e. what has been achieved using action research. More research is needed in developing the practises of action research, e.g. how the research is planned and communicated with the participants in advance, and also comparative studies, e.g. comparing case studies with action research.

### **5.1.2 Benefits and Challenges of Action Research**

The advantage of action research is that it produces practical solutions aimed at solving the problem at hand. However, the distinction between consulting and action research is clear (Baskerville 1997). The similarities and differences between action research and consulting have been analysed by Baskerville (1997). The similarities, in terms of action research phases, show in initial setup, problem diagnosis, action planning, action taking, evaluation, and specifying learning. In both cases, the presumption is that cooperation will be beneficial for the target organisation. In action research experiments are allowed, whereas in consulting the consultant is supposed to bring external knowledge about solutions in similar cases in other organisations. Both parties analyse the problem, researchers in close cooperation with practitioners, and a consultant with external analysis. Similarly, researchers plan their activities in cooperation with practitioners, and a consultant may present alternatives to choose from. In both cases, the actions are taken according to plans. The evaluation of the results is a key issue in both disciplines. Researchers are interested in the validity of their theory, whereas consultants collect know-how for future cases and keep up customer relations with follow-up meetings. Learning is specified for action development purposes, but also for theory completion.

The main challenge in action research is that either action or the research may be forgotten. If only an action is taken it is merely consulting, and if only research is conducted it is merely a case study. However, action research has been interpreted in different ways, which is easy to understand because in many cases limiting the research approach to one label can be difficult. For example, Akkermans and Helden (2002) used an action research approach in their single case study of the interrelations of ERP implementation CSFs. At first, they were consultants to the management of the company for 3 months, and then they changed their roles and became neutral observers for two years. They used the CSF list of Somers and Nelson (2001) to analyse how an initial crisis in an ERP implementation led to the success of the implementation. This example illustrates the ERP implementation-related challenge in action research, that companies, especially at the management level, are willing to receive consultation on the complex implementation process. However, this can be changed into action research if, e.g. a new method is developed and staff members from various levels actively participate in the activities.

### **5.1.3 Methods used within action research**

In this research the action research was directed to the development of a method for ERP implementation requirements analysis. Therefore the methods selected should, on the one hand, provide information on the business processes of a company, and, on the other hand, involve users in the design activities. The methods selected in this research included interviews and group interviews, conducted in a structured and semi-structured manner. As this research applies the User-Centred Design (UCD) approach, some UCD methods, e.g. Contextual Design (Beyer and Holzblatt 1998), were also used as research methods.

#### **Interviews and group interviews**

Kuniavsky (2003) states that an interview can generally be divided into six phases: (1) introduction; (2) warm-up; (3) general issues; (4) deep focus; (5) retrospective, and (6) wrap-up. First the participant(s) are introduced to the interview situation, to the other participant(s), and the interviewer. Then the interview is warmed up so that the participant(s) focus on the topic. General issues revolve around the main theme, asking about attitudes, experiences, expectations, and assumptions, whereas deep focus dives into the details. In the retrospective part the interview goes back to the general level, but now the discussion relates issues considered in the deep focus phase to issues discussed in the general part. Finally, the interviewer needs to wrap up the interview so that the participant(s) are not “left hanging” at the end of the interview.

Four types of interviews exist; unstructured (open-ended), structured, semi-structured, and group interviews (Preece et al. 2002, p. 390). The structuring refers to the interviewer’s control of the conversation with predetermined questions. A group interview instead involves a small group discussion guided by an interviewer. A focus group is an example of a group interview. Particularly in requirements gathering, focus groups and workshops are suitable methods for raising discussion and finding risk areas, i.e. problematic or conflicting issues.

#### **Contextual Design (CD)**

Contextual Design (CD) is an approach to designing products based on the designer’s understanding of how the real user works (Beyer and Holzblatt 1999). CD aims at the multidisciplinary studying and redesigning of work, and designing a system that supports the redesign. The method includes seven steps: (1) contextual inquiry (CI); (2) work modelling; (3)

consolidation; (4) work redesign; (5) user environment design; (6) mock-up and testing with customers, and (7) putting into practise. Contextual Inquiry (CI) is the primary data-collecting method of CD. CI basically involves observing the user in their working context while he or she is working and talking with her/him about the work. One way to make the observation more natural is to apply a *master-apprentice model*, where the user is a master that teaches the designers how the work is done.

CI applies four principles: *context; summary vs. ongoing experience; abstract vs. concrete data*, and *partnership*. The designers observing the user in a real context reveals things that would not appear in an interview. For example, the task is interrupted by a phone call, or the user checks a detail from the local folder on the shelf. If users are asked about their work, they tend to summarise and gloss the work flow. However, the designer should be aware of the mundane rituals that relate to the user's everyday work. Therefore the designer should observe the user in an ongoing manner in context. To abstract is natural behaviour for humans; it helps us to group things and generalise phenomena. In the case of contextual inquiry, the designer merely needs concrete data - authentic tasks conducted with the tools that the user would normally use, real reports - or else the designer has to carefully interview the user in a very detailed manner. Partnership develops the master-apprentice relationship further. A traditional apprenticeship impedes the observer-interviewer from asking questions. The aim, however, is to have data that help to invent a system for supporting the work. In a partnership the user and designer are able to collaborate in order to understand the work thoroughly. Partnership is also needed when the data are interpreted, shared with the user, and fine-tuned by the user (Beyer and Holzblatt 1998, pp. 41-56).

First the users are studied one by one, and each CI is followed by a design team interpretation session. In order to capture details related to the work and the context, the CIs are modelled with five visual models:

1. flow model: communication and coordination;
2. cultural model: culture and policy;
3. sequence model: detailed steps of accomplished task;
4. physical model: environment as it supports the work,
5. artefact model: papers, folders, etc., that are used in the work (Beyer and Holzblatt 1999).

The collected, interpreted, and modelled data need to be consolidated to cover the target user group of the system that will be designed. The models are consolidated, so that all the flow models are consolidated as one flow model, and so on. The consolidation shows the patterns of work without losing individual variance. The consolidation step includes building an Affinity Diagram (AD), which is a "hierarchical diagram showing the scope of issues in the working domain". The issues are single points that are discovered during the interpretation session. The AD can be built up on the wall, e.g. with post-it notes. Before the technical solution is defined, the work is improved by redesigning it with storyboards. Storyboards form a vision of the future work. In the user environment the design captures the structure, function, and flow of the system without planning any user interface yet. The mock-up and testing is for trying system design alternatives. Paper prototyping is strongly recommended, because it is flexible, moveable, cheap, and encourages users to comment on designs. When put into practise, it has to be ensured that the implementation architecture supports the designed work structure (Beyer and Holzblatt 1999, Beyer and Holzblatt 1998, pp. 21-25).

Contextual Design derives its origins from ethnography but is augmented by psychological principles, which help for example in observations. The advantage of ethnography is in its capability to capture tacit knowledge behind e.g. workers' activities (Isomäki and Pekkola 2005).

Furthermore, Contextual Design especially commits personnel to participate in the ERP implementation requirements analysis activities. Therefore the Contextual Design is a potential method to be applied in ERP implementation requirements analysis. These methods, interviews, group interviews, and Contextual Design together, help to collect, produce, and analyse the information needed for the ERP implementation process. Together they form the methods that are applied in the C-CEI method developed in this research. The methods provide sufficient information on the operations and processes of a company to the researchers.

## 5.2 Research process and resources

The research process in general consists of background studies, constructing a Customer-Centred ERP Implementation (C-CEI) method, and action research on the development of the C-CEI method. The research began in 2003, and the last interviews were conducted in the autumn of 2007 (Figure 12). At the beginning of this research, three case companies were interviewed in a post-implementation manner by the author. Next, the basic idea of constructing C-CEI was jointly invented by the author and by the researcher Ilkka Kouri from the Institute of Industrial Management at Tampere University of Technology. Then the C-CEI method was developed in cooperation with four other companies, using an action research approach. Altogether five researchers or research assistants, including the author of this thesis, were involved in the practical work within the companies.

The four companies paid for a minor part of the research costs, but the development of the C-CEI method was mainly funded by the *Finnish Work Environment Fund (TSR)* and the *Finnish Funding Agency for Technology and Innovation (Tekes)*. The results have been published in various proceedings and Journals in 2005-2008, and a book in Finnish about the main body of the C-CEI method (Vilpola and Kouri 2006) was published in March 2006.

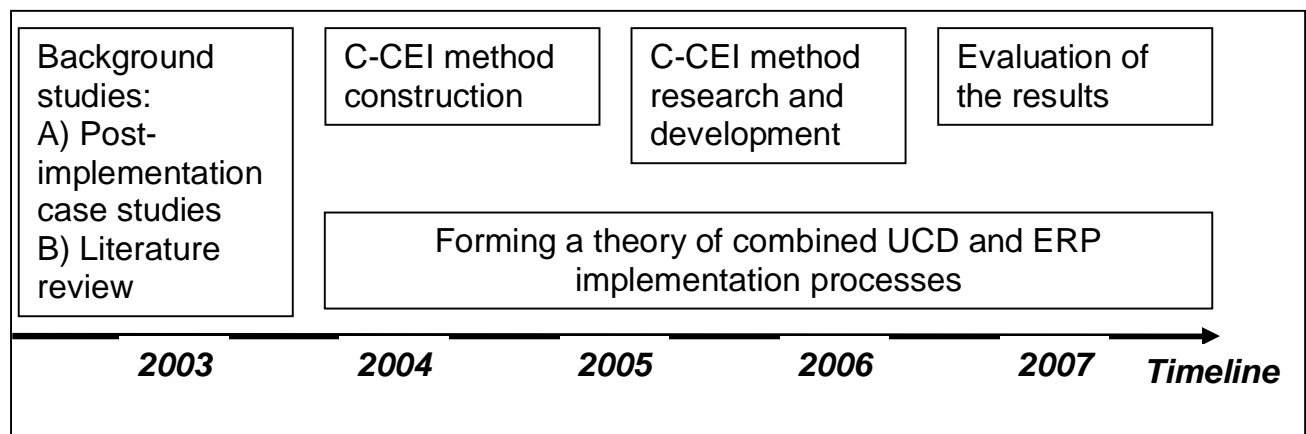


Figure 12. Overview of the research process, including the timeline.

Background studies concretised the ERP implementation challenges presented in the ERP-related literature. The post-implementation case studies were conducted as structured interviews on various organisational levels of the case companies. The interviews are presented in Paper I. On the basis of the background studies it was possible to define the major problematic areas, and how those obstacles are currently avoided or surmounted. Thus it was possible to identify what had not been tried before, i.e. to attempt to actively affect the CSFs of ERP implementation in the early phases of ERP implementation, and apply a UCD approach to an ERP implementation.

Then the C-CEI method was constructed by the author and the researcher Ilkka Kouri. The author was responsible for introducing the principles of UCD to C-CEI, and especially the novel UCD-based analysis of the C-CEI method, whereas Ilkka Kouri was responsible for another analysis, an operational analysis of C-CEI. Together the author and Ilkka Kouri then developed a third analysis, a risk analysis. The author was the manager of the two research projects that were conducted in order to develop the C-CEI method. First, a company was approached to implement the C-CEI method as a research project. The initial plan included a description of the general objectives of the research. Soon after the initial research, three more companies volunteered to continue the research and development of the C-CEI method. The companies were found via different vendors that hinted at their prospect customers. Those customers were unable to proceed in their ERP implementation even though the discussion between them and the vendor had been going on for over a year. These companies then formed the cycles of action research in which the C-CEI method evolved. The evolution is described in Paper VII.

After the new method for ERP implementation requirements analysis was developed and published, the results needed to be studied from various perspectives. Data including 1) the lessons learned during each action research cycle, 2) the contents of the produced documents, and 3) interviews of the personnel from the participated companies was collected and analysed. The aim was to have multiple sources of data related to same research activities within each company. However, the interviews can reflect only subjective data that may not present the most reliable source of knowledge, at least if used as the only source. In addition, representatives of ERP vendors were interviewed for their opinion about a resulting document of the method. The author is the main responsible for the evaluation. The summary of research material is presented in Table 8. However, not all the companies have yet finalised their implementation activities, and thus follow-up research can be conducted in the future.

**Table 8. Account of all the data gathered and produced during the C-CEI method development.**

Material	Quantity	Description
Memos	30 pages	Minutes of meetings with companies project groups
Recordings	308 MB	Recordings of sessions with companies personnel
CI-files	133 pages	Minutes of contextual inquiries in companies
Individual models	147	Modelled data based on contextual inquiries
Consolidated models	15	Consolidated company-specific data based on individual models
Reports for the companies	586 pages	Includes reports of operational, contextual and risks analysis, and an end report for each participating company
Photographs	73	Affinity diagram building session and the diagrams
Transcribed interviews	52 pages	Interviews of the personnel of the companies after C-CEI development project

During this research a theoretical model of combining the UCD and ERP implementation processes was formed. The C-CEI method partly realises this model. The model presents a detailed introduction of how UCD principles and process should be exploited in several phases of ERP implementation. The C-CEI method is an implementation of the model, or part of it, but other experiences from different phases of the ERP implementation process are needed in the future. However, the C-CEI method is an example of what results can be achieved from combining UCD with ERP implementation.



### **5.3 Conclusion**

ERP implementation is a complex process and is influenced by multiple factors, e.g. organisation, information systems, and processes, In this research the objective is to affect the implementation, and study how it can be realised utilising user-centred design. This research is qualitative and active and focused on the requirements analysis phase before an ERP system is selected. Therefore action research is considered an appropriate approach, compared to e.g. a case study approach. However, not to slip into consulting, but to plan and conduct the activities of ERP implementation requirement analysis together, represent a challenge. The novel construction and, especially, applying the participative Contextual Design method supports the selection of an action research approach.

## 6. Development of C-CEI method

The research work started from post-implementation interviews (Paper I), and consideration of how small- and medium-sized enterprises (SMEs) could be helped in their ERP implementation (Paper II). The user-centred design (UCD) approach seemed to have similar objectives, to improve effectiveness, efficiency, and user satisfaction, to those that companies have in their ERP implementation (Paper VI). Several publications considering the risks and critical success factors of ERP implementation also emphasised human factors as a key concern that affects the success of ERP implementation. However, accounts of attempts to affect the success of an ERP implementation were sparse. Therefore, a UCD approach was considered to be a novel one and complementary to those existing ERP implementation requirements analysis approaches.

UCD methods had not been systematically applied to ERP implementation requirements analysis before (See e.g. 4.1 Related research on ERP implementation and user-centred design, p. 28). Therefore a new method called Customer-Centred ERP Implementation (C-CEI) was constructed. C-CEI was first specified by its principles and objectives, such as:

- the method should be vendor-independent;
- the method should apply a UCD principles and process as a whole
- the method should utilise a UCD method called Contextual Design (Beyer and Holzblatt 1998);
- the method should specify the requirements for the ERP system and its implementation, and
- the method should also consider the company-specific risks of the implementation.

The aim was to develop C-CEI as a method that could be applied by other academics and practitioners as well. Therefore the method was developed iteratively with companies, using an action research approach. An overview of C-CEI and its evolution within this research is presented in Section 6.2, and three analyses of C-CEI are introduced in Section 6.3. The expected results of C-CEI for companies are discussed in Section 6.4.

### 6.1 Background and Motivation

Part of the background study is post-implementation interviews that were conducted in 2003-2004 in order to have shop floor users' views of the ERP implementation project. The results are reported in Paper I. The companies represented different industries, had implemented different ERP systems, and their implementation scope varied from vanilla to comprehensive (Table 9).

**Table 9. General characteristics of the three case study companies (Paper I).**

Company reference	Company A	Company B	Company C
Manufacturing branch	Paper industry	Inks	Metal Industry
Turnover	130M€	700M€	11M€
Personnel	over 1000	3200	110
ERP system implemented	SAP (MySAP 2004)	IFS (2004)	Powered (2004)
Category of implementation	Comprehensive	Middle-road	Vanilla

In the background study, the project managers were first interviewed in an unstructured manner, and then structured interviews were conducted with the production planners and shop floor workers. The number of interviewees in companies A, B, and C was seven, five, and two persons, respectively. The structured questions concerned the workers' tasks before and after implementation:

1. Which of your tasks have been dropped or changed or are new?
2. What tasks do you perform after implementation, because or regardless of the ERP system?
3. What is the basis (data) you build your working and production decisions on?
4. What indicator do you personally follow as an indicator for production?
5. Does the current ERP system support your indicator?

In Company A the ERP implementation failed initially because of the lack of internal change in operations. Production decision-making suffered from competing priorities, e.g. the reward system was based on the amount of production, and operational efficiency metrics were based on production reliability, delivery reliability, and delivery cycle, while one priority was salesmen's preferences and yet another was the importance of the customer. Additionally, the visibility of decisions made those responsible feel uncomfortable, because the decisions were entered in the ERP system. However, the company then nominated an internal development manager to make the new processes with the ERP system work.

Company B suspended the implementation of its first ERP system and reused the results of a requirements analysis for another ERP system. The implementation lasted less than a year, but five existing systems were left interacting with the new system. Company B implemented only a limited set of modules of the ERP system. The new system was the only system for production planning after implementation. The expectations of the workers were raised by promising that their value in the labour market would rise because they had been trained in the use of the new system. However, the workers thought that this would mean a rise in wages, whereas management had meant an increase in their skills. The introduction of the new system to the organisation was left till training sessions.

Company C replaced their previous character-based ERP system with a new graphical one. As in Company B, the introduction of the system was left until training, and therefore multiple change proposals and additional requirements arose during the training sessions. The system was still not fully utilised in production planning and workload management, but manual cards and Excel sheets were used even after implementation.

These cases showed that if the end users are not included in the ERP implementation process as key players, the risks of resistance to change and ignoring necessary requirements increase. As a conclusion from these cases and the previous research literature, it was recommended that:

- The context of use, i.e. the users, their tasks and objectives, and the physical and social environment, should be analysed at the beginning of an ERP implementation process in order to understand the organisational aspects of the implementation.
- The end users across the organisation should be included among the key players, and they should be involved in the early implementation activities.
- Usability principles and methods should be applied systematically in ERP system requirements analysis and implementation planning. (Paper I)

These findings, together with a literature review of ERP implementation-related studies, directed the research to focus on users and the introduction of an ERP system in an organisation. The changes in an organisation, in work flows, and in information system usage were seen as major challenges in ERP implementation. However, the changes need to be carefully designed. A user-centred design process has the potential to consider both the need for changes in the organisation and the users' and organisation's requirements for the system. This research was targeted to the ERP system requirements analysis phase, because ERP system selection affects how the operations will be carried out during the next ten years. Therefore the results could enable the selection of an

ERP system to be well-grounded and support the organisation in the changes specified during the requirements analysis.

## 6.2 Overview of C-CEI Method and its Evolution

The main target of this research was to develop a method that applies principles and process of user-centred design in order to improve the success of ERP implementation. The C-CEI method was initiated in late 2004. The motivation to develop the C-CEI method lay in the previous research on ERP implementations and companies' difficulties with their ERP projects. At the beginning it was unclear e.g. how the C-CEI method should be implemented, who should be involved in the implementation, how useful the results are for the companies, and what the organisational impacts are. Therefore the action research approach (See 5.1) seemed to provide tools for developing C-CEI in an iterative manner from one company to another. Paper VII focuses on the evolution of the C-CEI method.

Four companies were selected as participants in the implementation of the C-CEI method (Table 10). The selected companies represented different industries. From the business and organisational perspective, Company A was an expert organisation with tailored products, whereas Company B belongs to the processing industry, Company C operates in projects and has fewer than 10 officer workers, and Company D has various positions and types of businesses, such as design, assembly, and installation services. All four companies have had difficulties initiating their ERP projects, and therefore were enthusiastic about participating in the C-CEI method research process.

**Table 10. Parameters of participating companies (Paper VII).**

<i>Company</i>	<i>Industry</i>	<i>Turnover</i>	<i>Personnel</i>
A	Measurement devices and services	\$ 2,4 M (2005)	32
B	Explosives	\$ 10,4 M (2005)	144
C	Construction projects	\$ 15,2 M (2006)	115
D	Automation design, implementation, and installation	\$ 20,8 M (2006)	236

The C-CEI promotes for applying principles and process of the user-centred design (UCD) that are described in Chapter 3. (p. 21), in an ERP implementation requirements analysis. Particularly the principles of user involvement, design solution iteration, function allocation and multidisciplinary design team were followed already during the development of C-CEI. In every company it was first explained that the objective was to develop the C-CEI method and the activities would require the active involvement of the company representatives. At the same time, when a company participated in the development of C-CEI they produced company-specific results that could be utilised in their forthcoming ERP implementation project. The development of C-CEI was carried out in the four companies in such a way that the development cycles overlapped. Thus the lessons learned in one company could be utilised in the next company. Figure 13 shows the action research cycle in a company, and that cycle was iterated four times during the development of the C-CEI method.

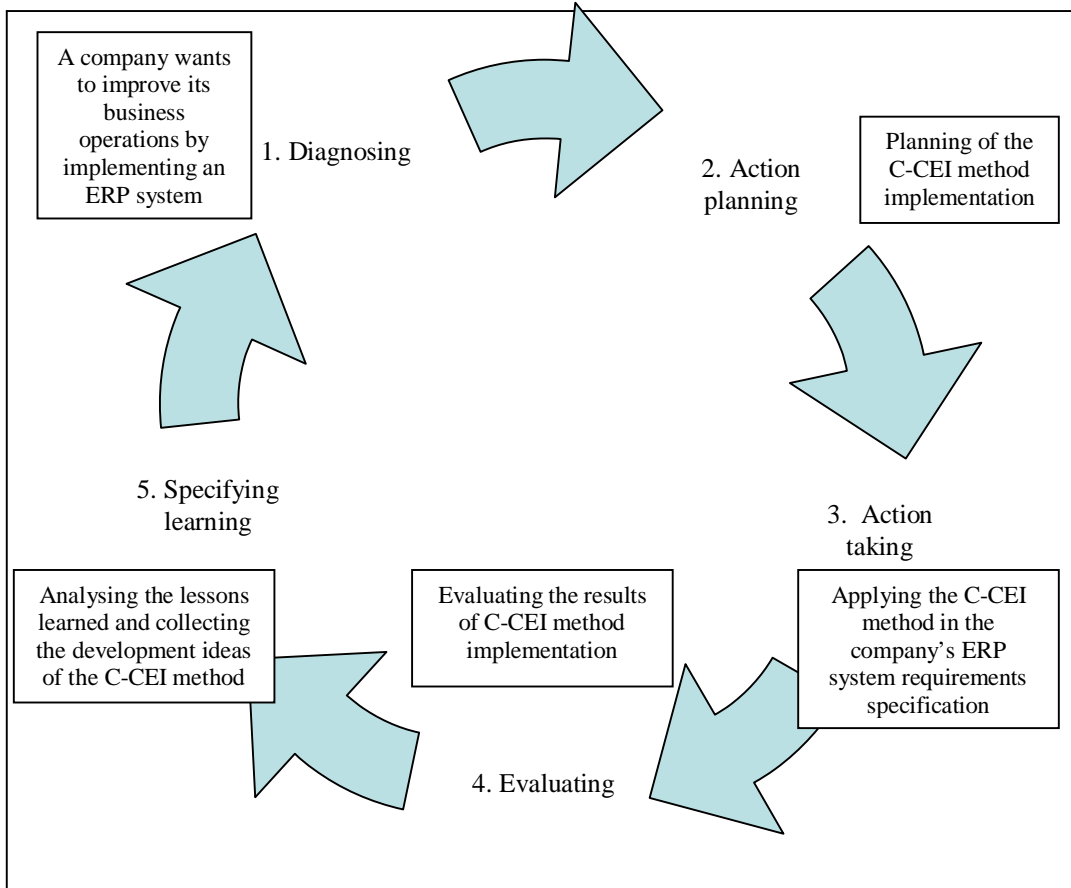


Figure 13. Iterative cycle of action research (Susman 1983) augmented by action on C-CEI method research work in the participating companies.

C-CEI developed within every company and its action research cycle. In order to describe the development process logically, first the main structure of the method has to be introduced. The C-CEI method consists of three analyses: *operational*, *contextual*, and *risk analysis* (Figure 14). The first of the analyses, operational analysis, provides input for the subsequent analyses, just as the contextual analysis provides input for the risk analysis in turn. If the contextual analysis has already started before the operational analysis has been completed, it can create new subjects to discuss in the operational analysis. The C-CEI method is well explained in Paper V.

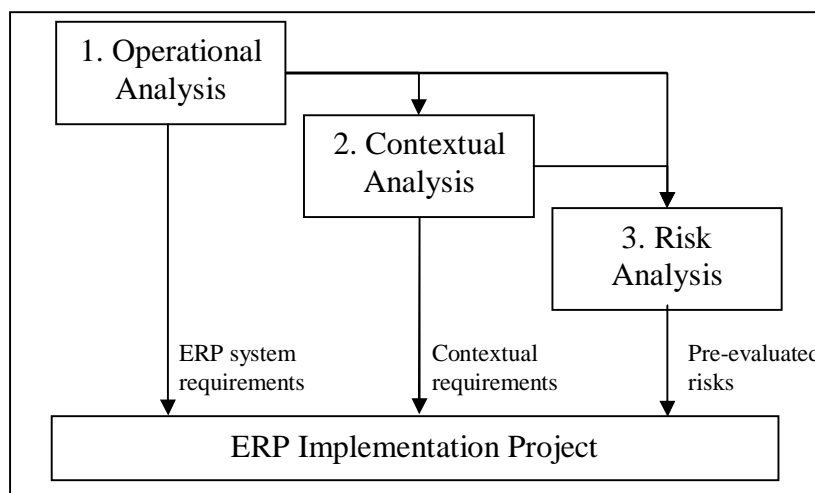


Figure 14. Phases of the C-CEI method (Paper VII).

The results of the C-CEI method are always company-specific, although some of the risks can also be considerable in other companies. The results of the C-CEI method support the ERP implementation project in various phases. ERP system requirements documents support the early phases in which the ERP system is selected and modifications specified. The contextual requirements provide an insight into the organisation and specific task flows, and are useful in planning the implementation activities. Pre-evaluated risks concern the entire implementation and they need to be repeatedly re-evaluated throughout the implementation. In the next section each analysis is described in more detail.

The main results of the development of the C-CEI method were that the contextual analysis developed the most whereas the other analyses, operational and risk analyses, had less to improve (Table 11). A conclusion of the development is presented in Table 6 of Paper VII. Operational analysis follows the more traditional requirements gathering approach by interviewing key personnel from different functions of a company. Therefore the development of operational analysis was small compared to contextual analysis that applied the Contextual Design method in a new context, the ERP implementation requirements analysis. Also to conduct a risk analysis has been a part of companies IS projects for a long time, and therefore the elements of this analysis already existed before C-CEI. The novelty, however, was to combine these analyses by using the output of one analysis as an input of another. Therefore the development of C-CEI has to be also discussed as terms of interaction between the analysis and the value of C-CEI and its analyses to the customer organization. The discussion is presented in Sections 8.4 and 8.5.

**Table 11. Summary of the development of the analyses of the C-CEI method.**

Company	Operational analysis	Contextual analysis	Risk Analysis
A	Must requirements could be used for reducing the amount of potential ERP systems.	Physical and interaction models can be combined. Results of affinity diagram need to be linked more closely in the planning of ERP project	Risks need to be categorized according to ERP project phase. 3-step scale is too sparse to evaluate the effectiveness and probability of risks.
B	-	Introduction of the Contextual Design method needs improvement. The affinity diagram needs to be built on a 3-level hierarchy. A tool to analyze attitude of personnel is required.	Risk interviews can be integrated into interviews for the operational analysis
C	-	Results need to be iterated further in order to prioritize them and plan appropriate actions. Observations should focus more on personnel who are the key users of the ERP system.	-
D	-	-	-

In the operational analysis the use of prioritised ERP system requirements was specified; only the top priority requirements are used for selecting appropriate vendors. Then the other requirements can be used as selection criteria. The contextual analysis had several improvements. For example: (1) the modelling techniques of the Contextual Design (CD) method (Beyer and Holzblatt 1998) were further developed; (2) the construction and utilisation of the Affinity Diagram of the CD in the

ERP implementation context were improved; (3) the need for a tool for measuring the attitudes of users was identified, and (4) further activities after C-CEI were considered. In the risk analysis the categorisation of risks was improved and the risk assessment scales adjusted. The developments occurred on the analysis level, as well as in the entire C-CEI method. The progress on the method level consists of combining the analyses more tightly together and suggesting further development directions e.g. the development of tools for analysis purposes or the development of a management tool for an ERP implementation. The learning specified in company C was implemented in company D. After C-CEI development in company D, any development ideas related to single analyses. However, different ideas for further development of C-CEI are presented in Sections 8.1 and 9.1. The method presented in Section 6.3 describes the method used in company D and is the result of this development process.

### **6.3 Detailed description of C-CEI method**

The C-CEI method consists of three analyses: operational, contextual, and risk analysis, which are explained in Paper V. Each analysis contributes to the ERP implementation from a different perspective. Operational analysis focuses on ERP system requirements, whereas contextual and risk analyses focus merely on the requirements of the implementation e.g. the changes needed in the organisation and planning for the implementation activities. Each analysis is described in the following sections: operational analysis in Section 6.3.1, contextual analysis in Section 6.3.2, and risk analysis in Section 6.3.3. The motivation of C-CEI is to apply principles of user-centred design in ERP implementation requirements analysis.

#### **6.3.1 Operational analysis**

Operational analysis focuses on the current and target states of the company's operations. The aim is to find the critical points that have an effect on the selection of an ERP system. The critical points can be e.g. operations that are changed, or tasks that are particularly important from the business objectives perspective, such as tasks in the customer interface. The aim is to concentrate on requirements that can be challenging in the selection and implementation of an ERP system instead of routine tasks, e.g., financial operations, because most ERP systems have a commonly established functionality for such a routine operation. Attention is also paid to the frequency of operations and the number of staff members or amount of material involved in operations.

The methods used in operational analysis are group interviews and iterative evaluation of ERP system requirements. The result is a document that presents the company's business objectives, current state (business model, operations, and personnel), and the prioritised ERP system requirements. An example of a table of contents of an operational analysis document can be seen in Appendix 1 of Paper VII. The document can be used as an attachment to a request for proposals to ERP system vendors. The document also supports communication with e.g. third-party ERP implementation consultants.

The UCD principles such as user involvement, multidisciplinary design team and solution iteration are fulfilled in the operational analysis. As an ERP system will be common for all operations in a company, the different processes and thereby different user groups has to be covered in the operational analysis. In order to be efficient, the use of ERP system specialist is recommendable as a specialist is able to identify the distinctive requirements that can be used as selection criteria for the ERP system. From the critical success factors' perspective involvement of users from wide variety of operations in company and multidisciplinary iteration of ERP system requirements increases the potential occurrence of interdepartmental cooperation and communication. The goals

and objectives may also become clearer as the requirements are iterated among the users. The operational analysis document defines the business context and quantity of operations that provide valuable input for the following contextual analysis.

### 6.3.2 Contextual analysis

The contextual analysis of C-CEI applies a user-centred design (UCD) method called *Contextual Design* (CD) (Beyer and Holzblatt 1998). Specifically, the first four out of the total of seven phases of the CD are applied in the C-CEI method. The phases are: (1) contextual Inquiry (CI); (2) modelling and interpretation; (3) consolidating the models (Affinity Diagram included), and (4) work redesign (Figure 15). The contextual analysis can also be considered as *a rapid contextual design* (Holzblatt et al. 2005), in which those parts considered appropriate and useful are adopted from contextual design phases.

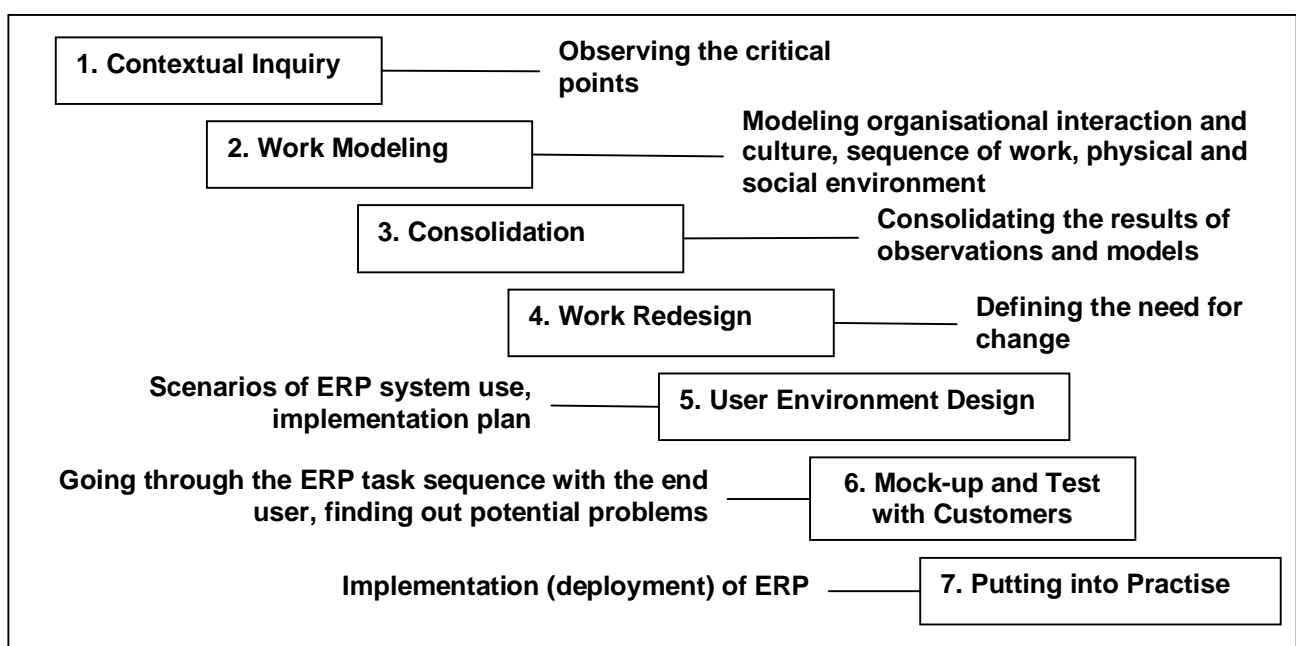


Figure 15. Contextual Design method (Beyer and Holzblatt 1998) applied in contextual analysis of C-CEI (Paper V).

The phases that are not utilised in C-CEI are: (5) user environment design; (6) mock-up and test with customers, and (7) putting into practise. However, the phases from five to seven could be conducted after selecting an ERP system. This research considers the C-CEI method before an ERP system is selected, and therefore the last phases of the CD method are not used. In the following subsections each of the four phases of CD applied in the C-CEI method is described in detail.

#### Contextual Inquiry

Contextual Inquiry (CI) method is described in Section Contextual Design (p. 38). The method combines user observation and interviews in the natural work environment while the user is conducting the normal tasks at hand. The advantage of CI, compared to an interview, is that the researcher can actually see how the task is conducted, what the desired outcomes are, and what the possible obstacles are during the task. The user might not be able to remember the necessary details of the work in an interview conducted elsewhere. The advantage of CI compared to observation is that the misinterpretation of observations is avoided by asking the user ‘why’, ‘what’, and ‘how’ questions.



*Contextual inquiry* (CI) is used in the data-gathering phase of contextual analysis (Figure 16). Although the basic information on the target process or task has already been collected in operational analysis interviews, more detailed data about the context, e.g. work flows, task sequences, information systems usage, and artefacts, are needed. The company culture and social relationships are also revealed in CI. This information is relevant when implementation activities are planned and key players selected. The CI in the contextual analysis of C-CEI focuses on the critical points found in the preceding operational analysis, and, specifically, the utilisation of current information systems. The CI deviates from the original CI in the CD method in that the workers observed do not do the same work. Instead, the workers are e.g. from different phases of the target work process (Paper III).

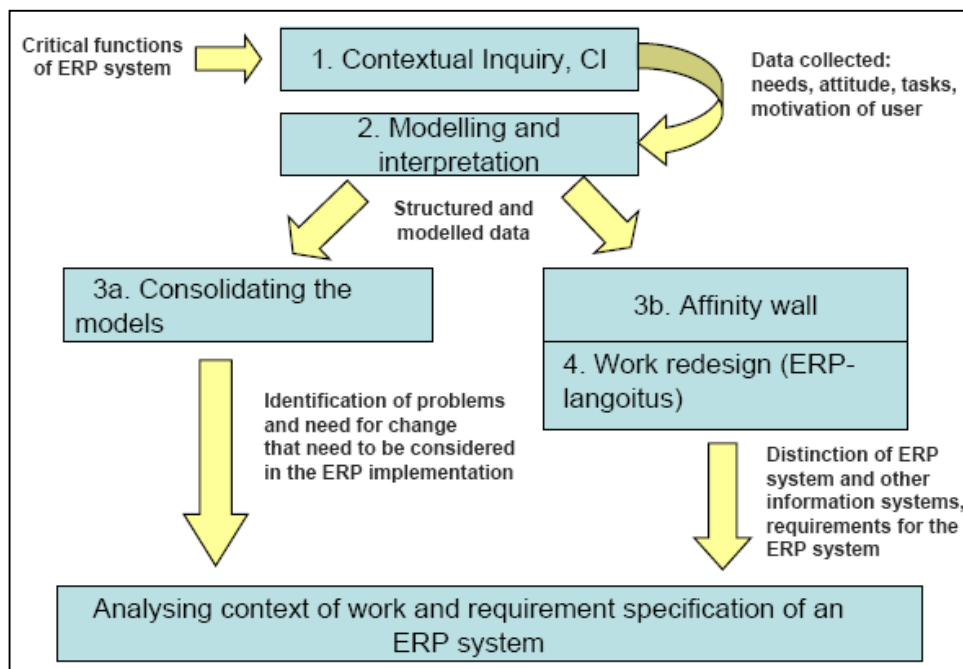


Figure 16. Phases of the Contextual Design method applied in contextual analysis of C-CEI (Paper V).

The data are collected as written notes, but could be recorded or video-recorded as well. During the CI of the contextual analysis, a task is usually observed step-by-step, and meanwhile the user's other relations to the rest of the organisation, as well as other duties, such as weekly project meetings, are topics of the interview at the same time. The observation can be conducted in pairs so that one observer can take notes and observe the surroundings while the other maintains the focus and asks questions. Even though artefacts are not modelled in the contextual analysis of C-CEI, they can be collected in order to help the interpretation.

### Modelling and Interpretation, and Consolidating the Models

In the modelling and interpretation phase each CI is modelled using a *flow model*, *sequence model*, *cultural model*, and *combination of flow and physical models*. The only model that is not utilised is the *artefact model*, because before selection of the ERP system that would provide information that is too detailed. However, during the ERP implementation those artefacts can be used as a source of configuration or report specification. In the models, the problems are marked with a lightning bolt symbol. In each model the observation day, the sequence number, and the name of the model are identified, e.g. "22.1.2005 CI2 Flow model". Models are sketched as a group activity and therefore

often drawn by hand, but the modelling can be supported by a computer tool as well. In this research the modelling of a single CI was performed on an A4-sized piece of paper and then the models were consolidated on a large A1-sized piece of paper. Finally, the models were photographed and transferred as electronic attachments to the contextual analysis document.

The flow model describes the individuals, responsibilities, groups, the flow (i.e. communication), artefacts, communication topic or action, places, and breakdowns (Beyer and Holtzblatt 1998, p. 91). The flow model of contextual analysis shows the target of the observation in the centre of the picture in a circle (Figure 17). The persons, roles, or functions in the organisation this observed person is in contact with are drawn as circles on the edge of the paper. In each circle the title and responsibilities of the person are identified. The interaction is described as an arrow from one circle to another and the type and content of the interaction reads within the line. A lightning bolt is added if there is a problem within the communication, e.g. official decisions are transferred only via unofficial communication, such as chat in a corridor.

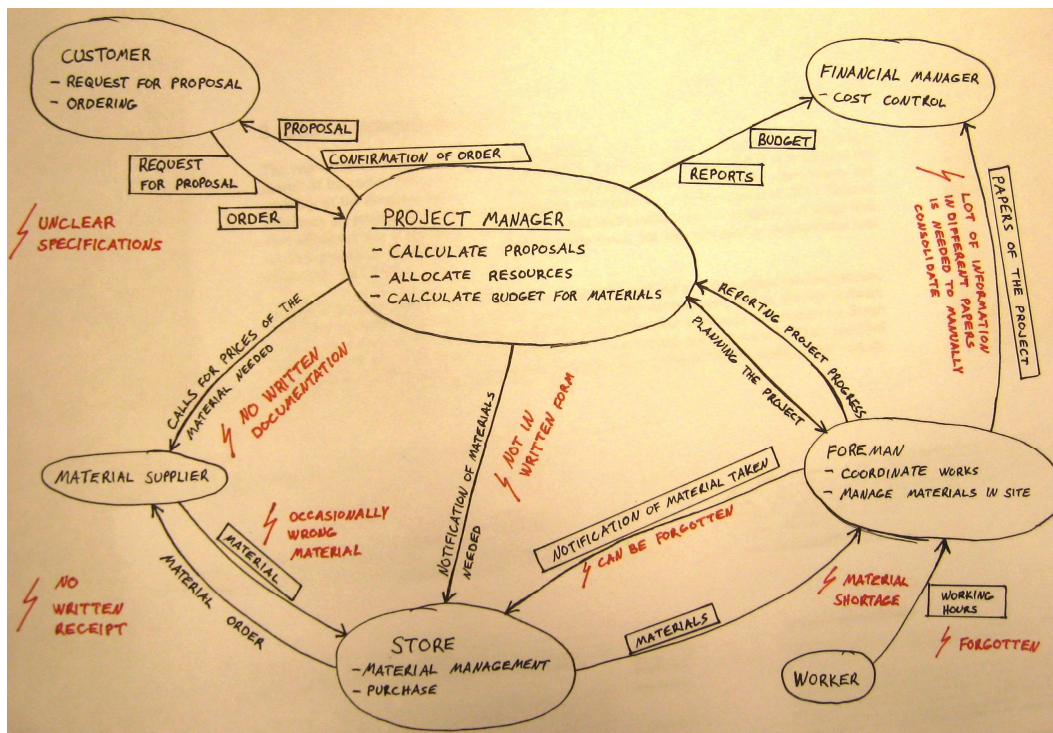


Figure 17. Example of a consolidated flow model.

The cultural model presents influencers, the extent of an effect, influence on the work, and breakdowns (Beyer and Holtzblatt 1998, p. 109). In the contextual analysis the cultural model of the organisation expresses the attitudes, politics, and expectations that affect how the organisation works. Again, as in the flow model, the persons, roles, or functions are in circles, but now the circles overlap each other to the extent that their cultures affect each other (Figure 18a). The influence is depicted by an arrow, whose breadth tells the strength of the influence. Texts in the cultural model express the often unspoken attitudes and cultures that prevail in the organisation. Above the circles is an arc that describes the company culture, which dominates every group and subculture of the company. A lightning bolt indicates if there are cultural collisions between the parties, e.g. sales operations' top priority is time to market, whereas production's top priority is the maximum load of capacity.

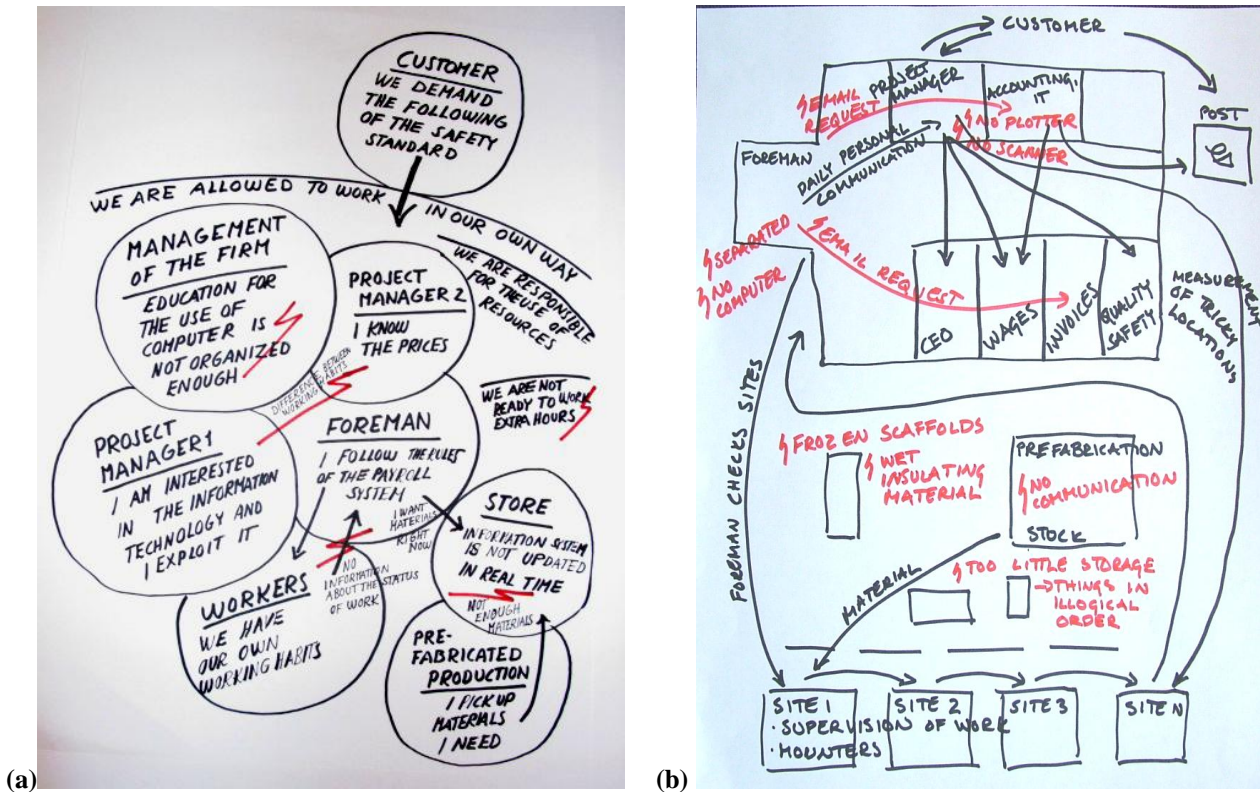


Figure 18. An example of consolidated cultural model (a), and consolidated physical and flow model (b) of the contextual analysis.

The physical model of contextual design presents places, physical structures, usage, and movement within the place, hardware, software, and communication lines, and other tools, the artefacts, the layout, and breakdowns (Beyer and Holtzblatt 1998, p. 117). The combined physical and flow model of the contextual analysis describes the company area in focus (Figure 18b). For example, the physical model can illustrate a multi-site environment, an area occupied by a number of buildings, or the layout of a unit. The interactions, i.e. information flows, are then added to describe the potential need for communication support or to illustrate the problems of current interaction. Again lightning bolts indicate problems in physical layout or problems in communication caused by physical issues.

The sequence model includes an intent, a trigger, steps, order, loops, and branches, and breakdowns (Beyer and Holzblatt 1998, p. 99). The sequence model in the contextual analysis describes the task at hand that the person being observed was doing. The model consists of the objectives, triggers, and steps of the sequence (Figure 19). In the contextual analysis of the C-CEI method, many sequence models are usually being interpreted from a single observation, because today workers typically have multiple responsibilities, and these do not naturally form just one sequence but multiple shorter sequences. The breaks and problems during the sequence are marked with lightning bolts. For example, if a person is performing a task with the computer, and some information has to be checked from the local paper folder, that can be a problem in the event that someone else tries to perform the same task elsewhere without the paper folder.

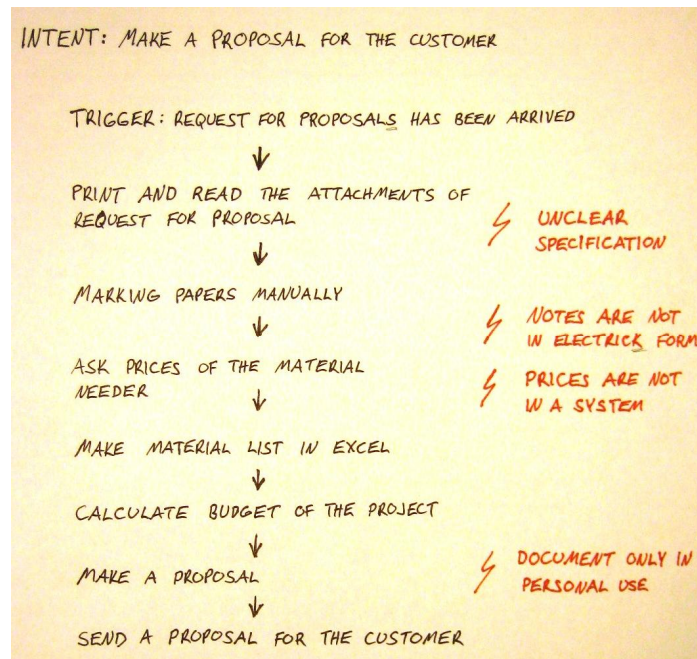


Figure 19. An example of sequence model of the contextual analysis.

Models are then consolidated i.e. incorporated as one flow model, one cultural model, and so on. The lightning symbols are also enclosed in the consolidated models. The consolidation of sequence models is exceptional, because different models are not describing the same sequence, but merely parts of the same process. Therefore sequence models either cannot be consolidated at all or they need to be linked as a (piece of) process. The consolidated models combine the results of individual observations into an overview of the organisation, without any loss of individual variance. The consolidated models are utilised in planning the changes for the organisation during the ERP implementation. Sequence models are particularly for identifying the potential focus of ERP system demonstrations and ERP system training.

### Building an Affinity Diagram, AD

An *Affinity Diagram* (AD) is built up from notes captured from the CI. Those notices are excluded from the models. The AD is built in bottom-up style in a group work session together with stakeholders in the ERP implementation. The instructions given in contextual analysis are to attach notes pair-wise to the diagram one by one, discussing the content with the pair first. When a group exceeds 6 notes it should be divided into two groups or some notes should be attached to other groups. First, all of the notes were put on the wall in groups of a maximum of six notes. Second, each group was given a name, and, third, these groups were collected in clusters, with a maximum of six groups in a cluster. Finally, these clusters were given a name. The final AD consisted of levels of headings and notes attached under first-level headings.

When ready, the AD shows the challenges of the context. The AD is then used in the work redesign phase in analysing which of the challenges are to be solved with the ERP system, and which require organisational changes, e.g. changes in organisational settings or changes in culture. Building the affinity diagram with representatives of the organisation is challenging as it requires a new perspective to be obtained on the familiar issues presented in the notes. During this research the company staff tended to pre-categorise notes according to the function they related to, or a computer system that was mentioned in the note or according to a process such as sales, orders, manufacturing, and logistics. However, with a few examples the personnel learned to build the AD

from the bottom to the top and consider the common objective or idea in two notes and thereby within a group.

### **Work redesign**

This part of the contextual analysis aims at developing the organisation for managing the changes during an ERP implementation. The models are read and the AD is walked through by reading the headings. As the AD presents the contextual issues of the organisation, the potential impact of an ERP system on these issues needs to be discussed. One possible way is to highlight the notes or groups that are affected by the ERP system. Those issues need to be considered in the implementation plan. In order to get fixed, the issues that are not highlighted need some other activities before, during, or after the ERP implementation.

The current reality is shown in the consolidated models and in the AD. That needs to be notified by the managers so that they will understand the amount of changes needed in the organisation. However, workers also need to identify the problems and commit to the change. For the project team, this exercise provides the ground for the planning of ERP implementation activities.

### **Contextual analysis document**

Finally, the consolidated models and the work redesign results are documented as the result of the contextual analysis. An example of a table of contents is in Appendix 2 of Paper VII. The contextual analysis document describes the current context of use, i.e. users' tasks, objectives, and the physical and social environment, and analyses the consolidated models in detail. The AD and the results of the work redesign activity are described. The most important part from the organisational perspective, however, is the proposal for action that the organisation should use to improve the context. The document can be utilised in planning the implementation activities, e.g. the sequence in which the ERP system functionality is taken into use or planning how the training is organised.

Conducting a contextual analysis within an organisation follows all the principles and the process of the UCD. The users are actively involved as objects of the contextual inquiries, as participants in building the affinity diagram, and in work redesign. The design team involves representatives from various functions of a company. The contextual findings and designs are iterated several times during the building of Affinity Diagram and work redesign. The functions are allocated between the ERP system and the organisation using the system. Moreover, the context of use is at first specified and then the work is redesigned against the requirements. More iteration could be conducted, but merely in later phases of an ERP implementation. A relevant phase could be the modification phase (Fig. 1) when the business process reengineering is actually taken place.

### **6.3.3 Risk analysis**

Risk analysis is the third analysis of the C-CEI method and receives input from the preceding contextual and operational analyses (Figure 14, p. 47). Risk analysis is described e.g. in Paper V. Risk analysis has four phases:

1. identification of the risks;
2. categorisation of the risks;
3. assessing risks, and
4. planning risk management operations.

The risk *identification* has already taken place in the preceding operational analysis and contextual analysis phases of the C-CEI method. Those critical points identified in operational analysis, those problems marked by a lightning symbol, and the notices on AD are, in fact, potential risks in ERP implementation. The risk analysis emphasises company-specific risks instead of using a common ERP implementation risk list (e.g. Sumner 2000). In some cases, using this company approach, multiple relevant risks that cannot be found in common risks can be found.

Risks are *categorised* on the grounds of their possible occurrence in a certain phase of the implementation. A rough division of ERP implementation into three phases, selection, implementation, and usage, is useful for ERP project risk management purposes. The *assessment* of risks is again a workshop activity, because people can interpret the same risk in different ways. Therefore the risks are also described in more detail: cause; occurrence; consequences, and proposals for action (Paper V). Then the effectiveness and probability of each risk as assessed on a scale from one to five, and the risk production (probability multiplied by effectiveness) is calculated. Those risks that have a risk production of 12 or more can be considered as serious risks, which mean that one of the effectivenesses and probabilities has to be at least 3 and others even higher. *Planning risk management* operations includes, for instance, making a decision on what risks are actively prevented from occurring, and when the risk list is re-evaluated during the ERP project.

The risk analysis relies on analyses of the context that are conducted on preceding operational and contextual analyses within the organisation. Therefore the risk analysis follows principles of UCD like user involvement, iteration of produced design i.e. identified risks, and a multidisciplinary design team. The function allocation is not so evident although the risk management activities are designed during the risk analysis. The company-specific result of the UCD-based risk analysis of C-CEI is compared to a common risk list in paper IV. The results indicate of possible connection between a company's ICT capability maturity and amount of company-specific risks.

## **6.4 Expected results of C-CEI method**

The main target of this research was to develop a method that could be used for ERP implementation requirements analysis. In addition to ERP system requirements analysis, the method should also cover organisational changes and implementation risks. Various motivations have affected the construction of the Customer-Centred ERP Implementation (C-CEI) method. They are listed below:

- unsuccessful ERP implementation reported in scientific publications, as well as in business magazines;
- particular problems of small and medium-sized companies in initialising their ERP implementation;
- lack of tested, documented, and vendor-independent methods for ERP system requirement specification;
- lack of a user-centred approach in ERP implementation.

One of the major objectives of the C-CEI method is to influence the whole organisation, from managers to shop floor workers. The aim is to improve the initial readiness and thereby enhance the critical success factors of ERP implementation. The C-CEI method, with its three analyses, produces three documents consisting of data needed in different phases of a company's ERP implementation. Documents are only the physical appearance of the partial data generation. An even more important result of the C-CEI is the organisational impact for the participants that shows in possible appearance of the critical success factors of ERP implementation.

After the implementation of the C-CEI method the organisation is aware of the focus of ERP implementation, the objectives of the implementation, and the major threats to their organisation in the ERP implementation. The company is able to approach ERP vendors and select a system with justified criteria. The company is also aware of the changes needed in operations and the organisation in order to benefit the ERP investment. The implementation project can be planned in such a way that the changes are conducted and managed in a controlled way. The company has prioritised company-specific ERP implementation risks that are managed with a preventive manner, e.g. checked at every ERP project meeting. Staff members on various levels of the organisation have been involved with the ERP implementation requirements analysis. Thus the critical success factors are affected positively, and the ERP implementation competence of the organisation has increased.

## 7. Evaluation of the C-CEI method

The aim of C-CEI is to analyse the organisational requirements of an ERP implementation before an ERP system is selected. The purpose is to have a positive effect on the critical success factors and, thereby, the overall success of the implementation. The novelty of C-CEI is to apply a user-centred design approach and actively involve users in the requirements analysis activities. In order to evaluate how the C-CEI method has promoted these issues, various evaluation activities were conducted. This thesis consists of constructive research work, which involves multiple stakeholders, as well as plenty of qualitative material. Therefore, the results are descriptive, and provide practical know-how on ERP requirements analysis. The aim is to give a holistic overview that includes customer and ERP system vendor perspectives. Perspectives on the development of the method are provided by the participants in C-CEI development activities.

Since the C-CEI method is developed during this research, some evaluations are conducted in order to have an insight into its appropriateness for ERP implementations. Evaluations include:

- activities that the companies have undertaken during the development of the C-CEI method, and the course of each analysis (Section 7.1, Paper V);
- content analysis of the documents produced within C-CEI (Section 7.2, Paper VII);
- interviews with staff members that participated in the development of the C-CEI method (Section 7.3, Paper VII), and
- interviews with the vendors that had received the operational analysis document from a customer company (Section 7.4).

In this chapter the evaluation results are concluded, because most of the results have been thoroughly presented in Papers V and VII, except the interviews with ERP vendors (Section 7.4).

### 7.1 Results of the development of the C-CEI method with the companies

The companies that participated in the development of the C-CEI method (Table 10, p. 60) expended a considerable amount of resources during the development activities (Table 7). The resources were used for planning the activities, e.g. scope, schedule, objectives, conducting the activities, e.g. affinity diagramming, prioritising risks, and commenting on the activities, e.g. documents and the C-CEI method. However, the participants felt comfortable, because they could work on their ERP implementation requirements at the same time.

**Table 7. Resources of participant companies and researchers (Paper VII).**

<i>Company</i>	<i>Company resources</i>	<i>Researchers' resources</i>	<i>Duration</i>
A	18 days	47 days	2 months
B	40 days	39.5 days	4 months
C	22 days	24 days	6 months
D	33 days	42.5 days	4 months

The human resourcing needed was monitored. The C-CEI method took 490, 600, 350, and 560 hours in Companies A, B, C, and D respectively. The companies' shares of the hours were 27%, 50%, 48%, and 44%. The results for Companies A, B and C are described in Paper V, and only those of Company D briefly here.

In Company D the number of participants in the operational analysis of the C-CEI method was a total of 41 persons from the organisation. The persons either specified the requirements or commented on the requirement specification, i.e. the operational analysis document. In the



contextual analysis a total of 8 persons were observed, and that resulted in 43 models, i.e. visual representations from various viewpoints. The consolidation and building the affinity diagram were done with 6 representatives from Company D. Risks identified in the preceding operational and contextual analysis were then analysed and prioritised, and the risk management activities conducted together with 5 company representatives.

As a result the requirements for an ERP system was identified, discussed, and prioritised, as was the target operational model of Company D. In the operational analysis different operations, e.g. contract manufacturing, project manufacturing, and installation work, create requirements for an ERP system. The target operational model will include the possibility of remotely logging into the system. The contextual analysis revealed e.g. inconsistent practises in the logging of materials and working hours. These operations will be corrected with an ERP system at the latest, but preferably before that. The risks were identified and divided according to the ERP implementation phase: ERP system selection, ERP system implementation, and ERP system usage. For example, the most severe risk for the company in the ERP system selection phase is ignorance of other requirements from the group level. From the change management perspective, the situation is challenging, as there can be competing priorities in the group. Those priorities need to be considered within all the companies in the group.

## 7.2 Content analysis of the C-CEI documents

The content analysis of the documents produced in the development of the C-CEI method is described in Paper VII. In this section some of the tables are displayed, but only the conclusions of the findings are presented here. *Operational analysis, i.e. the requirement specification document*, included 67-202 requirements (Table 8). However, the ‘must’ requirements were only from 8 to 18 of the total number of requirements.

**Table 8. Content analysis of companies’ requirement specifications (Paper VII).**

<i>Requirements/ Company</i>	<i>Must</i>	<i>1<sup>st</sup> priority</i>	<i>Others</i>	<i>Total</i>	<i>To be tested</i>
A	18	77	26	<b>121</b>	20
B	12	75	56	<b>143</b>	15
C	8	38	21	<b>67</b>	2
D	- *	- *	- *	<b>202</b>	- *

\* Company D forms part of a group, and the requirement specification was to be extended to cover the group.

The results of the *contextual analysis* culminated in the results of the Affinity Diagram (AD) activity of the C-CEI method. The AD is built from notes that each present an issue observed in the context (See p.47). The notes form a hierarchy of common themes that represent the problems of the working context. In this case, the difference between the *total number of notes* and the *notes related to ERP* (Table 9) should be especially noted. This difference may indicate potential areas for improvement that already existed before or despite the ERP implementation.

**Table 9. Results of building Affinity Diagrams (Paper VII).**

Company	Problematic areas (number of notes total/related to ERP)	Total number of notes	Number of notes related to ERP
A	Data storage (5/*) Quality management (11/*) Schedule management (17/*) Price lists (5/*) Production data management (14/*) Time management (13/*) Human resources (8/*) Order data management (13/*) Customer needs (9/*) Communication (9/*)	104	*Not identified
B	Maintenance (23/0) Logistics (25/21) Communication (14/6) Documentation (13/13) Packing and delivery (22/10) Production management (42/26) Data logging (19/15) Production planning (22/22) Quality management (36/3) Basic data (19/13) Interest groups (7/4)	242	133
C	Project management (32/32) Material management (18/14) Proposals (20/7) Company culture (9/9) Utilisation of technology (9/4) Interest groups (11/3)	99	69
D	Data utilisation (35/7) Cost management (32/27) Customer (19/8) Sales and project management (31/19) Resources (40/6) Materials, construction site (28/22) Materials, stock (24/14) Project management on site (33/28)	242	131

In the *risk analysis* the company-specific risks are identified and then assessed according to their probability and effect on a scale from one to five (the most probable or effective). The risk product is calculated by multiplying the value of the probability by the value of the effect. A severe risk has a risk product of 12 or more. The content analyses of risk analysis documents shows that the share of severe risks is about half of the total risks (Table 10). The share of severe risks increases in the ERP implementation phase, but decreases again in the usage phase. In Paper VI, company-specific risks identified by the risk analysis were compared to the common ERP implementation risk list of Sumner (2000). It turned out that only 27-35% of the company-specific severe-rated risks were on the common list. Therefore, without the risk analysis of the C-CEI, 65-73% of the severe risks could have been left unidentified.

**Table 10. Analysis of risk document. The number in parentheses refers to the number of risks identified as having a risk product of at least 12, according to effectiveness and probability, or on a 5-step scale. (Paper VII).**

<i>Risks/Company</i>	<i>Selection</i>	<i>Implementation</i>	<i>Usage</i>	<i>Total</i>
A	10*	21*	7*	38
B	17 (7)	33 (18)	15 (8)	65 (33)
C	17 (5)	33 (17)	13 (6)	63 (28)
D	21 (5)	34 (16)	14 (5)	69 (26)

\* The scales of both effectiveness and probability were 3-step in Company A, but 5-step in the other companies.

The content analysis of the C-CEI method documents illustrates the amount of work needed to analyse the requirements for an ERP system, even in a small company, such as Company A. In the number of requirements, as well as in the number of notes in the AD, the wide variety of areas to discover can be seen. The challenge for a company is to conduct an ERP implementation requirements analysis with such a wide scope. However, the workers of the company will become the key players in the ERP implementation and end users of an ERP system. Therefore, the participants in this research should also express their opinions and viewpoints on the C-CEI method.

### **7.3 Interviews with participants from the companies implementing the C-CEI method**

In order to evaluate the development of the C-CEI method from the participants' perspective, a total of six interviews was conducted in spring 2007. The interviewees represent different organisational levels, genders, and work experience (Table 11). In these interviews, the potential effects of the C-CEI method on the critical success factors (CSFs) of an ERP implementation are studied. The results and quotations from the interviews are explored in Paper VII, but a summary is presented here.

**Table 11. Information on interviewees: position, experience, age, gender, and information systems usage at work.**

Code	Position	Company	Time in the position	Time within the company	Age in years	Gender	Share of using IS of the total working time (0-20%, 21-40%, 41-60%, 61-80%, 81-100%)
A1	Chief Executive Officer	A	10 years	15 years	54	Male	21-40%
A2	Production manager	A	4 years and 1 month	4 years and 1 month	44	Female	41-60%
B1	Foreman	B	14 years	29 years and 7 months	54	Male	41-60%
B2	Production designer	B	4 years and 9 months	34 years and 6 months	55	Female	21-40%
C	Safety and quality manager	C	5 years	8 years and 6 months	37	Male	21-40%
D	Production manager	D	4 years	5 years	29	Male	0-20%

The interviewees were asked to comment on the C-CEI method, first in general and then analysis by analysis. The documents created during the C-CEI implementation were used as a memory aid.

Generally, the implementation of the C-CEI method was considered helpful and clarifying the scope and impact of an ERP project for the participants. As the CEO of Company A commented, *“The C-CEI method in our case was beneficial, because we got the idea of our current operational status and how large the scope of an ERP project will be.”* The production manager of Company D stated: *“This [C-CEI] has been opened our eyes what this [ERP implementation] is about, how this is pushed forward, and what this demands”*. Some of the participants were concerned about how satisfactory the data-gathering approach used was: *“personnel of our level [in the organisation] were only partly involved in that [C-CEI]”* (Interviewee B2). They were afraid that the data were not correct or relevant: *“Did we manage to reveal our current state broadly enough?”* (Interviewee C). On the other hand, one participant (Interviewee B1) wished there had been more investment in initial data-gathering: *“It [ERP implementation] is easier when the ground work is properly done....A lot more should be invested in the ground work.”* Another participant (Interviewee C) proposed that the initial status of operations should be questioned in order to develop the operations. He stated *“I doubt if our operations and needs were described correctly. I mean, are our operations reasonable in general?”*

Single analyses, operational, contextual, and risk analysis, were discussed together with the corresponding documents. The interviewer first recapitulated the main phases within each of the analyses, and then asked about the impressions, implications, advantages, and disadvantages of each analysis. The usage of the documents after the implementation of the C-CEI method was asked about. Operational analysis was seen as useful and all the companies had used the ERP system requirements in their request for proposal (RfP). The operational analysis consolidates the target state of operations for the personnel: *“This [operational analysis] goes like through the whole company. Everyone is able to check here and get the idea that oh yeah, it goes like that”* (Interviewee A2). Contextual analysis led to divided opinions. On the one hand it was considered fast and crisp. Furthermore it was considered to elicit the problems: *“This [contextual analysis] has revealed us the problems that we have partly known related to our information management, production schedules, resource management and time management.”* (Interviewee A2). On the other hand it was considered trivial because of the small sample and irrelevant because of the non-industry-related observers. *“We have had almost as many ways of working as people, but we have interviewed [observed] 5, which is a quite small sample”* (Interviewee C). The contextual analysis document was not known to have been used after the implementation of the C-CEI method. However, the document gives information for the planning, business process reengineering, and training activities, in phases that Companies A and B had not yet received. The risk analysis was unanimously considered to be beneficial. *“It is just alright, because at least they [risks] are written down in words”* (Interviewee B2).

In addition, the interviewees' impressions of how the implementation of the C-CEI method had affected their organisation and of ERP implementation were asked about. The questions were based on the critical success factors (CSFs) presented by Somers and Nelson (2001), although C-CEI has not means to directly involve with e.g. interdepartmental cooperation or project champion. Akkermans and Helden (2002) also used the same CSFs in explaining the initial failure and eventual success of an ERP implementation case study. They found the factors correlated highly in that case. In this research the interviewees could respond that the C-CEI method has had either a positive, negative, or no effect on their ERP implementation (Table 12).

The most positive effects of the C-CEI method were reported to be careful package selection (6): *“It [selection] has been tried to do right and carefully, because based on these [C-CEI] papers the management has been capable even to discuss about the proposals in the bidding phase”* (Interviewee D). C-CEI was also considered to have positive effects on top management support

(5): “They [top management] have become enthusiastic on getting a good [ERP] system” (Interviewee B2). “I think it has been improved that our management have realised that this ERP project is not as simple as picking software from a list and it will fit our company. They have began to think about the context and how this kind of a project will be managed”, commented production manager of Company A. Vendor support is also reported to have improved (5): “Yes, I believe that it [C-CEI] has effect on that they [vendors] will assertively take this thing [ERP implementation]” (Interviewee B1).. Some negative effects were reported, as interdepartmental cooperation may suffer from an ERP project (-1), and managing expectations may become more difficult (-2) as the organisation is now aware of what type of solution to expect: “I would say, we have pretty high hopes” (Interviewee B2). For the same reason it might be more difficult to find a project champion (-1). However, the total of 38 positive comments exceeded the 4 negative ones. The result indicates that the C-CEI method can have a positive effect on the realisation of the critical success factors of an ERP implementation.

**Table 12. The impact of the C-CEI method on the top ten critical success factors, according to interviewees.**

Critical success factor	A1	A2	B1	B2	C	D	Total of positive/negative effects
1. Top management support	+	+	+	+	0	+	5 / 0
2. Project team competence	+	+	0	+	+	0	4 / 0
3. Interdepartmental cooperation	0	0	0	-	0	0	0 / 1
4. Clear goals and objectives	+	+	0	+	+	0	4 / 0
5. Project management	+	+	0	0	0	+	3 / 0
6. Interdepartmental communication	+	+	0	+	0	+	4 / 0
7. Management of expectations	+	-	+	-	+	+	4 / 2
8. Project champion	-	+	+	+	0	0	3 / 1
9. Vendor support	+	+	+	+	0	+	5 / 0
10. Careful package selection	+	+	+	+	+	+	6 / 0

## 7.4 Interviews with ERP vendors

Three ERP vendor representatives who had received results of the operational analysis of the C-CEI method were interviewed in autumn 2007. Their positions and experience are presented in Table 13. The vendors’ representatives were selected from among those to whom a company that had implemented the C-CEI method had sent their request for proposal (RfP). The interview included two main themes. The first theme was about what kind of knowledge is received or collected at the beginning of a customer relationship that aims at an ERP investment, what methods the vendor uses to gather the information, and what information the vendor needs in order to be able to give a proposal. The second theme was about the vendor’s comments on the operational analysis document of the C-CEI method, and how it had affected their proposal and customer relationship. The material was the same that the vendor had received from the potential customer (the customer had not announced their selection yet).

**Table 13. Information on vendors that were interviewed in 2007.**

Vendor	A	B	C
Position	Sales Manager	Sales manager	Sales manager
Number of years in the position	1	10	10
Number of proposals per year (irrespective of the result)	10-12, 80 meetings	20-30	30

*What kind of material is usually received from a customer at the beginning of a customer-vendor relationship?* The material received from a customer usually covers the current status of the customer company, some requirements, and basic data on the company, such as net sales, staff

numbers, and products. The target state, i.e. 'TO-BE', is usually described well, but the strategy that shows how an ERP system would support the achievement of the objectives is missing. If, for example, a company is planning to build a network, then the ERP system functions should facilitate this. A vendor can usually see whether there has been a project for preparing the requirements, or whether, for example, an external consultant has been using a ready-made requirements specification. The risk of using copy-paste requirements specifications is that the relevancy of the requirements suffers. An RfP made by the customer usually emphasises the characteristics of their industry, whereas external consultants focus on processes. Using external consultants is an increasing trend. Vendors can even have their own in-house ranking for external consultants. If the requirements have been collected by an external consultant, they may include a lot of details. A vendor commented that 'the devil lies in details' meaning that customers are eager to grab details, even irrelevant ones, because they are concrete and easy to discuss.

*What methods are used by vendors to collect the requirements?*

The vendor usually interviews the person responsible for the business, e.g. the CEO, and the person responsible for the ERP project, e.g. the CIO. Other representatives of a company could be financial and production managers. The interviewers may include a sales person and solution architects. The main interests of the vendor are:

- the business development objectives;
- management principles, e.g. production management, and
- opportunities

One of the vendors focuses on three topics: the product; the customers of the company, and how the production is managed. This covers only the requirement specification. The feasibility study is done separately. In smaller cases it includes one to three persons and takes about 10 days. In large cases the feasibility study includes several project managers and takes more than 100 days.

From the vendor's point of view, the ERP investment is an opportunity for the customer to adopt best practises and change their mindset about their business processes. Naturally, there are some logistical and IT constraints that limit the amount of possibilities. An interview was usually the primary method for collecting information on requirements. A survey was not considered an option, because it was thought to be difficult to specify the questions. Demonstration, i.e. a situation in which the displays and functions of an ERP system are used in front of a customer, was often used as a selling and also requirement-gathering method. The session was followed by customer-vendor discussion. In some cases customer companies' operations were visited for a day. Workshops were used in some cases, as well as a checklist as an aid to ensure the essentials were asked about. A vendor stated "if there are more than ten references from the same industry, then the system will not have teething trouble".

*What kind of information is needed in order to be able to give a proposal?* For a proposal the following are needed (summary of interviews):

- the main process and business
- business objectives (trend, growth, internationality)
- what ERP product is wanted
- number of licences needed
- number of users
- size of the company
- volume data, e.g. transactions and products
- scale (or scope) of functionality, e.g. sales, financials, production

- schedule of ERP project
- tailoring needs
- resources of the customer, e.g. human resources for the ERP project
- the amount of ERP system components needed
- workload estimation (defining this is an iterative process, because it depends on the solution, and the customer does not need to know the solution but the objectives.)

The number of users or licences needed depends on the case. For example, HR solutions might have only a few users, but they are paid according to the number of employees. However, the ERP systems do not differ much in their financial modules. The number of users also has an effect on the training and support needs. One of the vendors tries to write in proposals the reason why the proposed solution would suit the company. Another vendor says “we try to counsel customers on these topics”.

#### *Comments on the operational analysis document*

The vendors commented on the operational analysis document of the C-CEI method that they had earlier received from the customer within the request for proposal. The vendors did not know about the C-CEI method and its other analyses. They commented that the document is systematic and speaks out for the business and objectives. It was also stated that it presents the business environment (networks, cluster), and it presents the future changes in the business. According to some comments, the operational analysis document seemed to lack the objectives of the ERP implementation, to lack e.g. the determination of prices, and to include some things that were self-evident, such as “possibility to sort products in different stocks according to stocks” However, the way in which the document presents the amount and frequency of materials, products, and transactions has effects on which system is provided for the customer, and, furthermore, presents the issues that are problematic or critical for an ERP system, was praised. Even though the document was seen as one of a typical kind, these kinds of specification processes and practises had rarely been studied and documented.

One of the vendors interpreted the situation through the document: “They could achieve a lot by production design”; “It seems to be important to sustain the current way of doing things”, and “This is a specialised business and requires work from us.” Another vendor had worked the RfP so that the requirements were copied into a table and every requirement was either marked as ‘ok’, or ‘changes needed’. The changes either meant a change in the customer’s mindset or a change in the ERP system. The operational analysis document, in this case, had formed the skeleton of the proposal, and additional questions were presented to the customer before the proposal was sent. The document had made the early steps more straightforward, but the number of details among the requirements had cost extra work and might turn out to be trifling during the project. The document helped to prepare an ERP system demonstration session for the customer. The proposal, however, had been given before the demonstration.

#### *Comments on prioritised requirements*

Prioritising the requirements was generally held to be good, except if all the requirements were accorded top priority. The prioritising also guides vendors’ work for the proposal and demos. A huge number of requirements, i.e. hundreds, was considered as the customer’s inability to prioritise their needs. The use of an external consultant usually increases the number of requirements. A consultant may derive the requirements from the process descriptions. One of the vendors claims that “nobody reads a hundred pages (of requirements)”. Criticism was also made of phrases such as ‘easily’ and ‘fast’, because in the requirements they do not lead to any specific solutions. One of the vendors thought that requirements represent too much how things are currently handled. This might lead to demonstrations of how the same things are done similarly with a new ERP system, instead

of how the results could be improved by doing things differently with a new ERP system. One vendor encouraged customers to ask the vendors “how can our operations be performed more effectively?”

*What type of material would enhance the work of vendors?*

In order to support the work of vendors it was suggested that:

- the customer is aware of the objectives of the business, as well as the objectives of the ERP project
- the customer knows the ‘big picture’, what affects the bottom line of their business
- a description of the current operations
- difficulties and exceptions in operations or processes
- explicitly expressed IT strategy
- processes
- volumes, e.g. transactions, products, materials, users.
- user groups
- what the benefits of the ERP system are

One vendor claimed that argumentation is not used in customer companies. However, customers should find the profit or benefit in order to achieve the objectives of the implementation. Overly detailed requirements were seen as a waste of time, as it takes time to collect and validate them, and the result can be, for example, 11 working days on a proposal, so it is quite a marginal share of the total cost.

One concern of a vendor is that if the users are included and the top management excluded from the requirement specification process, then the top management is not committed but neither do the users have the power to make decisions. The responsibility gets fragmented. The IT department is not usually reaching out to the future, and therefore the vision of the top management is needed. Sometimes company policy overrides the fit of the system. For example, if a customer company is part of an international group, the group has an effect on the selection of the system. Or some technologies or brands can be preferred, e.g. the database should or should not be Oracle’s. If the policy is not expressed in the RfP, the vendor might offer alternative solutions in parallel. The end user is considered to have too narrow a point of view on the ERP system, and therefore the risk of sticking to discussion of displays and cursors is high. This follows the commonly agreed opinion that an ERP system might even increase the workload of a single worker and still make the process more efficient.

As a conclusion of the vendors’ perspective, the default content of ERP requirement analysis is well established, but is often tacit knowledge that depends on the professional skills of an analyst. Vendors seem to utilise only a few methods, such as interviews. The activities of the vendor are efficiency-driven, i.e. minimum resourcing should produce the maximum number of requirements. However, on the basis of these interviews it can be seen that vendors benefit from well-defined requirements. The advantage of the C-CEI method, (not necessarily seen by the vendors) is that the organisation is now more prepared, and the business process re-engineering has also begun to some extent.

## **7.5 Conclusion of the evaluation of the C-CEI method**

An ERP implementation is a complex process that involves multiple stakeholders and activities, but also risks and critical success factors. C-CEI as a method was analysed via the activities of C-CEI in a company, as well as via the content of the resulting documents. In order to evaluate how C-CEI affects the stakeholders in the implementation, two parties were interviewed. The groups



represented were the staff members that had participated in C-CEI activities and ERP vendors that had received part of the resulting documents of the C-CEI. Compared to the expected results of C-CEI (6.4, p.55), conducting C-CEI in a company commits the organisation to requirements analysis activities. According to the interviews with the participating staff members, C-CEI increases an organisation's readiness for the ERP implementation. In a future a more thorough evaluation e.g. an interview with more representatives, needs to be addressed. The study of how C-CEI affects the critical success factors of ERP implementation shows that the positive effects (38) clearly exceed the negative (4) ones. Each of the companies that participated in the development of C-CEI has approached ERP system vendors with the results of their C-CEI, and thus proceeded with their ERP implementation. The ERP system vendors that were interviewed found the results of the operational analysis useful from their point of view. Otherwise, the vendors did not utilise any user-centred design methods in their own ERP requirements analyses. In order to analyse the benefits and challenges of C-CEI, its implications for the ERP implementation stakeholders should be discussed.

## **8. Discussion and conclusion**

A successful ERP implementation has different meanings for different stakeholders. The success of ERP implementation is influenced by many factors, such as the success of a business (can afford to invest, human resources to commit to activities, willingness to build a system for the future), the company's ICT capability maturity (ICT management, congruence between business and ICT strategies, capability for integration decisions and activities), and change management strategies and activities. Therefore the connection between a single activity, such as the Customer-Centred ERP Implementation (C-CEI) method, in one phase of implementation and the end result is difficult to prove. The critical success factors (CSFs) of ERP implementation have been widely studied (See 2.4, p.12). Even though their presence does not ensure success, their occurrence is common in successful implementations. If those CSFs are positively affected by any means, e.g. with the C-CEI method, the possibility of the success of ERP implementation increases.

In this section the development of the C-CEI method is considered from various perspectives. The suitability of the research methodology and its implications for the results are first discussed. Then the main research goal, the applicability of UCD in ERP implementation requirements analysis, is analysed. The four last sections before the conclusion cover the possible implications of this research to: scientific community (8.3), ERP implementation projects and processes (8.4), the companies that are adopting or adapting an ERP system (8.5), and ERP implementation consultation service providers (8.6).

### ***8.1 Research approach and its implications for C-CEI method development***

The C-CEI method was developed via iterative action research, and the three analyses of the C-CEI method developed from one company to another. The action research made the multidisciplinary planning, conducting, and evaluation of the C-CEI method possible. The researchers and staff of each company worked together, and this supported the practical relevance of C-CEI. However, the scientific basis was maintained e.g. as the researchers were familiar with the contextual design method that is applied in C-CEI. Because of the novelty of the method, the expected results were predefined on a coarse level, but the results were specified in more detail during the research. Furthermore, it was possible to expand the results by several iterations, e.g. workshops or prioritising and planning sessions before the C-CEI development process or that could be integrated as the first activity of the C-CEI method.

In this research the C-CEI method was developed and applied in four organisations (Paper VII). The basis for the research was fruitful because of the companies' long-standing intentions to renew their ERP systems. The first analysis, operational analysis, underwent minor development during this research. The participants may have considered the contextual analysis as ready and thus were ill-prepared for suggesting improvements. However, the research team developed the contextual analysis from one company to another, which meant that no single company saw the progress. The emphasis on the C-CEI method development was challenging to maintain among company representatives as they could not experience the enhanced method immediately in their ERP implementation. This type of development could also have been conducted in a single company by further iterating the focus, methods, and results of the contextual analysis. The focus on the requirements analysis phase of ERP implementation is narrow, because most of the results, i.e. the results of the contextual and risk analysis, can be utilised in later phases of the implementation. This

was prompted by the participants interviewed, who hoped that C-CEI could continue further in the implementation.

The risk analysis of C-CEI was effective in that the company-specific risks were collected during other analyses. The risk analysis was also considered worthwhile in the interviews with participants. However, the list of risks was not revisited according to the interviews. The method used to improve risk management during the next phases of implementation should be discussed in companies. For example, the risk list assessment could be linked to regular ERP project meeting activity during the implementation. If the risk management activities, i.e. what should be done to prevent a risk, are well documented in the risk analysis, then the activities would be transferred as ERP project activities.

The action research approach in this study provided an expedient way to simultaneously develop the C-CEI method and support the ERP system requirements analysis of the companies. Therefore its practical relevance could be observed at the same time, and it was possible instantly to apply the improvements to the C-CEI method. This approach has its challenges, as the researchers are involved in the implementation, and it is difficult to compare companies. Baskerville (1997) states that “Action research presumes that complex social systems cannot be reduced for meaningful study.” ERP implementations, already in the requirements analysis phase, involve multiple aspects (strategic, technical, and operational) and several different stakeholders from various levels of an organisation that forms a kind of complex system. Lau (1999) have found that in some articles action research has been combined with other methods such as organizational ethnography, soft systems methodology, socio-technical system design and evaluation research. Thereby an action research study for developing a method, that applies UCD and utilises participatory design method, is natural continuation to increasing IS-related action research studies.

Davison et al. (2004) provide five principles and total of 31 criteria that are applicable to the practise and review of canonical action research (CAR). The term canonical refers to iterative, rigorous, collaborative and process-oriented AR model provided by Susman and Evered (1978). The C-CEI method development process is assessed using the five principles of the CAR :

1. the principle of the Researcher-Client Agreement (RCA);
2. the principle of the Cyclical Process Model (CPM);
3. the principle of theory;
4. the principle of change through action; and
5. the principle of learning through reflection.

The *principle of the RCA* is followed in development of the C-CEI. The approach, research focus, client organisation’s commitment, and objectives of the research were unanimously agreed. The roles of researchers as C-CEI method developers and client organization as an expert of the business objectives were mutually specified. The *principle of the CPM* is followed even though each cycle of this research is a mixture of the C-CEI method development and analysis of ERP implementation requirements of an organisation. Therefore both, each phase of the AR cycle and every criteria of CAR, can be considered from method development as well as requirements analysis points of view. The *principle of theory* requires that project activities are guided by and evaluated against a relevant theory or set of theories. In the development of the C-CEI, multiple theories, such as ERP implementation models, critical success factors, user-centred design, are used as for guiding the CAR.

The *principle of change through action* calls for common understanding of the organisational situation between the client and the researcher. The criteria are met and the organisation situation is

assessed after the intervention from the critical success factors perspective. However the assessment could be more comprehensive as the sample were now only 1-2 interviewees from an organisation. The *principle of learning through reflection* is especially met in this research. For example this thesis focuses on the criteria that implications of the research and also applicability of CAR are considered.

The principles of CAR provide a framework to assess the conducted action research. Davison et al. (2004) state that “it is unrealistic...to identify a single, seminal published report of CAR that precisely follows all five principles and 31 criteria”. However this research has succeeded to fulfil most of them. The exception to traditional action research cycles are that not every cycle is in single organisation. Instead the research continues to develop the C-CEI method using the action research approach. From a single organisation’s perspective the analysis of ERP implementation requirements could continue until the ERP system is in everyday use. In this research the exit of researchers was agreed to occur when operational requirements, contextual requirements and risks are iteratively documented, analysed and agreed.

If the research approach used for developing C-CEI would have been *multiple-case study*, then each case would have been selected do that it predicts either similar or contrasting results (Yin 2002, p. 47). However, in this study the emphasis is on collaboration between researchers and the organisation, learning through reflecting and causing changes. Although the companies for this study were selected based on their problems to progress in ERP implementation, the results could not be predicted in advance. For example, the results such as directions for the C-CEI method development or the content of each analysis in every company could not have been predicted. However, the case study is a common approach for different disciplines, such as IS and social sciences, as the action research approach.

In summary, an ERP implementation is a phenomenon that may last for several years, involve hundreds of different stakeholders, is hard to predict because of external forces such as markets, and whose results are hard to interpret via finalised implementation projects. ERP implementation always involves changes in the organisation. In minimum the changes include the change of a system and thereby changes in users’ tasks. In upper level the changes may include change of business processes, change of strategies and change of organisational settings. Therefore action research is a particularly appropriate approach to the study of such a process and to providing insight into the factors involved.

## **8.2 Applicability of UCD in ERP system requirements analysis**

The principles of User-Centred Design (UCD) include active user involvement, a multidisciplinary design team, the distinguishing of users’ tasks and the function of technology, and the iteration of design solutions. In the C-CEI method the users are involved from the beginning until the improvement of the requirements. Extra attention is paid to having users representing various levels of the organisation and various operations of the company involved. A user as an object of an interview or observations is better than no user involvement, but those closest to the design in the C-CEI method are those users that participate in the building of an Affinity Diagram. The level of user involvement could be increased still further by common design activities, e.g. workshops, or assignments to clarify business processes and their business objectives. The activities should involve users without bias in order to also communicate the common objectives to the organisation so as to have a system for everyone to use.

A multidisciplinary design team appears easily in the ERP requirements analysis as the experts on different operations need to be heard. In addition, as in the C-CEI method, the team could also involve usability and risk management specialists. Other relevant team members could include e.g. ERP system specialists, an implementation consultant, or a human resource specialist. An ERP system requirements analysis mostly covers what the ERP system should do, but what the challenges in the organisation are and the operations that the ERP system does not fix are included less often. In the C-CEI method this issue, one which is relevant from the organisational perspective, is covered in the contextual analysis. The iteration of design solutions could be conducted during a requirements analysis to some extent, but as no ERP system has yet been selected, the evaluation of requirements is left for ERP systems comparison. However the requirements could be iterated and compared to business and ERP implementation objectives. Thereby the requirements could be reduced, focused, and prioritised.

A UCD process and an ERP implementation project have many common objectives, such as the usability of the end result, implementing a system that supports the work, and committing stakeholders to the activities that are conducted in order to achieve the usability (Figure 20). In combining UCD in ERP implementation the aim is to complement rather than replace current practises.

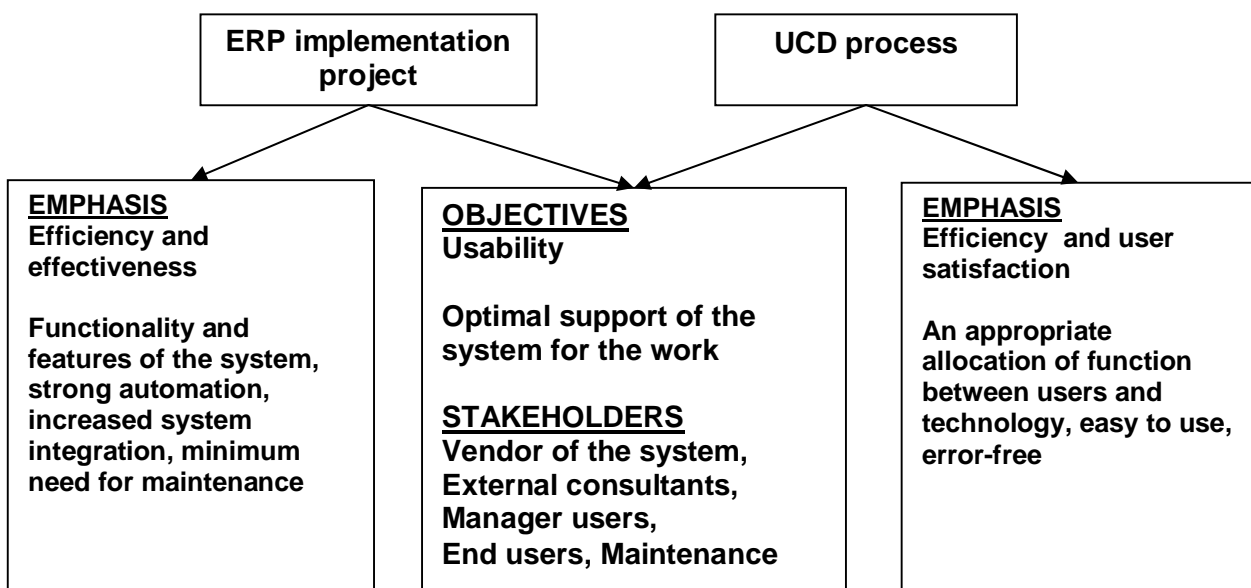


Figure 20. Common objectives of ERP implementation and UCD process applied in ERP implementation. (Paper VI).

In ERP implementation initiatives, the emphasis is often on conducting the work more efficiently and making the operations more effective. However, it is commonly agreed that a single individual's workload will not necessarily decrease because of the ERP system, but the efficiency lies in real-time records and automated decisions, for example in the material resource planning process. System integration is usually the driving force in ERP implementation. The objective is to replace multiple old systems with a single application. This, however, is seldom the reality even after implementation. Most often factory systems, financial applications, or CAD applications will remain in parallel to the ERP system. Therefore, it is crucial to carefully plan, visualise, and decide the role and interface of each application. The role of UCD in this case is to look at the issue from the point of view of workers' tasks. Workers should be able to use the system that is most appropriate for the task, and the amount of applications needed to accomplish tasks should be kept

to a minimum. This may require the implementation of extra input interfaces or reports, but the investment is repaid by reduced frustration and the more efficient use of the system.

In C-CEI the Contextual Design (CD) (Beyer and Holzblatt 1998) method was applied. CD includes activities such as Contextual Inquiry and modelling to explore the company context of use for the ERP implementation planning. In addition, conducting CD involves multiple stakeholders as participants in its activities. The results of CD present the user and organisational requirements for an ERP implementation. Furthermore, the issues, e.g. communication breakdowns or tasks prone to errors, are identified in the CD. Those problems should be solved within the organisation and in work flows during the ERP implementation. Other usability methods, for example task analysis (Redish and Wixon 2003) or Work Flow Game (Ruohomäki 2003) could have been considered instead. The advantages of CD are that it is well documented and thus easy to explain for the participants. It produces concrete outcomes such as visual models and affinity diagrams. It involves multiple stakeholders and is holistic. The disadvantage is that in COTS-type ERP system implementation the system is not designed from scratch, and therefore the full CD cannot be applied. The final phases of the CD method are intended for designing and prototyping the new system. Furthermore, the visual models of CD, flow, sequence, artefact, physical and cultural models, are not equally relevant for the ERP implementation requirements analysis. Therefore the modelling of the context was developed in C-CEI, e.g. the flow and physical models were combined as one. CD as a method is quite multi-phased, and commits a lot of human resources. The participants should be able to conduct modelling and design activities. However, during the activities, the need for changes in the organisation and work flows are discussed. Therefore, commitment to these activities increases participants' understanding of changes within ERP implementation.

During this study the ERP systems have developed and the ERP market shifted towards SMEs, and more light-weight solutions, smaller applications, or internet applications are on offer. At the same time predefined business processes in ERP systems have become established, and many companies are considering implementing an ERP system as such. In that case the vendor-independent requirement analysis needs to be conducted at the business operations level. The focus in that phase is more on the initials; how the business is expected to develop in the next 2-8 years and what are the company's main business objectives? And the IS strategy is created to support the business plan. The UCD in that case is needed in the phase in which business processes are matched to ERP system procedures. In these activities UCD has the potential to have a positive effect on the critical success factors of ERP implementation.

### ***8.3 Contribution to scientific community***

The role of action research is to help solving a practical problem, extend scientific knowledge and improve competencies of the research participants (Hult and Lennung 1980). In this study of developing the C-CEI method the expanding of scientific knowledge can be analysed for example using two different perspectives: action research in ERP implementation studies, and action research in methodology development.

Action research in ERP implementation studies is relatively rare approach. Cumbie et al. (2005) in their review of 49 ERP research articles find 20 field studies but only few field experiments, but any methods were named. Even though the development of C-CEI in this research is not a controlled experiment, but it aims at solving the ERP implementation related problem of a company. In order to improve results of an ERP implementation, action research could be used as an approach to

promote joint activities between academics and practitioners. The era of analysing past implementations and critical success factors is passing by, and more proactive approaches are needed. Also the complexity of social settings in ERP implementations requires methodologies that can cope with all the related variables. However the results of action research could be further evaluated and compared using other scientific approaches such as case studies or ethnographic studies.

In this study the C-CEI method was developed together with four companies using action research approach. The approach enabled researchers learn about the method and continuously improve it from a company to another. Simultaneously the learning process occurred in different levels. The organisations learned step by step what the ERP implementations would require, and how to use the C-CEI method, and the researchers learned about conducting the analyses by discussing the feedback of C-CEI in companies. Therefore this research can be used as one example of how to develop a method using action research.

For the scientific community Papers I-VII highlight various topics (Section 1.3). This research is a novel attempt to combine UCD and ERP implementation processes (See Table 10). The ERP related research seems to have discussed usability referring to user interface of an ERP system (Section 4.3). However, then the ERP implementation is not the focus. If the ERP implementation is discussed, the research approaches are, for example, to provide a theoretical model of ERP implementation phases (Section 2.2) or post implementation analysis of critical success factors (Section 2.4). The ERP related research lack of implementation methods or methodologies focusing especially implementation requirements analysis (Table 6). ERP implementation requirements analysis methods could be borrowed from the COTS type system selection methods (4.2), but then the UCD focus is missing (Table 7).

This research contributes directly scientific communities that relate to UCD or ERP research. Furthermore this research opens a dialogue between the communities. Although this research covers ERP implementation requirements analysis and not all the implementation phases, the C-CEI method is a step towards utilising UCD also in other phases of the implementation. UCD can be considered as unexplored potential that can be used for improving the ERP implementation success.

#### ***8.4 Implications for ERP implementation projects and processes***

The C-CEI method development process, the method itself, and the valuable comments on its implementation together bring new information on ERP implementation requirements analysis. The C-CEI method complements the current analyses provided by ERP vendors by focusing on the development potential of the customer's context of use. The development needed in the context is important, because no system can fix inefficient processes or insufficient communication in an organisation. The development can then be conducted by e.g. business process reengineering during an ERP implementation.

A user-centred design process and methods are not utilised in ERP system requirements analysis. Instead of providing a list of ERP implementation-related issues, the C-CEI method proposes what to analyse and how. When a company has implemented the C-CEI method, they will have an overview of the changes needed in the organisation and the range of risks related to the ERP implementation project. The C-CEI method, used in the requirements analysis phase, changes the area of focus of ERP implementation slightly towards the beginning of the implementation. However, with a proper requirements analysis before even conducting ERP, vendors can save time and money later in the implementation. For example, well-defined requirements and business

objectives may already reduce the amount of appropriate ERP system candidates. Similarly, inefficient working process, identified in the contextual analysis of C-CEI, can be reengineered and tailoring of the ERP system perhaps avoided.

One of the objectives of the C-CEI method is to emphasis business objectives rather than merely a technical solution. In order to survive, a company needs to be competitive and produce a profit. Therefore the implementation should focus on improving processes so that profitability is improved or at least remains at the same level as before the ERP implementation. To support the process improvements, the current state can be analysed in detail by contextual analysis of the C-CEI method. User-centredness means shifting the focus from how the product is made to how the product is used (Kuniavsky 2003, p.505). User-centred design (UCD) activities are participatory and therefore commit the organisation to the forthcoming ERP implementation. UCD also improves communication within the organisation. Communication is an essential requirement, for instance for the realisation of many critical success factors.

### **8.5 Implications for companies adopting or adapting an ERP system**

In this research the C-CEI method is used in the requirements analysis phase of an ERP system implementation. However, the method can be used as a whole C-CEI method, a partial one, or the results from the requirements analysis phase can be used later in the implementation process. In particular, the contextual and risk analyses of the C-CEI method are also applicable in the phase in which business processes are reengineered and ERP system modifications are implemented (Figure 1, p.1). Furthermore, the contextual analysis as such is suitable for any process or ERP system improvement activity during or after the ERP implementation process. Even if the C-CEI method is conducted only in the first phases of an ERP system implementation, the results are valid throughout the ERP implementation process. For example, in the risk analysis, the risks concerning the implementation and usage phases of an ERP system implementation have also been analysed.

The contextual analysis of the C-CEI method is useful for companies in itself. The analysis is solely described in Paper III. Even though it requires some orientation towards user-centred design (UCD) principles and process, it can be used for many purposes. For example, if there seem to be problems in a certain area of a company, the contextual analysis can be used for defining the causes of the problem. Or if an information system needs to be renewed, the contextual analysis can be used for gathering the requirements. Furthermore, if the contextual analysis is extended with the Contextual Design steps that are not utilised in the current C-CEI method, the analysis is also applicable for work and information systems design activities.

In some cases companies are introduced to the UCD principles and process for the first time when they consider the C-CEI method. The requirements of the multidisciplinary team and user involvement may sound demanding. For example, if a company has a long power distance, i.e. is highly hierarchical, involving the end users as part of an ERP implementation team may well be unprecedented. On the other hand, the shop floor workers may consider their work as only a means to earn money, and nothing more. In that case their involvement will probably not commit them more than if they were not involved. On the other hand, involving the users in the early ERP implementation activities reduces the risks of misunderstanding, and helps the steering group and project management follow the progress of the project on the shop floor level too.

Resourcing is one of the key problems in current ERP implementation projects. There should be a competent full-time project manager on the ERP system customer company's side. The manager should be familiar with the business processes, but also capable of handling the implementation project. There is a demand for project champions, process owners, and example users. However,



productivity and everyday operations should not suffer too much. The top management should consider whether a few months' resourcing of key persons reduces the productivity of the company relatively less than if the ERP implementation is poorly conducted, the results do not support the work, and staff members refuse to use the new system. The middle option, that, for example, the project manager both performs his/her operational tasks and leads the ERP implementation project, will not work. The participation of users in the early phases of ERP implementation is more important than a temporary reduction in productivity. The reduction can be anticipated by informing customers, by ensuring products are in stock, or reducing the capacity for a while.

## **8.6 Implications for ERP implementation consultation service providers**

User-centred design (UCD) processes and principles provide a new competitive approach and tools for ERP implementation consultation service providers. For example, vendors seem to currently use interviews as the main method for requirements analyses (See 7.3, p.62), whereas UCD methods present an extensive repertoire of usable tools. If e.g. field methods are used, then the transfer of knowledge from the customer organisation to a consultant could be more efficient and reliable. In some cases this could lead to new deals when a customer need is identified during field research. Learning the UCD process and methods may take some time, but, at the same time, it increases the competence of a consultant. The C-CEI method and especially its application of the Contextual Design method (Beyer and Holzblatt 1998) can be unknown to ERP vendors or consultants. However, it has been described in Papers V and VII. Also an example of its documentation is given as appendices of Paper VII.

Customers may, at first, prefer a consultant using a minimum of payable hours to do the work, but the benefits of UCD are easily justified. First, UCD reduces the risk of misunderstandings, and thereby the risk of disinvestments. Second, with UCD a customer receives a more extensive solution, because the scope of the problem has been treated and specified. Third, the iterative process and customer participation in design activities help the customer to understand and affect the solutions in a more effective way. Even though the project aims at COTS-type ERP system adoption, the customer company still needs to understand the rationale behind e.g. the changes required in their processes. In this case the UCD can motivate both parties understand the requirements and communicate them. Understanding helps in accepting the solution.

## **8.7 Conclusion**

This dissertation presents an active approach to developing a method for the requirements analysis of an ERP implementation. The C-CEI method was developed together with four companies. The method seems to have potential for far-reaching implications e.g. for these organisations. Furthermore, the method indirectly involves their potential ERP system vendors. The C-CEI method mostly affects companies' operations and business processes, and their forthcoming ERP implementation projects. The methodology in the C-CEI method could be developed still further. For example, the interrelationship between the three analyses of C-CEI could be more bidirectional, and the active involvement of companies' personnel could be enhanced. However, user-centred design (UCD) appears to complement the otherwise ERP system-focused ERP implementation approaches. UCD enables users to be involved and the context of use to be developed. Moreover, UCD has improved the shared understanding of the organisation, its processes, and the business objectives among the key players, such as the end users of an ERP system, an ERP system vendor, a customer organisation's top management, and an ERP project team.

This research provides a wide variety of results to be exploited and further enhanced by academics and practitioners. For the academics this research provides a study of how UCD is applied in the early phase of an ERP system implementation, and how the action research approach is utilised in development of a method. As the principles and process of the UCD are applicable in interactive systems design (ISO 13407 1999), this study expands the objects to requirements analysis of a COTS type ERP systems. Furthermore, this study combines two formerly unconnected processes: the UCD and ERP implementation processes. For the practitioners this study provides relevant tools and methods how to conduct the ERP system requirements analysis. For example, the tables of contents of the documents (Appendixes of Paper VII) give an insight into the issues that should be covered in an organisation before selecting an ERP system. In particular, ERP vendors and consultants are now able to complement their methods and customer services processes with UCD elements, and thus achieve increased customer satisfaction and an improved requirements analysis process.

The main research goal was to study the applicability of the UCD principles and process in ERP system implementation requirements analysis. The principles of UCD, which are generally followed throughout the C-CEI, seem to fit the objectives and activities of the ERP implementation requirements analysis. However, the iteration of requirements before the ERP system is selected is purposeful only to some extent. A supplementary goal of this research was to develop a method that enables the critical success factors of ERP implementation in its part. The preliminary results of interviews indicate that C-CEI affects positively to CSFs like careful ERP package selection and top management support. The second supplementary goal was to gather real-world experience of the iterations of the C-CEI method within target organisations. The experience has been collected and reported in forms of resource allocation, material produced, content analysis of documents and citations of participated personnel of the organizations. On the basis of this action research an application of UCD principles and process can be recommended to complete the current ERP implementation requirements analysis methods.

## 9. Summary and future work

Companies adopt Enterprise Resource Planning (ERP) systems in order to improve their business processes and to integrate their information systems. Nowadays ERP systems are mostly Commercial-Off-The-Shelf (COTS) systems that seldom totally fit in the business processes of a company. The main concern in ERP implementation is whether a company aligns its business processes according to an ERP system, or the ERP system is modified according to the processes of the company. Therefore the ERP implementation objectives have to be specified carefully. In previous research on ERP implementations, several methods, such as interviews, surveys, and case studies, were used, but field studies are in a minority. Besides, the research has mostly been carried out after the ERP implementation, without any attempt to affect the results.

This novel research adapts user-centred design (UCD) methods in ERP system requirements analysis. The research applies an action research approach to the development, implementation, and evaluation of an ERP implementation method called C-CEI (Customer-Centred ERP Implementation). The C-CEI method consists of three analyses; *operational, contextual, and risk analysis*. The analyses are conducted in a corresponding order and the previous analyses always contribute to the next analysis. As a result of the implementation of the C-CEI method, a company has three documents. The operational analysis document describes the operational model and operational requirements of the company for the ERP system. The contextual analysis document describes the current context of use and challenges in the context of use and categorises these according to their relationship to the ERP system or organisational development. Finally, a risk analysis document divides the risks identified according to ERP implementation phases: selection, implementation, and usage. Each risk is described and prioritised with effectiveness and probability. Even though in this research the C-CEI is conducted in the ERP system requirements analysis phase, the risk and context documents are intended to be used iteratively during the implementation. A characteristic of the C-CEI method is that it is a vendor-independent ERP implementation method.

As the C-CEI method was iteratively developed in action research within four companies, the method evolved further from company to another. The contextual analysis, which applies the UCD method Contextual Design (Beyer and Holzblatt 1998), developed most. In contextual analysis the modelling technique was improved, as was the communication of the results from the ERP implementation perspective. Still, the C-CEI method could be developed further and more actively so as to last throughout the implementation. The evaluation of the method is conducted from various perspectives. First, the measurable metrics, such as workload and documentary statistics, are collected. Within every iterative cycle of C-CEI the method is evaluated in order to develop the practises of analyses. Afterwards the participants from each company were interviewed. In order to estimate the relevance of results, ERP system vendors were also interviewed on the basis of the results of C-CEI.

The results indicate that UCD can be applied in an ERP implementation, and it can positively affect the critical success factors of an ERP implementation. Because of the use of the C-CEI method, the users were involved in the ERP implementation requirements analysis. According to interviews with participants, the holistic approach improves the preparedness of the organisation for the selection and implementation of an ERP system. The results of C-CEI support vendor-customer communication by specifying the company's goals and objectives for an implementation. These qualitative estimations need to be further evaluated with other methods, such as the case study. However, the development and experiences of the C-CEI method highlight the issues of companies'

ERP implementation requirements analysis, and give valuable insight into organisational perspectives. The use of the UCD approach in the ERP implementation phases after the selection of an ERP system should be further explored.

In this research user-centred design (UCD) was applied in the *evaluation phase* of an ERP implementation (See Figure 1, p.1). However, the interviewees wished that the supporting methodology could reach the next phases of implementation as well. The future work should include some guide, map, or method of how the implementation is continued using UCD principles and process. The UCD in the ERP implementation framework, presented in Paper VI, proposes a second UCD process conducted in the *modification phase* and a third UCD process in the *exploitation phase* of an ERP implementation.

*UCD in the modification phase* of an ERP implementation process is dominated by two competing objectives. One objective is to modify the ERP system so that it supports the work flows and tasks of individual workers. The other objective is to reengineer the business processes so that they will fit in the processes supported by the ERP system. The balance between these changes is a key concern in an ERP implementation. Modifications may cause delays in the implementation project, lead to extra costs, and worsen the upgradeability of an ERP system. However, radically changing all the business processes to match an ERP system may cause a company to lose its competitive advantage. Therefore, UCD in the modification phase carefully identifies the alternatives and evaluates their appropriateness for a company.

*UCD in the exploitation phase* of an ERP implementation aims at business process improvement. Therefore the new business processes established during the ERP implementation are studied in the organisation's context of use. Then the users' and organisation's requirements for the process improvement are specified, the current state measured, and changes for the process are designed. The evaluation is conducted partly against the measurements, and partly against the user and organisational requirements. UCD in the exploitation phase can be finished when the process is improved, e.g. productivity is increased, and work flows are fluent.

Even though the model of three UCD processes in an ERP implementation is not yet fully exploited in current ERP implementation research, the development of the C-CEI method is the first part to begin its realisation. Paper VI presents practical examples of how to conduct UCD further in the modification and evaluation phases of an ERP implementation as well. Therefore, research on the UCD approach for an entire ERP implementation process should be conducted, and the results analysed so as to refine the scientific model and give recommendations for practitioners. For evaluation of C-CEI as an information modelling method, the framework by Siau and Rossi (1998) including non-empirical and empirical evaluation techniques should be applied. Furthermore, future work should apply, e.g. the case study approach to the ERP system implementation of companies.

In this research, the evaluation of the results of the development of the C-CEI method (Chapter 7, p.57) provokes issues for further development of C-CEI and UCD in ERP implementation. UCD has objectives, such as improved usability, but the iterativeness and user involvement may require more resourcing than a company is willing to put into the requirements analysis. Therefore, more rapid and agile methods could be applied in order to conduct UCD in a more efficient manner. For example, the Rapid Contextual Design (Holzblatt et al. 2005) method applies only those parts that are applicable for solving the problem. Another cost-effective and efficient method would be to apply a walkthrough method, such as socio-technical walkthrough. Another key issue in ERP implementation is to improve the business processes as well. To support this, a survey, checklist, or some other type of self-aid could be useful for quickly identifying the areas that need improvement.

The results could serve as provocative input for subsequent workshops or other activities. The same lists could later on be used for ensuring that the problems have been solved and new problems have not occurred. In Paper V, the applicability of the C-CEI method in other phases of implementation as well is discussed. However, experiences and recommendations should be collected in further studies of companies' ERP implementations.

According to the interviews with ERP vendors, the methods used in their customer cases are limited and focus on interviews. C-CEI is vendor-independent, and thus can be utilised by different vendors. A study in which A) a company, B) a consultancy company, and C) a vendor apply the C-CEI method, e.g. a requirements analysis, could give qualitative comparable information on efficiency and the impact on the implementation process as well. In this research the companies represented various manufacturing branches, but the transferability of C-CEI was not the main focus. In future research, other contexts, such as government institutions or service companies, should be included into C-CEI research as well. In future research the focus should be on how UCD could be established in the overall ERP implementation process, and who the stakeholders are that should participate in UCD activities. Moreover, the results, i.e. the impact of UCD activities, should be analysed. Thereby, guidelines for planning and managing UCD in ERP implementation can be formed and then further evolved.

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## **Paper I**

Vilpola, I. and Väänänen-Vainio-Mattila, K., (2005), Evaluating Human Factors in ERP Implementations. Proceedings of the 12th European Conference on Information Technology Evaluation (ECITE2005), Edited by Dan Remenyi, Academic Conferences Limited Reading, UK, pp. 511-520.

# Evaluating Human Factors in ERP Implementations

Inka Vilpola and Kaisa Väänänen-Vainio-Mattila

Tampere University of Technology, Finland

[Inka.Vilpola@tut.fi](mailto:Inka.Vilpola@tut.fi)

[Kaisa.Vaananen-Vainio-Mattila@tut.fi](mailto:Kaisa.Vaananen-Vainio-Mattila@tut.fi)

**Abstract:** Enterprise resource planning (ERP) systems are ready-made software packages that are implemented in order to have the organizational data at hand in all business processes of the company. The highly risky implementation of ERP systems involves human aspect in addition to technical, strategic and operational aspects. To achieve successful implementation, the human factors need to be taken into focus throughout the implementation project. This paper presents three post-implementation case studies and evaluates the effects of human factors in them.

**Keywords:** ERP Implementation, Human Factors, Context of use, Key Players, Usability

## 1. Introduction

In the past ten years, Enterprise Resource Planning (ERP) systems such as mySAP (2004) and IFS (2004) have become crucial elements of many information and production processes. For example, manufacturing, purchasing, sales and distribution have been common targets for applying new ERP system modules. ERP implementation motivations have been described by Parr and Shanks (2000). *Technical motivation* aims at renewing aged computer systems and preparing basis for future investments, for example wireless technology. *Operational motivation* heads for simplifying and accelerating work processes, and *strategic motivation* operates on a higher level of abstraction, for example business restructuring. As a conclusion of the study of these motivations, Kumar et al. (2003) note that implementation challenges relate more to behavioural and management issues than to technical difficulties.

Somers and Nelson (2001) have listed 22 Critical Success Factors (CSFs) for ERP implementations. Eight of the top ten CSFs are related to *human factors* in the implementation process: *top management support, project team competence, interdepartmental cooperation, clear goals and objectives, project management, interdepartmental communication, management of expectations, and careful package selection*. The implementation approach can be affected by those who are closely involved in the design of company's ERP implementation. Somers and Nelson (2004) have analysed who are the key players, so called stakeholders, and what are their roles in ERP implementation. Skok and Legge (2002) have illustrated the complexity of the relationships amongst the stakeholders by depicting persons representing different stakeholders, their thoughts, and possible conflict points in the interaction between them.

A central aspect affecting human factors is the *context of use* in which the new system is to be used. The context of use is defined as users, their tasks, the equipment, and the physical and social environment (ISO 9241-11 1998). Changes in the human factors and their effect on the success of the implementation unveil only in post-implementation case studies. Skok and Legge (2002) have used a post implementation analysis approach in their study of key issues of concern with individuals involved in ERP change process. They state that the interpretive approach, in which they interviewed study subjects in a semi-structured manner, is a suitable means for catching the rich and complex context of ERP implementation.

In this paper we first define what aspects of human factors relate to ERP implementation. We then present the categorisation and analysis of three post-implementation case studies in which we focused especially on human factors. Based on the result we present guidelines for conducting activities that support taking human factors into consideration in an ERP implementation.

## 2. Human factors in ERP implementation

The success of ERP implementation projects is highly dependent on the human factors that stem from the various stakeholders in the implementation project. When every one of the personnel of a



company will be involved with the new ERP system and mostly on the daily basis (Akkermans 2002), the human and political issues arise parallel to the technological and organisational issues (Mendel 1999). By human factors we refer to:

- The organisation, its culture and context of use, in which the ERP system is implemented according to the selected strategy.
- The issues arising from ERP implementation key players, for example the ERP project manager of the company implementing the ERP system but also the ERP vendor, top management, project champions, the key users, trainers, etc.

Usability, especially the fluent work processes of ERP users that can be achieved by using user centered design principles in the ERP requirement specification and implementation.

These aspects of human factors are intertwined and overlapping. Some of the key players, for example top management, belong to the organisation. Also, analysing context of use is a usability activity. In addition to human factors listed in this paper, management plays a crucial role in ERP implementation process, but management issues are beyond this paper's scope. Next we explain the different human factors in more detail and connect them to the ERP implementation process.

## **2.1 Context and culture of the organisation**

The context of use is defined in ISO 9241-11 (1998): "*users, tasks, equipment (hardware, software and materials), and the physical and social environments in which a product is used*". Alvarez and Urla (2002) list culture and politics as contextual issues, and Krumbholz and Maiden (2000) present the model of culture's impact on ERP package implementation. The social context, hereby organisational culture, will change as a result of the business process re-engineering (BPR). Krumbholz and Maiden (2000) state that BPR affects both the organisational culture and simultaneously is constrained by it.

ERP systems are implemented according to the company's business strategy in order to achieve increased efficiency and competence. Nevertheless, the strategy is eventually put into practise by the workers of the company who are the users of the ERP system. The users vary in their knowledge, skill, experience, education, training, physical attributes, habits, preferences and capabilities (ISO 13407 1999). This fact affects the needs for training during implementation. Every task should be defined when the ERP system is specified; how a task will be performed within the new ERP system and if the task is left outside the system then it needs to be defined how is it carried out.

The social environment, which mainly refers to the organisational culture, can form a major obstacle in ERP utilisation. Divisions may find their autonomy threatened if suddenly everyone in the company can see the status of their business processes, and they are no longer able to define their own information requirements or computer systems (Davenport 2000).

## **2.2 Key player roles in ERP implementation**

Skok and Legge (2002) define the company selecting, implementing and using ERP system as "*a social activity system which consists of a variety of stakeholders*". Stakeholders come from at least two companies; an ERP vendor and a customer. In addition, third party consultants can take care of the requirement specification, implementation and training of the personnel. ERP implementation stakeholders are those who are somehow involved with the ERP customer company's ERP project, for example customer company's own subcontractors that may connect their information system to the new ERP.

Somers and Nelson (2004) list *top management, project champion, steering committee, implementation consultants, and project team* as the most important players in ERP implementation. The importance of ERP implementation key players vary depending on the implementation stage. Somers and Nelson use Rajagopal's six-stage model (2002); initiation, adoption, adaptation, acceptance, routinisation and infusion. According to Somers and Nelson, the vendor support was unexpectedly important during the early stages of implementation as was the importance of consultancy in the last stage of implementation. Kumar et al. separate key players in

two sections, project configuration and shakedown, of implementation (2003). Kumar et al. list key players, which include *project manager, project team members, technical and management consulting resources, executives, and operations managers, users, IT support personnel and external technical support personnel*. During the selection and training, managers and consultants are more important, whereas during system performance tuning maintenance personnel and users are more important.

Kumar et al. (2003) found *consultants* to be important implementation partners for ERP customer companies. According to their study the most important selection criteria were reputation and ERP experience. Skok and Legge (2002) warn that consultants may not have strong commitment to ERP Customer Company, or may try to strongly influence company's decisions. On the other hand consultants can have the time, skills and motivation for ERP implementation that is missing in company's own personnel. It is even suggested that consultants could have a bonus when the business goals of ERP implementations are met (Skok and Legge 2002).

*Users* are mostly considered as part of the context, as was described in the previous subsection, but they are not currently listed as key players by Somers and Nelson (2004). This is somehow paradoxical since the key players representing the company that implements an ERP system are to be users after the implementation. Achieving the increased efficiency in business processes highly depends of the users. However the users may not be so interested in the business results achieved by the ERP implementation than enhancing and lightening their own work (Kumar et al. 2003).

### **2.3 Usability in ERP implementation**

The usability is defined in ISO 9241-11 (1998): "extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use". Since ERP systems are commonly commercial-off-the-shelf (COTS) systems and thus are used without internal modification (Botella et al. 2003), the usability of such a system can only be ensured by proper selection of the vendor and appropriate training. However, what is important in achieving the usability attributes is that the system supports users' natural task flows in a fluent, thus effective and satisfying manner. The achievement can be measured with usability metrics, for example, time to complete a task or the ratio of failures (Preece, 1994). Usability is a central aspect of a system's acceptability. Other aspects are, for example, reliability, compatibility and cost (Nielsen 1993).

To make an interactive system highly usable, *user-centered design (UCD)* process (ISO 13407 1999) should be followed. The main principles of UCD are *involvement of users, distinction of users' tasks and function of technology, iteration of design solutions, and multidisciplinary design*. The standard also defines the following high-level activities of UCD:  
Plan the human-centered process,

- .Specify the context of use,
- Specify user and organizational requirements,
- Produce design solutions and
- Evaluate design against user requirements.

The high-level activities of UCD are iterated until user and organisational requirements are met. These activities can be put into practice by various usability methods, according to the project stages, e.g. *Contextual inquiry, Focus Groups and Scenarios* (Usability Net 2005).

### **3. Post-implementation case studies**

To understand the extent and effects of human factors in current ERP implementations, we conducted post-implementation case studies of three production companies. The data was collected by interviews. Every case study began by gaining an understanding of the framework of the ERP implementation project; timeline, scope, motive, vendor selection and go-live phase. Next, users from various organisational levels were interviewed to get detailed information from the end

user point of view. This data gave the pragmatic insight of ERP implementation in the companies and human factors in the ERP implementation process.

Most often the implementation projects are discussed in terms of time and money. Descriptive is also the physical scope, which means the number of sites in a single or multiple countries. Differentiative is also whether the ERP system has been modified or implemented almost as such, reports and user interfaces being the only exceptions. Parr and Shanks (2000) present a taxonomy of ERP implementations categories: *Comprehensive*, *Middle-road* and *Vanilla* (Table 1). Categories are described by five characteristics: *Physical Scope*, *the BPR Scope*, *Technical Scope*, *Module Implementation Strategy* and *Resource Allocation*. Categorisation helps managers understand the dimensions of ERP implementations, and researchers to do correct comparisons between implementations.

**Table 1:** ERP implementation categories (Parr and Shanks 2000).

ERP implementation category / Characteristics	Comprehensive	Middle-road	Vanilla
Physical Scope	Multiple site or international	Single or multiple site	Single site
Business Process Re-engineering (BPR) Scope	Local or international BPR	Alignment to ERP or local BPR	Alignment to ERP
Technical Scope	Major or minor modification	Major or minor modification	No modification to ERP (except reports and user interfaces)
Module Implementation Strategy	Skeletal or full functionality, module-by-module or integration to legacy systems	Skeletal, module-by-module, integration to legacy systems	Skeletal, module-by-module, integration to legacy systems
Resource Allocation	Time up to 4 years Budget up to \$A10M	Time up to 12 months Budget up to \$A3M	Time 6-12 months Budget \$1-2M

### 3.1 Implementation categories of case companies

To understand the human factors of ERP implementations, we chose three manufacturing companies that each had implemented new ERP system up to two years before the case studies. Characteristics of these companies are presented in Table 2. In order to understand the different nature of each implementation project, the three case study companies' ERP implementation projects are categorised according to Parr and Shanks (2000).

**Table 2:** General characteristics of the three case study companies

Company reference	Company A	Company B	Company C
Manufacturing branch	Paper industry	Inks	Metal industry
Turnover	130 M€	700 M€	11 M€
Personnel	Over 1000	3200	110
Implemented ERP system	SAP (MySAP 2004)	IFS (2004)	Powered (2004)
Category of implementation	Comprehensive	Middle-road	Vanilla

Company A's ERP implementation can be categorised as "Comprehensive". The company is multi-national and has sites in different countries. The scope was to replace 20 earlier systems. Business process reengineering was done heavily to adapt to the new ERP system. The implementation needed large resource allocation and therefore also external consultants were used. The old production planning system was run parallel for more than a year after the new ERP system was started. Overall the ERP project took three years and was put into practise in two phases. The first phase included standard implementation process using external consultants and took 1,5 years and 30-40 man-years to complete. Shortly after, major problems in the use of ERP system were noticed and corrective actions included nomination of an internal development manager and using the consultancy. Results of consultancy such as process reengineering were applied 1,5 years after completing the first phase.

Company B's ERP implementation can be categorised as "Middle-road". The company is also multinational, but only particular modules of the ERP system were implemented. Five existing systems were left to interact with the new ERP system. The resource allocation was smaller compared to company A, and the implementation took less than a year. The requirement analysis was already made in purpose to apply another ERP system, which implementation was suspended as unsuccessful. Then the IFS ERP system was selected instead, and decided to be piloted in this plant, company B, reusing the same ERP system requirements. The IFS ERP system was used as the only production planning system after implementation was completed.

Company C's ERP implementation can be categorised as "Vanilla". Company C has only two sites in one country and the common database works in one place. The amount of users is fairly small and they have implemented only the core functionality of ERP system. However, the implementation took one year, because the company simultaneously carried out process certification. The ERP system was heavily tailored. Also the in the data conversion radical decisions included complete recreation of product descriptions. Only vendor, customer and raw material information was transferred from the previous system. The old ERP system worked parallel with the new ERP system in the production planning for half a year after the implementation, although the data was not updated. In addition company C still continued the usage of its old ERP system parallel with the new one in a few functionalities.

### **3.2 Research method**

Both structured and unstructured interview methods were used. The unstructured interviews, which allow free-form discussion, were used with companies' ERP implementation project managers and process owners to understand the frame of ERP implementation. This interview usually took several hours (companies B and C) or needed couple of meetings (company A). Then the structured interviews, lasting about an hour, with predefined open questions were used to get data about ERP system usage from production planners and shop floor workers. The questions of the structured interview were concerned with users' tasks before and after ERP implementation:

- Which of your tasks have been dropped, changed or are as new?
- What tasks do you do after implementation, because or regardless of the new ERP system?
- What is the basis (data) you build your working and production decisions on?
- What indicator do you personally follow as indicator for production?
- Does the current ERP system support your indicator?

Despite the fact that the questions were structured before starting interviews, the discussion was performed in an unstructured matter so that the interviewee could freely express thoughts about ERP system implementation and usage. Single interviews were assured to be confidential and that the material was gathered in the questionnaire form filled by the interviewee only for the researches, not to be published for anybody else in the organization. The interviews and discussions included seven, five and two persons from companies A, B and C, respectively, according to their implementation category and local branch size. From every company at least the ERP project key person and one production planner were interviewed.

### **3.3 Results**

*Company A* has multiple international offices and chose a well known, heavy, and diversified ERP system SAP, which is delivered in its entirety, but the customer chooses the parts to be used and configures the system by itself. *Company A* used third-party consultancy, whose implementation team ran into inner crisis after the blueprint phase, and company A had to change the consultancy to be able to continue the implementation project. For the implementation team of company A the implementation and configuration of the new ERP system caused extra workload, which overruled the redesign of the production process. Besides, the changes within the implementation were considered to be demanding for the personnel, and thus company A restricted itself from organisational changes at the time of the implementation. The organisation functioned as before and could not take advantage of the new system. Shortly after the implementation process was

completed company A noticed that the system was not fully used; the system lacked information, the production loading was primitive, and only the basic functionality such as order input was utilised. Despite the fact that ERP systems are commonly working through predefined processes, it seemed that these processes were not capable of handling the work loads of machines or phases in detail. Company A set a goal to make the process work and nominated an internal development manager who was placed in the division where the situation was the most acute.

One of the biggest problems before the implementation was that the volume of orders was not updated exactly enough, and thus wrong products were made at the wrong time. The new ERP hindered ambiguous orders from being put in the production process, and this put pressure on sales to clarify the order information. In addition, how the orders are chosen in the production was going through changes. Earlier the orders were pushed into production, but with the new ERP system the production pulls the orders to production depending on their priority and the production capacity available. The problem was now that *Company A had competing priorities for production decisions*. They measured the efficiency of production in terms of production reliability, delivery reliability and delivery cycle. Meanwhile the company rewarded employees based on the amount of production. With these two different priorities there were also competing priorities like the importance of certain customers' orders and salesman preferences. The decision making also went through changes. Earlier in the company A the information systems were used for gaining information about the orders, but the actions were entered only afterwards in the system. Now the ERP system required the decisions to be made and entered in the system at the same time, which makes personnel feel uncomfortable and scared about the responsibility it brings .

Company B started the ERP implementation project as a company-wide operation and proceeded to the requirement specification with defined processes and target operational models. Since the implementation failed in one branch office, the head office chose IFS as the ERP system and the case company B as the pilot place. The IFS consultants assisted the implementation, e.g. making the scope report, ensuring the business plan, choosing the process managers and key users, testing and fixing the software packages, making solution, integration and endurance tests, and training the key users. Company B's earlier ERP system heavily supported financials and the production was dependant on the information filtered from there. With the IFS ERP system the production is able to relay on on-time information and foresee further production needs.

Company B's drawbacks in the ERP system implementation were linked to the training and motivating the shop floor workers. The opinion of the project manager was that "Never let the consultant train your personnel". The IFS consultants trained the key users of company B, and they trained other users in turn. The users stated that a key user as a trainer might lack training capabilities. Concurrently within the new ERP system shop floor workers were given more responsibility and told that it would raise their value in the employee markets. Workers were disappointed that management meant growing skills for using the new ERP system with the value and the workers had thought that the increased value would show in the salary. The enthusiasm and motivation towards the new system suffered so, that the shop floor level workers usually saw the ERP application only in the training phase.

Company C motivated their national ERP project with the currency change and by the fact that the old system was character-based. The processes were defined within the ERP project. Company C used the ERP vendor's training services as they considered external trainers as key players to have the authority and ability to defend the resistance of change. Also in company C as well as in the company B the end users saw the system only in the training phase. A long list of additional requirements and change proposals was produced during the training, indicating insufficient user involvement, contextual analysis and usability testing during ERP requirement and system setup. As well as company A, company C also had problems of handling the work loads of machines or phases in detail. Also, parallel to new ERP system, Excel paradigms were used and shop floor workers used manual task cards.

ERP system will not be fully utilized if the organization and its culture, for example production prioritisation or usage of manual task cards, are not redesigned according to targeted operation model. The reengineering process needs contextual analysis to be successful. These cases show

that organization and its culture also affect in the selection of the key players for example consultants and trainers in ERP implementation. Most of all these cases show that the end users of the ERP system, including the shop floor workers, should be included among the key players. Common to these cases is that the production or shop floor workers have been introduced to the new ERP system only a short time before the system is taken into use. End user participation in the ERP system implementation process early enough also motivates and encourages efficient usage of the new system. Conducting contextual analysis and including end users among key players are part of the user-centered design principles and activities that should be followed to achieve efficiency of the new ERP system.

#### **4. Discussion and conclusion**

ERP implementation is affected by human factors in addition to technical and operational factors. Contextual analysis reveals the company's entirety; users, tasks, physical environment, culture and communication. Key players may represent personnel from company's ERP vendor or third party consultancy. Roles of the key players vary according to the implementation stage so that those who make plans and decisions for the implementation are key players in the early stages, and those who put the implementation in practice and support the usage are the key players in last stages in implementation. Usability activities are a way to take human factors into consideration in ERP implementation.

The post implementation case studies presented in the previous section show that human factors play a remarkable role in ERP implementations, and when ignored, can cause inefficient usage of companies' resources. For example, the workers who were expected to work according to the ERP system's production control and report through the system, were introduced to the new way of work in the very late implementation stages. In the ERP implementation the question is not only how the system works or how the user interface should be used, it is also a question of changing workers' daily tasks and sequences, possibly also their responsibilities. To avoid the negative effects, a systematic method of collecting data about the context, organisation, company's culture and the employees should be applied in early stages of the ERP implementation process.

As guidelines for human factors consideration we propose the following activities to be conducted in ERP implementations:

- A thorough contextual analysis in the beginning of the implementation project to support the organizational aspects in ERP implementation. For example, the content of informal communication can be defined only by studying the context of use.
- Including users among other key players, i.e. including shop floor workers in the implementation team.
- Systematic use of usability principles and processes, for example in ERP requirement specification and later, in ERP implementation activities planning.

Contextual analysis reflects the company's current operations model in which the new ERP system is to be implemented. Based on the results of the analysis, risks of ERP system underutilization can be found. In addition, prejudices and resistance can be expressed by the workers during the analysis, and based on this, better change management can be planned. The implementation activities, for example data conversion, training and go-live, can be appropriately designed according to the organizational accomplishment. To achieve organization-wide cooperation in implementation, several end users, for example production workers, should join the implementation team.

By carrying out the activities recommended above, the implementation follows the user-centered design principles and processes. In the design of ERP system implementation the users are involved both as actors in the multidisciplinary implementation team and as a target of action in the contextual analysis. The context of ERP system usage is defined, and users' and organizational requirements of the ERP system and its implementation are specified. The implementation is designed considering the context of use. The hardest thing to follow is the *iteration* of implementation design. Implementation plan can be iterated for example in the organization's

internal meetings. These kinds of meetings could also be part of an information dissemination strategy of the ERP project.

As further work, we have applied a user-centered design method – contextual design – to small and medium-sized enterprises' ERP requirements specification. The contextual design method is combined with more traditional operations model specification. This new concept, called *Customer-Centered ERP Implementation (C-CEI)*, is currently being tested and developed in industrial joint venture funded by the Finnish Work Environment Fund. On the basis of a pilot project, conducted in 1/2005, it seems that connecting UCD activities to traditional business process re-engineering helps with specifying the organisational – including human factors – needs more deeply. In addition, the organisation's maturity to carry out an ERP implementation clearly increases.

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## Paper II

Vilpola, I. and Kouri, I., (2006), Improving ERP Requirement Specification Process of SMEs with a Customer-Centered Analysis Method. Proceedings of the Frontiers of e-Business Research (FeBR) 2005, Eds Seppä et al. Tampere University of Technology (TUT) and University of Tampere (UTA), pp.140-151.

# Improving ERP Requirement Specification Process of SMEs with a Customer-Centered Analysis Method

Inka Vilpola<sup>1</sup> ; Ilkka Kouri<sup>2</sup>

<sup>1</sup> Usability Researcher, Tampere University of Technology, Institute of Software Systems,  
*inka.vilpola@tut.fi*

<sup>2</sup> Senior Researcher, Tampere University of Technology, Institute of Industrial Management,  
*ilkka.kouri@tut.fi*

## Abstract

Nowadays enterprise resource planning (ERP) systems are mostly ready-made software packages, which raises the importance of the ERP system selection. For SMEs a good fit between company business processes and ERP system functionality is a top priority in ERP selection. However, SME companies' resources are limited and quite often their experience and knowledge of ERP systems is inadequate. Current models of software requirement specification are too expensive and cumbersome for SMEs. Typically, these models are targeted at supporting the implementation process after the software selection.

In this study we first present the characteristics of SMEs' ERP projects and through case studies discuss how they could be evolved more effectively. We then propose a new advanced method for SMEs' ERP requirement specification that includes *operational*, *contextual* and *risk analysis*. Together these analyses provide a complete in-depth description of company business process development, specify the requirements for the new ERP system, and identify the restrictions and risks related to the ERP project. The results of a case study in which the method has been applied, support further development towards a holistic and multidisciplinary approach in the ERP requirements specification process of SMEs.

## Keywords

ERP, SME, operational analysis, contextual analysis, C-CEI

## Introduction

Enterprise resource planning (ERP) implementation projects have proven to be the most challenging of systems development projects. Kumar et al. (2003, 793) state that "ERP projects are set apart by their complexity, enterprise-wide scope and challenges posed by large-scale organizational changes in transition to new systems and business processes". Since current ERP systems can be defined as commercial-off-the-shelf (COTS) products (Botella et al. 2003, 225), the selection of an ERP system becomes crucial in the implementation project. Evidence shows that the selection process involves a consideration of the investment from various perspectives such as vendor, price, support, flexibility and implementation time (Bernroider and Koch 2001, 253-254). The selection could also be supported by proper requirement analysis.

The large ERP system providers, such as SAP and Baan, offer their own software specific methods for undertaking a complete requirement specification (Soffer et al. 2003, 674). These methods are targeted at large enterprises with multi-site offices and thousands of employees. Vendor-specific models such as DEM are software specific, cumbersome and their focus is directed to supporting the implementation process. They do not support the requirement specification or the change management adopted before the implementation process. To overcome these drawbacks, we propose a new ERP non-vendor dependent method for use in ERP selection by small and medium-sized enterprises (SMEs).

In this study we first present the characteristics of SMEs' ERP projects and give detailed examples of the case studies we conducted in two SMEs. We then propose an advanced method for SMEs' ERP requirement specification developed from the point of view of SME companies. The proposed method combines targeted business process analysis and contextual analysis. The Contextual Design method is utilised to gain a wider perspective of the organisation, its culture and interaction as well as a detailed picture of how its operations are carried out. In addition, the risks related to ERP system selection, its implementation and usage are identified in risk analysis on the basis of preceding operational and contextual analyses. We also describe how this type of methodology is applied in the ERP system requirements specification of an SME. Finally, we discuss the development of ERP-project management in SMEs.

## **Characteristics of SMEs' ERP projects**

SMEs are increasingly adopting ERP systems, although ERP projects are extremely expensive and highly risky ventures for them. A survey of Swedish manufacturing firms revealed that the ERP investment tends to be relatively heavier for small companies. ERP cost accounts for 3.5 % of annual revenue, whereas the cost is about 1% for larger corporations. (Olhager and Selldin 2003, 369)

Typical challenges for SMEs in their ERP projects are appointing competent management, allocating the required resources, and re-engineering their own business processes (Kalliokoski et al. 2001, 53-54). The major problem is that SMEs lack expertise in requirement specification and are thus often at the mercy of the ERP vendors. One of the basic methodologies of software selection, especially suited to smaller companies, is determining the particular features that are required to run the business (Umble et al. 2003, 248). Because the COTS nature of software solutions, small and medium size companies may opt for software that closely matches the specific functions and processes of their business. (Umble et al. 2003, 248).

Bernroider and Koch (2001, 253-254) in their study of 22 Austrian SMEs found that the adaptability and flexibility of the software is the most important ERP selection criteria. They note that SMEs might have company-specific business processes to sustain, and therefore the software needs to be modified to fit the process. The Enterprise resource planning survey of Swedish manufacturing firms concluded that almost all (92.4%) implemented ERP-systems needed to be customized to some extent. Although most of this customization was minor, one third of the companies reported significant needs for customization. The most frequently customized modules are associated with the core functionality of the ERP system, such as

purchasing, order entry, materials management and production planning. (Olhager and Selldin 2003, 370)

A large-scale Survey of 2647 European SMEs also supports the view that fit with current processes is the most important selection criterion (Everdingen et al. 2000, 29). In the study reported by Bernroider and Koch (2001, 253-254), the results indicate that a short implementation time and consequent low implementation costs are highly valued by SMEs. However, Buonanno et al. (2005, 422) reported in their study of 311 Italian SMEs that financial constraints are not major reasons for not adopting an ERP system. Instead of money, structural and organizational considerations were seen as the major obstacles to adopting ERP systems. These results suggest that SMEs have a competitive advantage in their agile business processes, and thus they prefer to support these rather than modify them according to an ERP system. SMEs need assistance in describing their company-specific needs to the ERP vendors.

In their case study of four ERP implementation processes of SMEs in the U.S., Muscatello et al. (2003, 868-869) claim that inadequate ERP requirements may well lead to a misfit between the ERP system and the organization. They recommend that the decision on the technology to be adapted is taken only after the requirements analysis. They also suggest conducting education and skill audits of managers and operators. In their conclusion, they observe that successful implementations of modern technologies have similarity in their practices in human-factors related activities. Vilpola and Väänänen-Vainio-Mattila in their study (2005, 518) propose conducting contextual analysis, committing end users in the ERP implementation team, and employing usability principles and processes in order to consider the human factors in ERP implementations.

### Case studies

In order to obtain further information on SME-specific problems, we analyzed two companies. Both companies were planning to purchase a new ERP system during the year 2005. The companies operated in different industry segments and their functions and management practices were dissimilar. However their problems were similar, in that these related to their current ERP software and the acquisition of a new ERP system.

Table 1. Company details

Company	Personnel	Turnover	Trade
A	120	15 M€(2004)	Sheet metal panel manufacturing for construction industry
B	40	8 M€(2003)	Measurement devices manufacturing for vehicle and aero-space industry

The major findings of the company analyses are presented below.

#### *Current ERP system*

Both companies are currently using their first ERP system. The ERP systems do not adequately support the critical business processes or data management and are, in fact, far from satisfactory. The information management is cumbersome and different spreadsheet and pc-database applications are utilized to support company operations, data management and reporting. The ERP system's features are underutilized. The selection and implementation of

the current system have been poorly conducted and personnel training have been almost nonexistent. Both companies were dissatisfied with their current system and saw it as a major obstacle to the development of operations efficiency.

#### *The acquisition of a new ERP system*

The companies have very limited resources and cannot purchase expensive software or extensive consulting services. However, their businesses and operations principles have many distinctive features that should be considered when selecting the ERP software. The personnel of both companies have very limited knowledge of ERP systems and they do not recognize the changes in operations, routines and data management related to ERP implementation. Their capacity to manage the ERP selection and implementation process is inadequate.

Though both companies are purchasing their second system and their overall knowledge of information technology is good, there remains a clear risk of unsatisfactory ERP acquisition. The companies lack the knowledge and resources to specify requirement and manage both the ERP project and the changes related to its implementation. There is clearly a need for a new method to help SMEs select an appropriate ERP system and manage the implementation process and the changes in operations and information management. Such a method should be efficient, well structured and give a wide overview of business process development and change management.

### **Proposed method for SMEs' ERP requirement specification**

We propose a new method for SMEs' ERP requirement specification, which supports the selection and implementation of a COTS type ERP-system. The method must take into account the nature of a COTS type software, the SME's special operations management needs and the limited resources and knowledge of the SME.

The requirement specification method should be efficient in use, have universal applicability and support the ERP-system purchasing project and change management in company business processes. The structure of the model must be clear and have well defined and documented phases. The need for specialized knowledge should be minimal. The requirements are specified in terms of business process needs, not software characteristics. Resources must be allocated to the most important questions, rather than to a wide-ranging and detailed analysis.

By universal applicability, we mean the independence of the business segment or ERP-software product. The model should be used by any company that needs an ERP-type operations management solution. The result should be both the development plan for the business processes and the related software requirement definition. The results should be documented in such a way that supports the software selection process and business process change management. From the point of the business management, the method should help to control and manage the risks related to ERP -system selection, implementation and change management.

One of the basic principles of the proposed method is the targeted top-down approach. Instead of modeling all the processes and information management requirements, the method focuses on critical points in the company's processes. These critical areas comprise the following:

- Areas where the company business processes mismatch the universal ERP systems logic and processes, as in the case when the company's product definition is divergent from ERP systems bill of material logic.
- Company specific data management needs, such as the serial numbering practice when a product consists of multiple parts and each has its individual serial number.
- Processes and routines that will be changed due to the new ERP system, for example production management or customer service process.
- Issues unique to the company implementing the new ERP system. For example, a company may have a strategy of using mobile devices connected to an ERP system in the near future.

The points are called critical either because they define the most important requirements for the ERP system to be purchased or because they are likely to complicate the ERP implementation process. The company specific requirements based on critical point analysis are often the most significant requirements influencing the software selection.

### **Operational analysis**

The main goal of operational analysis is to define future company business processes and also to specify the requirements for the new ERP system. The analysis is conducted utilizing a top-down method where the detailed analysis is carried out only on the most important areas of business. Standard routines and procedures, such as accounting, that are included in most ERP software are given little weight in requirement specification.

The operational analysis begins with a discussion of the company's strategy and vision by the board of executives (BOE). In the next phase of operational analysis, the key personnel from each major function (or business process) are interviewed in groups. The goal of the interviews is to analyze the main business processes and information processing along with the related planning tasks. The development needs and problems in current processes and information processing are collected as well as the quantitative information on volume and frequency of various tasks. The important areas identified at group interviews are analyzed in greater detail. The result of the group interview is a description of current "As-Is" operational model business processes, the problems and development needs. The discrepancies between standard ERP operations and current company processes are identified.

Part of the requirements for ERP software can be defined on the basis of the company's current "As-Is" model of operations. However, an ERP-project inevitably involves certain major or minor changes to business processes and information processing routines. The requirement specification should be carried out according to the re-engineered business processes and because of this, the future business processes are described in a "To-Be" model of operations. The development of this model is made in an iterative way in close co-operation with the company BOE. First, only the major questions are presented together with their possible solutions. These questions include the main principles of operations management, definition of the ERP system tasks and organization of the company core

processes. For example, the company needs to decide whether it employs a make-to-stock or an assembly-to-order manufacturing principle.

Once, the company board has decided on the most important facts, the model is further developed in greater detail. Such detail may include inventory management practices definition or a description of the manufacturing work centers utilized in capacity planning.

When the BEO has reached agreement on a future “To-Be” model of business processes, the detailed requirement specification is documented. The requirements are formulated into detailed requirements, i.e. “in the system for different products can be entered batch based stock place and balance”, that are prioritized and approved by the company BEO. The detailed requirement specification is written so that the company can include it with the request of quotations sent to the ERP-system vendors.

One of the most important issues in “To-Be” operation model development is finding the right balance between the change in business processes and software tailoring. If there is a clear gap between current business processes and ERP software standard functionality, the company board must decide whether the company changes its business processes or the software is tailored in accordance with company needs.

### **Contextual analysis**

Key processes and operational practices that deviate from the standard ERP system operational model (Orlichy 1975, Vollman 1997) are further analysed by *contextual analysis*. Contextual analysis applies a user-centered design method called Contextual Design (Beyer and Holtzblatt 1998), which was originally developed for designing interactive systems. In the contextual analysis the critical points are further analysed to gain a wider perspective by *contextual inquiry (CI)* (Beyer and Holzblatt 1999, 34). CI consists of observing and interviewing users in their natural working environment when the normal task or sequence is being carried out. First, contextual analysis *confirms* that any critical points found have a basis in fact and can affect ERP implementation. Second, contextual analysis gives detailed shop floor *knowledge of the organization, and its interaction and culture*. This knowledge will be useful in the design of implementation activities such as training or go-live. In addition, it helps the change management during the ERP implementation. Third, the *contradictions* found by the contextual analysis in the current operations model *indicate the potential source of ERP implementation risks*.

Data gathered by observing the users is then modeled into visual presentations. *Flow model* illustrates persons and their communication. The means of communication, such as documents and phone calls, are also depicted in the flow model. *Cultural model* represents company policy and attitudes. *Sequence model* focuses on one task at a time, for instance creating an order in the information system. The trigger and intention of the task are analysed and the progress is described step by step. *Physical model* visualizes the company area, the buildings, offices and possible sites outside the core area. In our application the information from the flow model is included in the physical model to illustrate instances where the communication is frequent but constrained by physical obstacles, e.g. walls, long distances, or lack of wireless connection to the IS of the company. These models are used for analyzing

how the changes within ERP implementation will change the company's context of use, i.e. users, their tasks, devices, social and physical environment (ISO 13407 1999).

The models illustrate the current "As-Is" model of a company, and can thus be used when operations are enhanced already before the new ERP system. The models do not bring out all the organizational issues observed during the CI. The rest of the data are placed in post-it notes and grouped in order to analyze how they will be affected within the new "To-Be" model. The models and the group of post-it notes are analyzed by a team made up of key personnel from the company's ERP project. The team has responsibility for deciding on the changes in the context, e.g. adding data entering responsibilities. External consultants can also be used for such purposes as illustrating the restrictions that ERP systems can set on the operational model. One of the goals is to increase the readiness of key personnel for managing the changes when the ERP system is implemented.

Contextual analysis produces an in-depth description of the company's current organization, its culture and interaction. The analysis creates contextual requirements for the ERP system and its implementation. Problems in current "As-Is" model are also a potential source of risks in the implementation and usage of an ERP system.

### **Risk analysis**

The definition of the risks is based on the operational and the contextual analysis. They are completed along with the ERP project risks presented in the literature. The risks are divided into *selection*, *implementation* or *usage risks* according the ERP project phase. In addition, a distinction is made between general and company-specific risks. Risks are evaluated by the key personnel of the company's ERP project in terms of probability and influence. The risks are analyzed further in a descriptive manner by identifying the source, effect and action plan for management purposes. The risk analysis completes the requirement analysis by highlighting the risks for the ERP project management. At the same time, it emphasizes the importance of planning preventive action already at the preparation phase of the ERP implementation.

### **Case study**

The proposed type of method, C-CEI (Customer-Centered ERP Implementation) (Figure 1), has already been implemented and tested in Company B (Table 1) by the authors in early 2005. Company B had decided to invest in a new ERP system, but wished to avoid the problems they had experienced in a previous ERP implementation a few years earlier. Their business strategy was under change from unique tailored customer-specific products to more standardized modular products. Company B is an expert organization and the various technology based departments are managed by design engineers. When the ERP system and implementation requirements are considered, it is unlikely the company will find any cross division consensus without an external analysis of its current operational model and context of use.



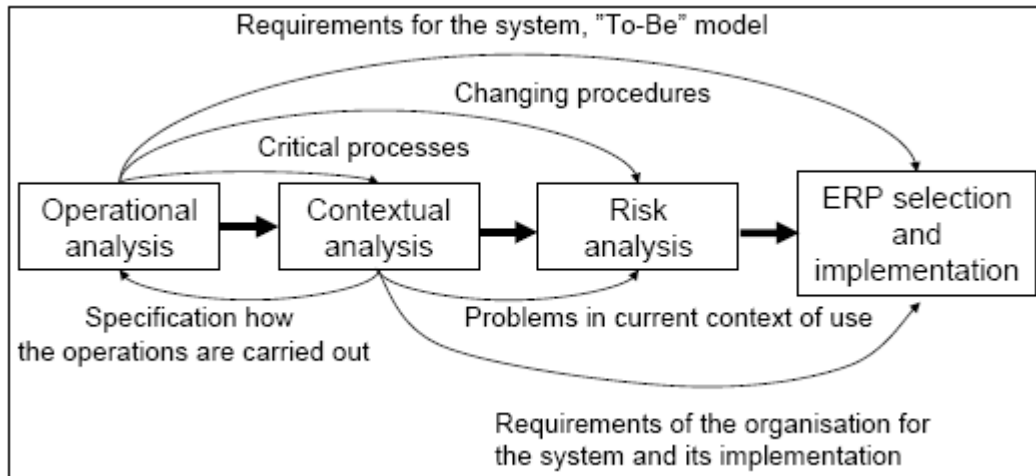


Figure 1. Flow of the C-CEI method.

### *Operational analysis*

The operational analysis was carried out according to the description above. Because of the small size of the company, most members of the BOE were present at every stage of operational analysis. The company strategy, vision and development goals were formulated in close co-operation with the group members. Major problems and development areas were articulated and documented. One of the most important areas discussed and defined was the scope of the ERP project and software. The company had a clear need for software supporting the customer relationship management (CRM) and order related product data management (PDM). However, the company decided to exclude such areas from the ERP project. The ERP software containing full-scale PDM and CRM modules would have been too expensive for a small company. The PDM and CRM features the company was interested in were quite unique and were best served by ad hoc solutions developed according to company needs.

The company-specific information processing needs discovered in the group interviews were analyzed in greater detail. The biggest gap between ERP system logic and company information processing was the unique product structure and serial number system based on product modules. Various solutions were discussed and finally all the group members agreed that their new product structure is based on order specific bill of materials (BOM). This set a requirement on the future ERP-system that it must be able to handle efficiently order BOM. The product modules and single components in the BOM must be easily changeable according to the customer order. The current serial numbering system was very important for the company because product design, manufacturing and maintenance was organized in terms of a module-specific serial number. This feature was considered so important that it had to be included in the ERP system requirement specification.

The major changes in company business processes were defined and described. The future “To-Be” business processes included, for example, a systematic purchasing process utilizing ERP functionality and increased inter-departmental coordination of customer orders. The ERP selection criteria were formulated on the basis of company-specific information processing needs and future “To-Be” business processes.

The result of the operational analysis was a requirement specification document that included a description of the company business, products and order delivery process. The company strategy and business goals were also described as well as the operations development and ERP project goals. The future “To-Be” business processes were defined together with the most important ERP-based information processing tasks. Finally, the document included about 130 prioritized requirements, in which 12 were ranked as must be features. The company later included this document with their request for quotation.

### *Contextual analysis*

Since the order delivery process was seen as the most critical process in Company B, six workers, each from different functions, were chosen as targets for observation. The model drawn from the observation data revealed problems in Company B’s current operational model.

The flow model revealed that project management was carried out via inter-personal communication. This involved an individual physically moving around the company area to ascertain the progress of the different divisions. The cultural model indicates a desire for solving a customer’s problems. The autonomy of the divisions is also shown in the cultural model. The Sequence model revealed that every division had the same type of problems in their part of order delivery process. First, the primary data of the order was incomplete and this had to be clarified before starting production. The corrections were poorly documented. Second, work was allocated on a division basis by each division manager with no managerial interaction. Third, when the division-specific part of the production was complete, any notification of production parts being ready was presented, for example, to the next division in the process or to the project manager. The physical model revealed no particular problems despite the fact that the key communication person sat behind a wall that prevented spontaneous communication about the project’s progress.

In the phase when the post-it notes were grouped in consultation with the BEO of Company B, a major question arose as to whether Company B actually needed an ERP system or whether a production data management software or module might suffice. The results in the contextual analysis relate to issues such as the use of previous production or order documentation as a source for a new one, and the documentation of changes in production structure. At the same time, the product of Company B was not sufficiently stable or modular to be structured in the ERP system and production could not be managed by an ERP system. Nevertheless, the ERP system could improve the communication between divisions and project manager.

### *Risk analysis*

In the risk analysis of Company B common risks were gathered from the literature and previous studies of critical success factors in ERP implementation. The company-specific risks were collected during operational and contextual analyses. A total of 38 risks were identified and analyzed (Table 2). The amount of risk was greatest in the ERP implementation phase because of the number of changes and persons involved. The share of company-specific risks increased during the ERP project because as the ERP project advances, there is a reduction in the influence of external factors such as the implementation partner or ERP

vendor. Finally, in the usage stage the efficient use of the new system is dependent on the company personnel.

Table 2. Amount and type of risk identified in the ERP requirement specification process of Company B

ERP project stage	Selection	Implementation	Usage	Total
Common risks	8	10	1	19
Company-specific risks	2	11	6	19
Total	10	21	7	38

The risks were evaluated with Company B's board of executives. The most serious risks in their ERP selection were unclear motivation of their ERP investment, and high expectations towards product data management of the ERP system. The implementation risks included change management in the operations and also in the organization. The ERP project manager being able to work only as a part-time for the project was seen as a risk, as well as strong person-specific focuses the implementation. In the usage stage the continuance of informal communication was evaluated as not having a strong influence but rather as a great probability. Keeping usage disciplined was the major risk of ERP system usage in Company B.

At the final meeting for applying the proposed method for ERP system requirement specification, Company B's board of executives praised the intensive working method, in which the interviews and discussions took a day at the time. They state that it prepared them to manage the changes in their forthcoming ERP implementation. They noted that they had received information on both their current operational model and organisation characteristics as well as the various management logics of ERP systems. They were confident that they could now decide on the ERP project and felt much more aware of the changes and risks involved in the project. They no longer believed they were at the mercy of ERP vendors.

This type of method has already been implemented and piloted by the authors in a small manufacturing and service company in early 2005. The method is now under development and the further development ideas are being tested during 2005-2006 in three other case companies.

## DISCUSSION

The method proposed in this paper is divided into three phases: operational, contextual and risk analysis. It should, therefore, be readily comprehensible even if the phases interact with each other. The division into phases provides for the inclusion of experts from such fields as industrial management, usability and risk, in the management of each phase. This helps an SME overcome the possible lack of expertise as a result of an ERP system implementation. On the other hand, in this method we discuss only company-specific requirements and a company's context of use. Hence, the company personnel are considered to be the experts of their business. It can be difficult to re-engineer one's own business processes, and even colleagues, may find it hard to be objective about each other's work

In the case study, where the method was first applied, the activities of analyses were conducted as intensive days. The company's board of executives (BOE) participated in these sessions. On some occasions this might be impossible, because in SMEs individual personnel may have multiple roles and are often irreplaceable. The involvement of BOE members on such a large scale increases the costs of the method. However, their involvement also makes the method the most efficient one because it directly improves the skills, awareness and commitment of the key players in ERP implementation.

Contextual analysis concentrates on the actual working of the organization. This is not normally revealed in a conventional interview because personnel typically tell the interviewee a) what is asked for, b) how they think the work should be done, or c) only selected parts of their job. By contrast the observations combined with an interview conducted in the actual workplace reveal more accurately all the minutiae of the employee's work routine. Though not all the workers can be observed, overall the method focuses only in the deviating practices of an SME.

The results of contextual analysis expose the problems of the current operational model. These problems should be solved before the ERP implementation. Some of them can be solved by other means than ERP-software. The scope of the ERP system implementation and functions to be included are decided only after all the operational and contextual requirements are known to BEO. Only then can they justify the investment and set goals for the implementation. SMEs can feel secure when applying this method because it gives them company specific-support at every level of organization and for every stage of any forthcoming ERP project.

## Conclusions

In this paper we have proposed a new vendor and software independent method for ERP requirement specification of SMEs. The proposed method has clear advantages since company specific requirements are taken into account. Today's ERP systems support standard business processes fairly well but those exceptions in companies' operations model can mean that ERP system are not fully utilized. In order to achieve a complete ERP requirement specification and analysis of an SME's current operations model, a contextual analysis is needed. This also provides practical knowledge of the company's interaction and culture throughout the entire ERP implementation project. Contextual analysis also identifies potential risks that may appear during the ERP implementation.

When the knowledge of the company's processes and contextual information are combined, the company specific extensive requirement analysis is complete. The analysis is a source not only for *requirement specification* but also for *risk analysis* and *implementation plan*. The method proposed in this paper for specifying SMEs' ERP requirements is *considerably light* and *independent of ERP vendors*. The results can be *used practically in the ERP selection* and *in the ERP implementation risk analysis*.

The new method of ERP requirement specification for SME supports the organization in the ERP system and selection in many ways. Recognizing the changing business processes and analyzing them in a comprehensive way, enables the SME to target its limited resources at the

most critical points of the organization. The definition and prioritization of the requirements provides a company with a solid basis for comparing various ERP systems. Without a clear requirement specification, the software is easily purchased on the basis of secondary considerations. The risk analysis, conducted as proposed in this paper, forces the management of SME to evaluate the risks related to their ERP project.

The new method will be applied in different SMEs, to ascertain its suitability for the company and its business. The response of ERP vendors' to these new types of ERP requirement specifications should also be investigated. Better integration of the results achieved by using this method, with the entire ERP implementation project is needed in order to take full advantage of the contextual analysis. Testing and training, in particular, could utilize the organizational data. We would argue that this new method is a solution to the SMEs' challenges in ERP implementations.

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## **Paper III**

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# Applying Contextual Design to ERP System Implementation

## **Inka Vilpola**

Institute of Human-Centered  
Technology  
Tampere University of Technology  
P.O.BOX 553  
FI-33101 Tampere, Finland  
Inka.vilpola@tut.fi

## **Kaisa Väänänen-Vainio-Mattila**

Institute of Human-Centered  
Technology  
Tampere University of Technology  
Kaisa.vaananen-vainio-  
mattila@tut.fi

## **Taru Salmimaa**

Institute of Human-Centered  
Technology  
Tampere University of Technology  
Taru.salmimaa@tut.fi

## **Abstract**

The aim of enterprise resource planning (ERP) systems is to integrate a company's information systems and to make the company's business processes more efficient. ERP systems are *commercial-off-the-shelf products* (COTS) that seldom totally fit into the company's existing business processes. Contextual design (CD) can be used to model the context of use of an ERP system. Three cases demonstrate that the application of CD supports the selection of a suitable system and helps the organization and people adjust their tasks to the new ERP system's processes.

## **Keywords**

Contextual Design, Enterprise Resource Planning System, COTS, ERP implementation.

## **ACM Classification Keywords**

H5.3. Group and Organization interfaces:  
Organizational design, Theory and models.

## **Introduction**

ERP systems are most often commercial-off-the-shelf (COTS) products that cover multiple business processes such as accounting, supply chain and human resources management [3]. ERP systems have an impact on millions of users in their daily work in different

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companies worldwide. ERP system vendors' total revenue in 2004 was over 23,600 \$M, and estimated growth was 3% in 2004-2005 [1].

The ERP implementation project covers a range of activities starting from a consideration of the ERP system investment to the phase where users customize the new system [5]. Implementation projects are generally considered risky and expensive since the need for resources is large and unknown. A company's ability to continue its daily business while implementing an ERP system may be jeopardized. Kumar et al [5] note that different stakeholders define the success of ERP implementation in different ways. Project managers define it in terms of time and money, business executives on how business goals are achieved, while end users prioritise ease of use and enhancement of their work.

Contextual Design (CD) is a user-centered design (UCD) process that consists of methods applicable to in-depth qualitative analysis of the context of use [2]. Our application broadens the applicability of CD from interactive products to organizational system design. Methods of CD can provide a means to achieve a new user- and organization-centered approach [6] to ERP implementation.

In this experience report we first discuss the motivation for incorporating user-centeredness into an ERP implementation. Next we introduce the three case companies and describe our application of the CD method. The results of applying the CD method are then presented. The conclusion discusses ideas for further development.

### **Motivation for introducing user-centeredness into an ERP implementation**

The ERP system implementation project changes the ways in which the organization works, and has a major influence on the context of the ERP system [6]. Many aspects of the contexts of use [4] change as a result of the ERP implementation project. While the users normally remain the same, even this may not be taken for granted. Tasks change radically as the work is redesigned according to what the ERP system supports. The physical environment, too, changes because of the new computer system, with a call for new devices and software. Even the social environment undergoes change: previously hidden information becomes available throughout the organization due to the ERP system.

Implementation of the ERP system does not follow the full SW development process in which the requirements of customers and users can be fully specified and taken into account. Rather, the aim is to find the best possible fit between the new business processes and the ERP system. Thus, ideal user-centered design is not an option; user-centeredness needs to focus on the selection of the appropriate system, configuring the software and training the users.

### **Case Studies**

Case studies were conducted during the period 12/2004-9/2005 to test the CD model which had been developed for ERP system implementation. In all three cases the application of the CD was linked with the ERP requirements gathering process during a phase before the ERP system had been selected. The order delivery process was selected as the target of the CD.

Application of the CD took approximately one-person month of multidisciplinary work per case company.

*Details of the Companies*

Application of the CD method was introduced in three small or medium sized case companies that were planning to implement an ERP system in the near future (Table 1).

Company	Branch	Turnover	Personnel
A	Construction projects	7 M€ (2004)	109
B	Measurement devices and services	8 M€ (2003)	40
C	Explosives	14 M€ (2004)	150

**Table 1. Parameters of the case companies.**

Company A's activities take place at customers' construction sites various distances up to 400 metres away from the head office. The company needs a means of monitoring resource costs such as wages and material costs, and a way of realizing projects in real time. The company's Contextual Inquiry (CI) targets were Financial manager, Project manager 1, Project manager 2, Foreman and Warehouse manager.

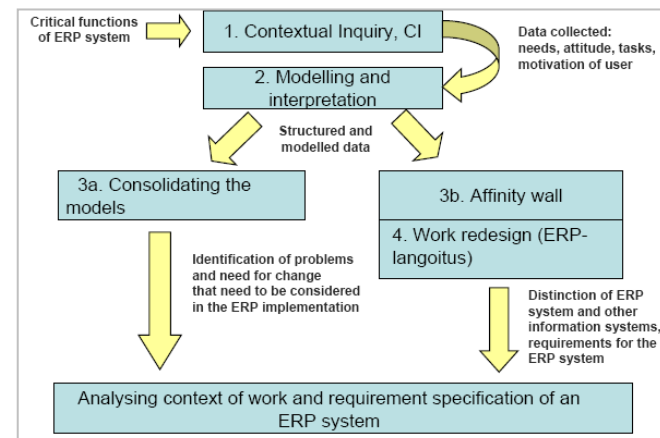
Company B's products are customer-based and somewhat unique. The organization is highly expert-oriented. The company's target is to harmonize the operational model throughout the organization, and increase information sharing in areas such as the status of offers, production or purchasing. Company B's CI targets were Sales manager, Project manager, Production designer, Designer, Programmer and Fabricator.

Company C is a traditional employer in its area with somewhat predictable levels of annual production. Key personnel have served the company for decades. A special feature of the company's activities is the danger of explosion and thus for safety reasons production phases are located in separate buildings. Company C's CI targets were Production designer, Official, Senior laboratory worker, Foreman 1, Foreman 2 and Information specialist.

**Applying Contextual Design to the ERP requirements specification**

Phases of the applied Contextual Design are as follows:

1. Contextual Inquiry, CI: Observing and interviewing users at work;
2. Modelling the results of observations;
- 3a. Consolidating: Finding common work practices without losing track of individual variation;
- 3b. Grouping topics by intention, habit or attitude on the Affinity wall;
4. Work Redesign: Mapping the functionalities of a variety of information systems to help users to increase their performance (Fig 1). [2]



**Figure 1. Phases of the Contextual Design method applied.**





### Conclusions and discussion

ERP projects are major and risky exercises for any size of company. It is therefore important that work in the early phases, such as requirements analysis and the selection of an ERP system, is carried out comprehensively and in sufficient detail.

Analysing the context of use in order to identify users' and the organization's requirements for the new ERP system is a challenging process. The method needs to be light yet comprehensive, while also being cost-effective and practical at the same time. It is not always possible to assign the time of the company's key personnel to multidisciplinary activities of Contextual Design. In addition, conducting Contextual Inquiries with long serving employees can often result in data with a highly personalised perspective.

The following extensions should be considered:

- Having more CIs and conducting them in a pre-defined order, for instance, according to the process procedures.
- Extending the multidisciplinary team in CD activities to include other stakeholders, such as an ERP consultant or vendor.
- Applying CD in the ERP projects of bigger companies.
- Monitoring the effects of using CD by planning the implementation.
- Creating guidelines for companies to apply CD without the need of external help.

Even though ERP systems as such cannot be designed from scratch, the application of CD ensures that the user tasks, UI modifications made by configuring the

ERP system, as well as changes in the context can all be designed according to UCD principles. Introducing user-centeredness in ERP implementation improves the implementation process and leads to the success of the contextual change. A company's efficiency and productivity depend on how fast and completely the organization adopts the new ERP system.

### ACKNOWLEDGMENTS

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## Paper IV

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# Risks in ERP Project – Case Study of IS/ICT Management Capability Maturity Level and Risk Assessment

Mika Ojala<sup>1</sup>; Inka Vilpola<sup>2</sup> Ilkka Kouri<sup>1</sup>

<sup>1</sup>*Institute of Industrial Management, Tampere University of Technology,  
mika.ojala@tut.fi & ilkka.kouri@tut.fi*

<sup>2</sup>*Institute of Human-Centered Technology, Tampere University of Technology, inka.vilpola@tut.fi*

**Abstract** — Enterprise resource planning (ERP) projects are considered to be expensive, time-consuming, difficult to manage, and extremely risky. ERP projects are risky from the strategic, operational, technical and organisational perspectives. The risks and critical success factors of ERP projects have been widely studied, and the management of risks is crucial to a successful ERP project. Generic risk analyses have faced inflation, and in the worst case companies do not manage risks in their ERP projects at all.

This paper presents the early stage assessment of ERP project risks in three firms' ERP projects. The focus is on company-specific risk identification. Companies of this study have limited maturity in IS/ICT management capabilities. Understanding of capability maturity level is useful to efficient risk management in an ERP project. In this paper we compare the company-specific risks to common risk list found in the literature. Qualitative case study of three firms provides empirical evidence of uncovered ERP risks if only common risk list is used. As a result we claim that in addition to generic project management risks there is also a need to assess company-specific-risks. In fact, company-specific risks are usually critical to company's ERP project success.

**Keywords** — ERP, ERP project, risk, capability maturity model

## I. INTRODUCTION

Nowadays even smaller companies are willing to implement Enterprise resource planning (ERP) systems in order to improve their business operations. In some cases the pressure towards ERP system investment comes from larger co-operation partners. ERP system implementation is a complex project which includes many critical phases, such as ERP system selection and configuration [3], before it is successfully in use. Currently ERP projects, their failures and success factors, are mainly studied in larger companies [6][1]. This is understandable, as in the past mainly large companies were investing in ERP systems. Currently, as small and medium-sized (SME) firms also implement ERP systems, the special characteristics in their case must be understood. In order to support SMEs in their ERP project, targeted risk management processes are needed in this context.

It is a known fact among practitioners and researchers

that many ERP projects are interpreted to be failures. It is even more challenging for smaller companies or business units to implement ERP systems successfully. IT investments, especially those as large as ERP systems, are difficult, as the smaller firms may not have enough resources, capabilities and ERP project experience. Many projects have faced the situation that at least some of the goals in the projects, e.g. schedule or integration, were not met. This stresses the importance of understanding the risks inherent in ERP projects. There is clearly a need for an ERP risk management solution that is dedicated to improve small companies' ERP risk management.

The main goal of the paper is to present a description, assessment and analysis of the early phase risks in three ERP projects. This goal includes several sub-topics to be discussed at least to some extent. Firstly, the special characteristics of smaller firms as ERP buyers are under exploration. We do this by analyzing the cases by IS/ICT management capability maturity levels. Secondly, the actual risks found in the case companies are presented and discussed. We also analyze in more detail how the maturity level has affected the assessed risks. Finally, we compare the company-specific risks, identified in case studies, and common ERP project risk list, adapted from the literature. The result of case studies and the comparison of risk lists' show that IS/ICT management capability maturity level can affect risk assessment. Therefore, this paper enhance the understanding of ERP projects risks end their management especially in companies where IS/ICT management capabilities are maturing.

## II. ERP PROJECT RISK THEORY

Various reports about common ERP project risks exist. Sumner in her article studies the experiences of seven enterprise-wide information management system implementation projects.[6] Table 1 shows the risk factors in Sumner's article. The research objects were thorough structured interviews with project managers of companies, all of which are from the fortune 500 list. As a result she lists 20 risk factors divided into 6 risk categories:

TABLE 1  
RISK FACTORS IN ERP PROJECTS ACCORDING TO SUMNER [6]

Risk category	Risk factor
Organizational fit	Failure to redesign business process Failure to follow an enterprise-wide design, which supports data integration
Skill mix	Insufficient training and re-skilling Insufficient internal expertise Lack of business analysts with business and technology knowledge Failure to mix internal and external expertise effectively Lack of ability to recruit and retain qualified ERP systems developers
Management structure and strategy	Lack of senior management support Lack of proper management control structure Lack of a champion Ineffective communications
Software systems design	Failure to adhere to standardized specifications which the software supports Lack of integration
User involvement and training	Insufficient training of end-users Ineffective communications Lack of full-time commitment of customers to project management and project activities Lack of sensitivity to user resistance Failure to emphasize reporting
Technology planning/integration	Inability to avoid technological bottlenecks Attempting to build bridges to legacy applications

Huang et al. [2] used the Delphi method to extract 28 risk factors within 6 categories adapted from Sumner. The risks were first identified by seven experts, each of them with experience of at least two ERP projects. Wright and Wright interviewed 30 experienced IS auditors from the Big 5 firms specialized in ERP evaluation and testing [10]. The interviews were conducted in a semi-structured manner. The study resulted in both qualitative and quantitative analysis of ERP problems, ERP application risks, ERP vendor risk comparison, and ERP effectiveness measurement. The eight most common ERP problems included:

- Inadequate user involvement
- Inadequate user training
- Process reengineering
- Lack of controls in ERP system
- ERP system does not match the required processes
- Poor implementation of systems
- Poor task-technology fit
- Poor data conversion

The problems can be transformed into risks, but they are on a very abstract level and thus applicable in any ERP system implementation. However, they do not encourage any specific risk management action as they are too general, and actually not in a risk list or check list form.

Instead, the ERP project risks most often reported are the critical success factors (CSFs). The experiences are usually collected in the post-implementation phase, and most often from large companies. For example, Somers proposes 22 factors recommended in the earlier literature produced by practitioners and academics [5]. Then the list was ranked by senior level IS executives of companies from fortune 500 list and companies from *Directory of Top Computer*

*Executives*. Top five of the ranked critical success factors list is:

1. Top management support
2. Project team competence
3. Interdepartmental cooperation
4. Clear goals and objectives
5. Project management

These critical success factors can more easily be turned as a risk list than problems discussed above. Still the factors are so common that they apply as a risk for every company despite the company's size or business. The self-evidence of these factors makes them easy to ignore as non-special risk, which does not need an extra attention and activities in order to be reduced or avoided.

The earlier research on ERP project risks is based on checklists and weighting of large companies. Those in fortune 500 lists especially are expected to have structured ICT organization and enterprise-wide ICT strategy. Renken has developed a capability maturity model (CMM) for assessing the IS/ICT management of a company [4]. The final model includes seven IS/ICT management capability maturity indicators refined from the original 15 by eliminating non-critical and duplicate indicators. Elimination was based on prototype modeling of the relationship between indicators and semi-structured interviews of five South African IT professionals.

The seven indicators are:

- IS/ICT applications i.e. how they are utilized
- Business-IT relationship i.e. inter-organizational relationship
- IS/ICT strategy alignment, meaning if IT strategy exists and whether it is aligned with business strategy
- IS/ICT user profile i.e. the IT skills of the personnel of a company
- IS/ICT managerial paradigm i.e. focus of ICT management
- IS/ICT governance i.e. if a predefined IT management process exists and how well it is established
- IS/ICT organization i.e. IT organization form and IT management level.

Each indicator has three to five maturity stages. The model can be used in comparative analysis on the IS/ICT management capability of different companies [4].

There are several other papers also dealing this topical research area of risks in ERP projects. Taylor [7] studied 22 project managers from different vendor IT firms in Hong Kong and the point of view is, in contrast to traditional ERP project risk papers, the IT resource provider's perspective. Amoako-Gyampah **Error! Reference source not found.** presents the ERP implementation factors, both managerial and end-user perspectives, and states that managers have different perceptions than end-users. Tatsiopoulos et al. [8] presented a paper, which stresses the strategic nature of the ERP implementation and especially the strategic issues in the early phase of the project and increasing the importance of operational issues in latter phases. Zafiroopoulos et al. [12] created an application for risk management in ERP



project and Yang et al. [11] applied the ideology of FMEA in risk management of ERP introduction.

### III. RESEARCH METHOD & CASE COMPANY INTRODUCTION

The risk analysis is a part of the *C-CEI method* introduced by Vilpolo et al. [9]. The method includes *operational* and *contextual* analyses in which the company-specific risks for *risk analysis* are identified. In this section the risk analysis methods are described and the resulting risks presented and discussed.

#### A. Research method

In our research we made an in-depth case study in three companies. Table 2 shows the phases in the research as well as the number of people involved in different phases. Due to a limited number of cases in this research, the results may not be generalized, but on the other hand we can evince a profound understanding of the cases studied.

TABLE 2

RESEARCH ACCOMPLISHMENT IN CASE FIRMS. PERSONS INVOLVED IN DIFFERENT PHASES (\* IN THE FIRM C THE RISK ISSUES WERE COVERED IN FIRST ROUND INTERVIEWS)

	Company A	Company B	Company C
First round interviews	12	8	15
Observations	6	5	8
Risk interviews	2	2	0*
Risk assessment WS	4	5	7
Ways of managing risks workshop	5	5	7

The basic idea was to identify the ERP risks arising from the company reality and therefore employees of various levels of organization were interviewed and observed. The goal throughout the whole project, in which the risk analysis was part of, was to help the company in creating a realistic requirements specification and analysis of the company's context. By understanding the business requirements and the limiting factors of the context it is possible to gain a realistic list of potential problems i.e. risks in the ERP project. This is a good starting point in project risk management.

In risk assessment we did not use any previous general list of ERP project risks. Instead, the risk list was formed during the firm interaction and divided by the project phases; *selection*, *implementation* and *use & maintenance*. The risk list was filled with issues emerging in close interaction with companies personnel.

Risk assessment for the risk list was done by evaluating each risk's probability and effect in a scale from one to five. The number one meant very small probability and effect. 5 meant high probability and catastrophic effect. In the appendix we have used risk multiplication as an indicator of risk significance. It is calculated as multiplying probability and effect. Range of this value is from 1 to 25.

#### B. Analysis of IS/ICT management capability maturity levels of the case companies

IS/ICT management capability maturity framework [4] is used for analyzing the maturity levels of the three case

companies. The case companies were not actually measured for the maturity estimation, rather the levels of indicators were revealed during the interviews and observations. The framework used includes seven indicators each with levels from 1-3 to 1-5. Table 3 shows the levels of the indicators for every company. Below the table the case companies are analyzed in more detail.

TABLE 3.

ESTIMATED MATURITY STAGE OF EACH IS/ICT MANAGEMENT CAPABILITY MATURITY INDICATOR IN CASE COMPANIES A, B AND C.

Company/ Indicator	Company A	Company B	Company C
Applications	1 of 3	1 of 3	2 of 3
Business-IT relationship	2 of 5	1 of 5	3 of 5
Strategy alignment	1 of 4	1 of 4	3 of 4
User profile	1 of 3	1 of 3	2 of 3
Managerial paradigm	2 of 4	1 of 4	3 of 4
Governance	3 of 5	1 of 5	4 of 5
Organization	2 of 4	1 of 4	3 of 4

All three companies have in common a need to renew their information system in order to better accomplish their operations now and especially in the future. The need for the new system has grown internally in the companies because of the problems in the current system(s) and, for example, poor usability of systems and complex historically developed system structure. Overall the levels of company B are lower than levels in company A and C (Figure 1), but first each company and its levels of capability maturity factors are described in detail.

Company A is a manufacturer of a complex chemical product (turnover about 14M€ and number of personnel approximately 150). Many of the operations are supported by Microsoft Excel and paper and pencil notes. Strict quality and traceability requirements for the product have forced the company to establish their performance and policies. Company A has a long history and the volume of the business has remained fairly stable. IS/ICT technology investments have not directly related to its business strategy. Rather the aim has been to automate and to improve the efficiency of operations. In fact, not all of the users are computer literate. However the maturity of IS/ICT management is higher than that of the users. The organizational issues have been considered and the focus is on information rather than data. Furthermore the matured governance includes defined, documented and trained procedures. The studied business unit is a part of a larger international group, but this capability maturity analysis concerns only the local site. In this case the IS organization is formalized but flat and the manager reports for the steering committee of company A.

Company B is a project-oriented company specialized in industrial assembly operations (turnover about 7M€ and number of personnel approximately 110). The projects are done mainly on the customers' sites. The company also has prefabrication. In order to run the daily business, company B uses operational IS applications for transactions. The IT organization is not explicitly defined and thus the

relationship with business is unclear. The IS investments are driven by other aspects than business strategy. The user profile is very narrow, and besides, as the company is extremely small, the data management is centralized and personalized. The IS management is focused on maintaining the current financial system and its data. The ICT organization is actually one technology-oriented person who has qualified for the current system by actively participating in its engineering process. The business is run mainly out of the ERP system. The current software is more or less an instrument to find out the financial result of a company. The system is not used in project management or financial control during the projects. It is still used for actual cost calculation after the project. This company is also a part of a larger enterprise. This business unit is still run as a separate firm.

Company C is a business unit in a group of total four business units (turnover about 24M€ and number of personnel approximately 250). These businesses are different, varying from contract manufacturing to selling the knowledge and work of design engineers. The different needs of various business units create clear challenges for the ERP project. This particular business unit, company C, mainly earns its revenues by doing projects in planning and installing equipment in its customers' production facilities. IS applications are used for managing off-site assembly projects and for producing information on operations for the group. The relationship between business and IT organization is constructive and organizations have agreed how to manage IT operations. The group has formal ICT strategy and it is known also in company C. The users are competitive and also help the IT organization in specifying the requirements for IS systems. ICT management is actually common to all the business units and well coordinated and integrated. The processes of company C are continuously measured, and improvements are designed and implemented where needed. The ICT organization of the group is the highest level of maturity, but the ICT organization of this business unit lacks specialists, mainly due to a separate ICT department that is common to the group.

In every factor company C has a higher level than companies A and B. The strategy alignment factor especially is more mature than in the other companies. Company B is at the first stage of maturity in every factor and therefore may encounter fundamental difficulties in its ERP project.

#### IV. CASE STUDY RESULTS

The three case companies represented seem to be rather typical fairly small companies that are planning on making an ERP investment in the near future. The case companies have rather limited resources to put into this project and do not have opportunities and understanding to research all ERP projects' essential issues themselves. External experts are needed in order to support the company capabilities to become more professional system buyers. Still, it must be understood that this kind of firms, too, have individual characteristics that affect the choice of system. Some companies are really technically oriented and have skilled personnel, but others may be like "man-and-a-machine" without any former competence in IT buying, to better specify requirements, engineering, selection and system implementation.

Information technology is one key area when companies are developing their business and search for ways for more efficient operations. ERP solutions often seem to promise a full scale service to answer all possible information needs of a company. The range of systems and their differences are hard to understand even in larger companies, which do have significant amount of knowledge and resources to develop and analyze the information needs and different solutions for them. The case in low IS/ICT management capability maturity level companies, is rather different. They do not usually have large IT departments and many skilled personnel available for the ERP project. Pressure for the information systems may also rise externally from customers or partners rather than internally from the passion to make things work better.

In two case companies a large number of different information systems is a clear challenge. Today one system is used for wages, one for maintenance, one for bookkeeping etc. This system as a whole is complex and there are multiple links between different systems. Data is not easily available and automatically generated from this jungle of systems. In case of system updates or changes it requires a lot of manual work and testing. Links have to be tested to ensure that they work correctly.

Our risk assessment results are presented in the appendix. In fact, this document presents only the top six risks assessed in all three companies. These risks are analyzed in this section. The risks are presented in the same categorization as they were assessed; selection phase, implementation phase and use & maintenance phase.

In the *selection phase* there are many more generic and overall type of risks involved. Companies are concerned if they are able to choose a proper system, a good supplier and a project manager who is capable of this critical job. They were assessed as high risks in all three companies. Firms A and B were also rather worried about their

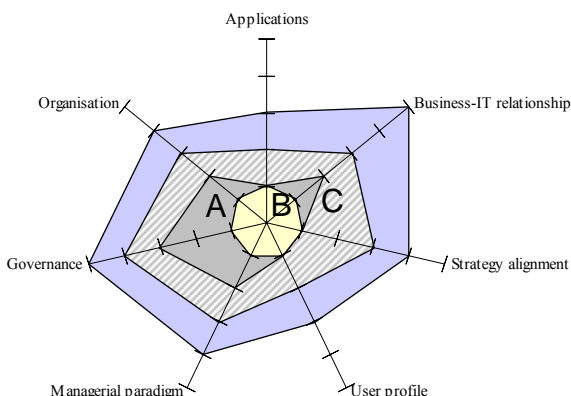


FIGURE 1.

AN IS/ICT CAPABILITY MATURITY RADAR CHART WITH FOOTPRINTS OF COMPANIES A, B AND C. THE SOLID BACKGROUND FOOTPRINT DESCRIBES THE MAXIMUM LEVEL OF EACH FACTOR.

competence in making a contract with the supplier. All these mentioned risks are more or less common to all ERP projects and should be tackled. In every company we can still see some risks in the top six lists that are company specific risks.

In company A the product and production system is rather complex and this has caused some special concerns. There was a lot of discussion about how the system could work in this kind of business and at what possible places standard ERP requires modifications. Company A was also in a situation where some significant changes were anticipated in the near future. The coming system should be able to adapt to an increasing number of customers, differing end products and changing raw material supplies.

For companies B and C the characteristics of the business constituted a special risk. Both companies do projects, with workers in different industrial sites. The projects may be rather short or very long. The system should fit into the project type of business and it should be easy to use from different geographical locations. In the case of company C one other special risk was mentioned. This company has different divisions and business units and many of these have rather different businesses. Some are more work intensive, some more capital intensive etc. The company also had a headquarters with certain requirements of the system. The new system should meet the needs of all the different organization units. Some want a really customized system and the business is clearly run with the help of a system. Some units want to keep the system as light as possible. It was seen as a great risk that the system becomes a poor compromise to all parties.

In the implementation phase the greatest concern was the motivation, commitment and education of the personnel. Companies A and B especially were worried about these issues as well as a lack of change management skills. These two companies had a history of not using IT extensively in their business. Similar concerns were mentioned in one unit of company C, but the overall risk estimations of this company were not as high as in other companies. The general risk of going over the budget was recognized by all companies and they were actually fairly realistic about this issue. Project manager choice in this phase was also worrying every firm but surprisingly in only company C was the lack of top management support in the top six list. The list of company C is slightly different from that of other firms. This company is also aware and concerned that the ERP project will disrupt normal business to some extent. Company C also has a problem of multiple systems, which will partly also remain in the future. These systems have to be linked and this may be challenging in the implementation phase. Companies A and B were worried about the ERP project because they do not have much competence and experiences of similar projects. This can be seen in the implementation risk assessment. Company C has had so many projects that there the problem is to convince people that this project has to be taken seriously. Some people were slightly bored with constantly starting IT projects which seem to make no difference.

In the phase of use and maintenance the disciplined use

of the system was a key risk. In these lists the main concern was if the desired benefits are received in the use phase. Are people forced / motivated to use the system, is only parts of the system used etc. All the companies wanted the system to be flexible to business changes. Here a large number of the risks were more or less general risks. Still, the list includes a few company specific issues; like in company C the concern about getting business relying too heavily on ERP, and this has a negative effect on key persons' motivation. To put this more precisely, in this company project managers had a lot of freedom to deal with their projects. This freedom and the project managers' motivation went hand in hand, and cannot be risked.

As a result of the risk assessment we can also made some quantitative findings from our three cases. Table 4 presents the averages and standard deviations in all three cases and in different phases. The overall results show that the greatest averages are assessed in the implementation phase. In all companies the assessments were similar. The smallest averages were seen in the selection phase. This seems to be understandable, because the case companies were currently in the selection phase and the issues in it were seriously under consideration. Standard deviations were similar in different phases in all cases A and C. In case B the selection and implementation phases' standard deviation was slightly smaller than in the use & maintenance phase and also differed slightly compared to cases A and C.

TABLE 4  
AVERAGES AND STANDARD DEVIATIONS IN CASE COMPANIES

	Company A		Company B		Company C		Total	
	A	STD	A	STD	A	STD	A	STD
<b>Selection</b>	9,3	4,6	8,7	3,8	8,5	4,4	8,8	4,2
<b>Implementation</b>	11,3	4,6	10,3	3,8	10	4,4	10,7	4,3
<b>Use &amp; maintenance</b>	10,4	4,4	10	5,1	9,9	4,4	10,1	4,5
<b>Total</b>	10,6	4,5	9,8	4,1	9,7	4,4	10,0	4,4

Figure 2 sheds some light on how many serious risks were assessed in the case companies. The total numbers of assessed risks were in three phases in different cases (A,B,C) as follows. In the selection phase (17,17,21), in the implementation phase (33,34,34) and in the use & maintenance phase (15,13,14). As we can see in the statistics below, roughly half of the risks were assessed to be significant, i.e. risk product  $\geq 12$ , in every phase.

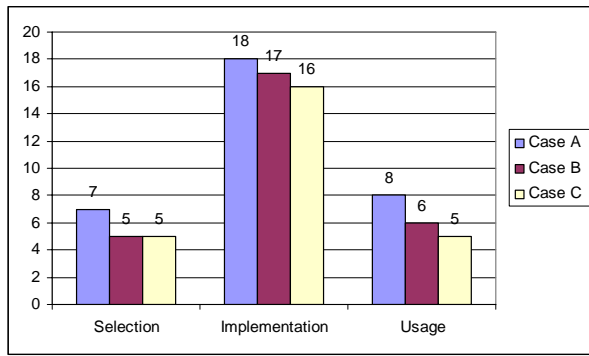


FIGURE 2.

THE NUMBER OF IDENTIFIED SIGNIFICANT RISKS (RISK PRODUCT  $\geq 12$ ) IN EACH CASE A, B AND C.

Finally in each case the companies received table of risks that were categorized according to implementation phases. Inside each phase the risks were ranked according the risk product, i.e. value of probability multiplied by value of effect. The purpose for this table was that companies could easily scan through the risks in every ERP project meeting, and address appropriate actions. The relevant actions could be decided based on risk analysis document. The document specifies reason, occurrence and possible preventive or corrective actions for each risk.

## V. DISCUSSION

In this section we compare the company specific ERP risks found in the case studies to earlier research of common ERP risks by Sumner [6] and discuss the effects of IS/ICT capability maturity. In a qualitative comparison of case risk lists (risk product  $\geq 12$ ) and Sumner's summary of the risk factors we found 8 common risks:

- Failure to redesign business processes
- Failure to follow an enterprise-wide design which supports data integration
- Lack of senior management support
- Lack of proper management control structure
- Lack of integration
- Insufficient training of end-users
- Lack of full-time commitment of customers to project management and project activities
- Attempting to build bridges to legacy applications

The number of common risks in each case was 9/33 in A, only 4/28 in B and 9/26 in C. The share slightly increases as the maturity grows. Sumner's list origin from cases where companies implementing ERP systems are large and the IS management most certainly established. The companies of our case study had fairly low stages of IS management capability maturity indicators. The amount of company-specific risks, which risk production was even or above 12, but not listed in the Sumner's common ERP risks, was big compared to how thorough the common ERP project risks have been studied in previous related research.

## VI. CONCLUSION

It is evident that today smaller companies are also interested in ERP solutions. The sourcing of these is still a rather complex issue and involves a multitude of potential problems. One of the key challenges in the ERP-project is the need to critically assess the whole company's operations. The ERP project is a large-scale change in many business processes and affects almost every employee. The company's context sets some crucial limitations and obvious potential problems, which have to be taken into account in the project.

Our suggestion is that the risks should be evaluated right at the beginning throughout the whole ERP project. Identifying and assessing implementation and usage phase risks are essential when considering system choice. The most important issue in a successful ERP project is an understanding of the company's business and context requirements. General risk list may be really useful tool to find out the greatest risks involved in the ERP project. However, these lists *per se* have a risk of omitting some crucial risks in the assessment. It is a generally known fact that a project's success is often decided in the early phases i.e. in goal description and planning. This is also the case in ERP projects. It is crucially important in this phase to seriously consider why the system is needed and what its effects on the organization will be. Our analysis, which starts from the company context and business needs, is one possible way to support project success. We can state that in the selection phase our analysis identified some significant risks that may have been neglected using a general risk list. In implementation and use & maintenance phases the risk lists were more similar. Our analysis presents the risks in a form and language that is understandable for risk assessment group as in the risk identification phase the risks are found in the company context. This is essentially important in low IT/ICT maturity companies, which may have problems of understanding the issues in a general ERP risk lists. As negative aspect of our risk assessment method is that it requires a significant amount of work and perhaps also help from external experts.

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APPENDIX. RISK ASSESSMENT RESULTS IN CASE COMPANIES (TOP SIX RISKS IN THREE PROJECT PHASES),

<b>Assessed risks in the selection phase (top six list of risks)</b>		
<b>COMPANY A (17 risks)</b> <b>AVER: 9,29 STDEV: 4,61</b>	<b>COMPANY B (17 risks)</b> <b>AVER: 8,65 STDEV: 3,84</b>	<b>COMPANY C (21 risks)</b> <b>AVER: 8,50 STDEV: 4,41</b>
Choosing wrong ERP system (16)	Terms of contract not agreed considering the changes in a system (16)	Misunderstandings between buyer and supplier (16)
Choosing poor project manager or project group (16)	Special needs of a company not defined (12)	Concern level goals and business unit goals are not coherent (16)
Inadequate competence in making a contract (16)	System does not adapt to future business needs (12)	System is a poor compromise to all parties (16)
Choosing wrong ERP supplier (12)	Inadequate competence in making a contract (12)	Poor choice of project manager or project group (15)
System not flexible enough under processes' exceptional circumstances (12)	Choosing wrong ERP supplier (12)	System does not support project type of business (12)
System does not adapt to future business needs (12)	Efficient use of the system is not possible from working sites (9)	Efficient use of the system is not possible from working sites (10)

<b>Assessed risks in the implementation phase (top six list of risks)</b>		
<b>COMPANY A (33 risks)</b> <b>AVER: 11,33 STDEV: 4,60</b>	<b>COMPANY B (34 risks)</b> <b>AVER: 10,30 STDEV: 3,84</b>	<b>COMPANY C (34 risks)</b> <b>AVER: 10,00 STDEV: 4,39</b>
Personnel don't have commitment to new way of working (20)	Personnel don't have commitment to new way of working (20)	ERP project disturbs 'normal business' (20)
There is not enough change management skills and managership (20)	People don't see the benefits of the system in their everyday work (20)	Lack of time to attend to education in implementation (16)
Costs rise compared to initial estimations (16)	Costs rise compared to initial estimations (16)	Company's project manager is not a full time PM (16)
Personnel is not enough supported in order to use new system properly (16)	Personnel is not enough supported in order to use new system properly (12)	Company is not successful in getting disciplined use of the system in the beginning (16)
Poor choices of project management and/or project team (16)	Supplier is not committed enough to system implementation (12)	Top management is not giving enough support / resources to project (16)
Disciplined use of the system (data entry) is not achieved (16)	ERP project disturbs 'normal business' (12)	Connecting system to other system creates problems (16)

<b>Assessed risks in the use and maintenance phase (top six list of risks)</b>		
<b>COMPANY A (15 risks)</b> <b>AVER: 10,40 STDEV: 4,39</b>	<b>COMPANY B (13 risks)</b> <b>AVER: 10,00 STDEV: 5,13</b>	<b>COMPANY C (14 risks)</b> <b>AVER: 9,90 STDEV: 4,40</b>
System not used in a disciplined manner (16)	System not used in a disciplined manner (20)	System makes operations too stiff and this weakens key workers motivation (20)
System does not support the new ways of working and changes in business (16)	System is not felt as helping the business (16)	Company's operations become too dependent on the system (16)
All needed information is not entered into the system (16)	System creates data security risks (15)	System not used in a disciplined manner (12)
System not easily developed (12)	Company's operations become too dependent on system (12)	System not easily developed (12)
Broad use of the system on the worker level is not started in the beginning (12)	Only part of the system used and benefits not realized (12)	Broad use of the system on the worker level not started in the beginning (12)
Only part of the system used and benefits not realized (12)	System does not support new ways of working and changes in business (12)	System not felt as helping the business (9)

## Paper V

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

Inka Vilpola  
*Institute of Human-Centered  
Technology*  
*Tampere University of  
Technology*  
Inka.Vilpola@tut.fi

Ilkka Kouri  
*Institute of Industrial  
Management*  
*Tampere University of  
Technology*  
Ilkka.Kouri@tut.fi

Kaisa Väänänen-Vainio-Mattila  
*Institute of Human-Centered  
Technology*  
*Tampere University of Technology*  
Kaisa.Vaananen-Vainio-  
Mattila@tut.fi

## 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.

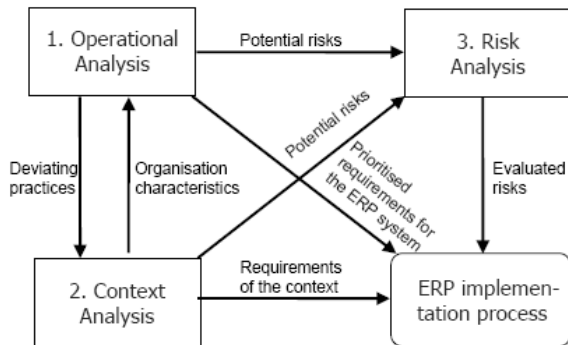
The companies should first analyze what is their main source of profit [6]. Then they should decide which of the deviating processes from the ERP system's point of view should remain, and which are changed according to the ERP system's logic. Only then will the companies be able to select an ERP system 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.

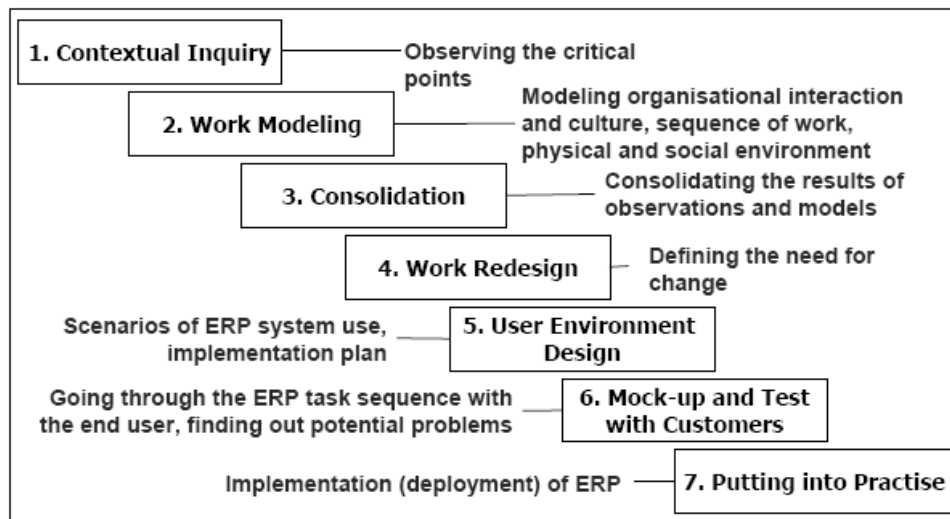


Figure 2. Contextual Design method [4] applied in C-CEI.

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.

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## **Paper VI**

Vilpola, I. (2007), A method for improving ERP implementation success by the principles and process of user-centered design. *Enterprise Information Systems (EIS)*, Vol. 2, Issue 1, Taylor & Francis, pp. 47 – 76.

# A method for improving ERP implementation success by the principles and process of user-centered design

INKA HEIDI VILPOLA

Tampere University of Technology

P.O.BOX 589,FI-33101, Finland

Phone +358 40 577 6308

Fax +358 3 3115 5532

Email: Inka.Vilpola@tut.fi

## Abstract

Enterprise resource planning (ERP) systems are implemented to increase the productivity and operational efficiency of companies. However, the implementation activities and changes within operational processes poses a temporary threat to productivity. Reported difficulties in implementation projects frequently relate to organizational and human-centered issues, like the ability and motivation of the organization to accept the new ERP system.

User-centered design (UCD) is a multidisciplinary process that aims at improving human working conditions by early user involvement in the system design, e.g. user observation or usability testing. UCD was originally developed for the design of interactive computer systems. The underlying question for this research is how the principles and process of UCD can be applied to ensure the usability of an ERP system. This article presents, first a literature review of ERP implementations, second a literature review of UCD applications, third a method to combine the UCD and ERP system implementation processes, and finally a discussion of the UCD approach for ERP implementation.

*Keywords:* Enterprise Resource Planning; ERP; User-Centered Design; UCD; ERP implementation; implementation model; UCD process

## 1.Introduction

Commercial-Off-The-Shelf (COTS) type ERP systems are considered to offer best practice for business processes. A well-known paradox is that the companies implementing ERP systems may actually lose their competitive advantage when they reengineer their processes to align with those of the ERP system (Ptak 2003). Thus, one of the main issues when selecting and implementing a COTS-type ERP system is to strike a balance between the organization's and the ERP system's adaptation requirements (Luo and Strong 2004). To some extent the COTS-type ERP systems are technically reliable, and the risks of technical problems in ERP systems have decreased. Thus, when ERP implementation critical success factors (CSFs) or risks are studied, (e.g., Somers and Nelson 2001), the main finding is a strong influence from the various key implementation players. For ERP implementation key players, such as IT personnel, project team and end-users, such a large combined entity is difficult to manage.

Boonstra (2006) makes the following observation: ‘ERP project is a complex cocktail of rational assessment mixed with various perceptions, quests for power, leadership and subtle processes to gain support for further progress of the project’. ERP implementation projects are considered difficult and risky, firstly because the project is large in scale and secondly because it causes changes in the individuals’ tasks. For example, the tasks and roles of the personnel are changed because the ERP system may automate some of the tasks or the system may require new work routines. ERP implementations have often been reported from the management point of view (Davenport et al. 2004, Boonstra 2006) and without attempting to affect the success of the implementation. However, success factors and risk lists from ERP implementation case studies indicate that a new, proactive implementation method could reduce the risk and enhance the success factors. The method should bring together implementation stakeholders throughout an organization to jointly design activities and evaluate results. The method should cover implementation stages from before the selection of a system until operational efficiency overtaken the level preceding implementation. Moreover, the method should enable the organization to continuously improve the implementation activities through to continuous evaluation of results.

Even though a COTS-type ERP system is not designed from scratch, the system modifications and work processes for a particular company are designed or redesigned during the implementation. In considering the benefit of ERP system implementation for the business of the company, the focus should be on the usability of the system. User-centered design (UCD) (ISO 13407 1999) is a process that focuses on the requirements of both users and the organization. UCD aims at improving the usability (ISO 9241-11 1998) of the system by early user involvement and continuous iteration in phases such as user requirements gathering, designing of solutions, and evaluating design against the requirements. Congruence between objectives of UCD process and ERP system implementation is evident (Figure 1).

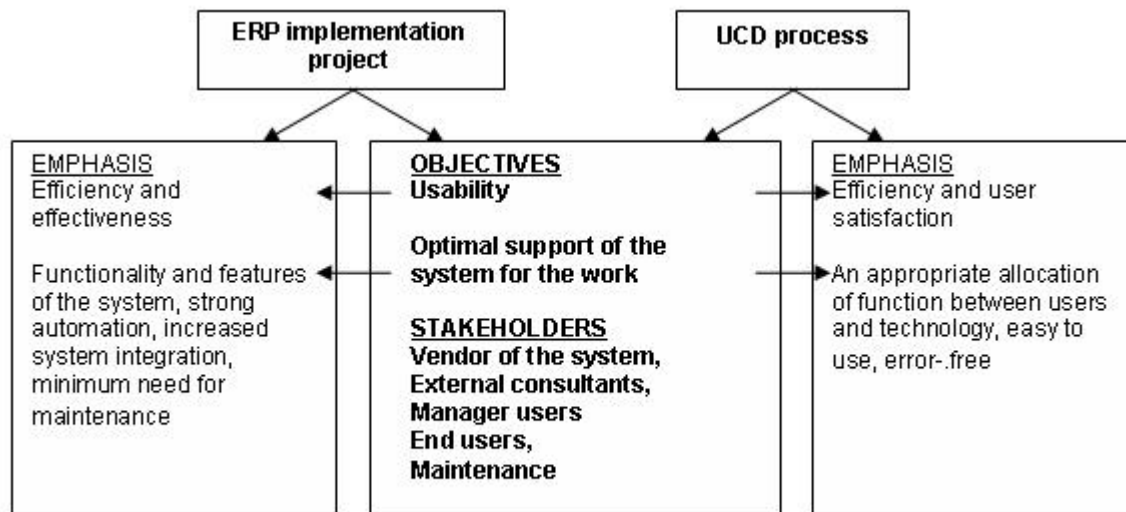


Figure 1. Common objectives of ERP implementation and UCD process applied in ERP implementation.

ERP implementation has various key players depending on the stage of a project (Kumar 2003). For example, external consultants have an important role in the early stages of implementation, but the contribution of manager users and end users is crucial for the success of the system in everyday use. The challenge is to have

shared understanding, objectives and activities during the implementation. One way to support the productive cooperation and communication among stakeholders is to use a predefined implementation approach such as a UCD process, during the implementation project. UCD has the potential to systematically reduce the known risks and support the appearance of critical success factors in the EPR system implementation. This article presents a method that combines UCD process in ERP implementation.

The next section reviews ERP system implementation and related issues. A theoretical background of usability and user-centered design processes together with actions and applications is presented after the next section. A novel model of applying UCD process in ERP system implementation is then presented, and each phase is described with actions and examples. The Discussion reviews research activities where a user-centered approach is being adapted in ERP system implementation. The Conclusions present the main points of the proposed process, and the directions for further work.

## **2. ERP implementation, project challenges and risks**

The reasons why companies implement ERP systems vary. They can be anything from replacing old inadequate and fragmented legacy systems to aspiring organizational changes for improved efficiency (Davenport 2000). Reasons are both technical and business originated (Markus and Tanis 2000). On the one hand, savings ought to be achieved from automating the tasks, rationalizing the data, changing the processes, changing the organization, and decreasing the inventory. On the other hand, revenues are expected to increase because of improved customer service, eased business growth, and by better data being provided for decision making. Some companies are subcontractors and the need for such a system comes from their client. The Y2K phenomenon was a great driver for ERP markets and European countries had Euro conversions around the same time. To gain an understanding of these unique projects, researchers have designed models of them (Markus and Tanis 2000, Rajagopal 2002, Parr and Shanks 2000b). Though the models differ in the number of implementation stages involved and in the level of abstraction, they are useful in analyzing and managing the overall complexity.

ERP systems that are available in the market are mostly ready-made software packages, and thus the implementation ought to be a simple installation or system replacement. However, ERP implementation projects are considered difficult and risky. The strategic decision to start the ERP project affects everyone in the organisation. First, the project is large in scale, and second, it causes many changes in the work inside a company. Such large system integration is hard to manage for the maintenance personnel and hard to understand for the users. For example, the tasks and roles of the users are changed because the ERP system may automate some of the tasks but the system may also require new work routines. The topic of implementation has bothered researchers, because so many failures have been reported in news and magazine stories (Botta-Genoulaz et al. 2005). The focus, therefore, has been especially on *critical success factors* (CSFs), and their opposite, risks. In this section the fundamental issues of ERP system implementation and, ERP projects are considered from the perspective of the company applying the ERP.

### **2.1 ERP implementation models**

Enterprise resource planning (ERP) systems are mostly Commercial-Off-The-Shelf (COTS) products that companies implement to integrate their information systems and harmonise their business processes. The implementation of ERP system has various phases or stages depending on the source, (e.g., Parr and Shanks 2000b). Most often implementation studies refer to the four step model introduced by Markus and Tanis (2000). The model is rudimentary and includes only four stages: project charting, project configuration,

shakedown, onwards and upwards. However, the model describes clearly the amount of preparative work needed before the system is in use and the crippling effect of the system when it implemented for the first time taken.

A more refined model is presented by Rajagopal (2002), who applies Kwon’s and Zmud’s earlier results (1987). The model has six stages; initiation, adaptation, adoption, acceptance, routinization and infusion. The model is iterative and therefore describes well the perceived use of an ERP project as on-going activity (Davenport et al. 2004). The first three stages analyze especially COTS-related activities like vendor selection, customizing the system, and business processes in order to achieve an optimal fit between them.

A more accurate model is described by, for example, Mäkipää (2003). The model is based on previous models and articles of ERP implementation. Mäkipää’s model has 8+2 stages, and presents alternative implementation paths (Figure 2). For instance the redundancy of business process reengineering (BPR), ERP system modification and enterprise data conversion illustrates the simultaneously on-going activities in ERP system implementation. Also the roll-out alternatives, big bang, incremental and phased, are included in the model. Moreover, the model has iteration embedded in various parts of the process. The configuration of the ERP system in the modification stage is iterative and so also is the last stage of the model “*Exploitation and development*”.

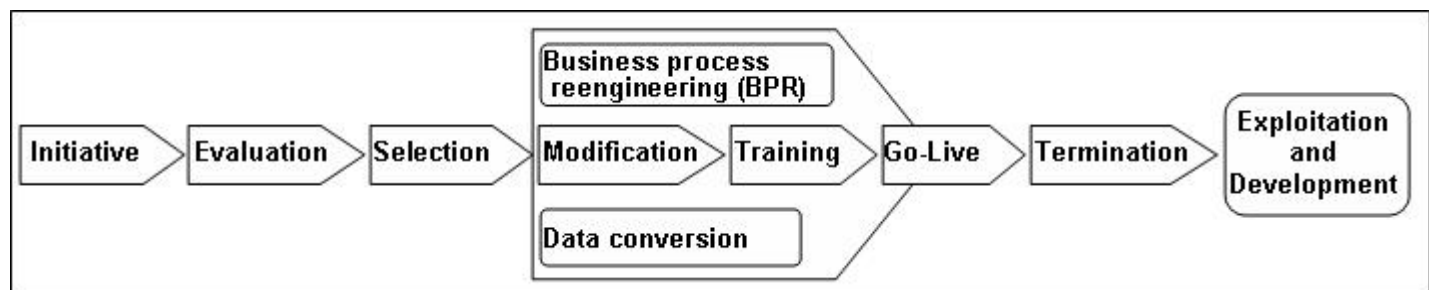


Figure 2. Model of ERP implementation (Mäkipää 2003).

*Initiative* is the trigger for the ERP project. According to Shebab et al. (2004) indicators like increased inventories, imbalance of stock, no systematic operations, poor customer response levels, relatively high costs compared to competitors and inefficiency of operations may suggest the need for an ERP system. The reason to invest in an ERP system can also come from outside the company. *Evaluation* is about processes and requirements for the ERP system inside a company and ERP system vendors and products available in the market (Mäkipää 2003). *Selection* is always a compromise between reasonable price, available products and services and the requirements of the company investing in the ERP system. Selection criteria may be different for large and small companies. Bernroider and Koch (2001) collected 29 different ERP selection criteria using a Delphi method for 138 Austrian companies (116 large ones) and evaluated the importance of each criterion. Large companies specially seek good support and process improvement, whereas small and medium-sized companies look for adaptability and flexibility of software.

After the system is selected, but before it can be used, it has to be *modified* and users *trained*. Modification can be tailoring at the code level, when the vendor does it at extra cost (Brehm et al.2001). Otherwise the company can modify the ERP system itself by changing parameters and configuring the system (Brehm et al. 2001). Luo and Strong (2004) present a framework of an ERP system and process customization choices. The ERP system customization options and process customization options form a matrix that covers all cases. Connections to other systems can be made at this stage or also later on. At the same time, a great deal of

enterprise data, such as customer, product, operational, financial and subcontractor information, must be transferred into the ERP system's database in order to continue to run the business with it. Furthermore, changes in operations, *Business Process Reengineering (BPR)*, have to be conducted so that the new system is used by the new processes. Training is crucial for the system's usage. In some cases, training is the first time end-users see the system at all (Vilpola and Väänänen-Vainio-Mattila 2005). ERP consultants also considered the training as one of the most crucial step in an implementation, because users are going to manage the new system on daily basis (Palomino Murcia and Whitley 2007). *Go-live* can be carried out as 'Big Bang', Incremental or phased, of which 'Big Bang' resulted higher user satisfaction levels than phased implementations in a study of 35 European production companies (Botta-Genoulaz and Millet 2005). Obviously, previous phases like modification, BPR, data conversion and training always precede every go-live phase if the system is launched either incrementally or in phases.

The model (Figure 2) nicely ends with the *termination* phase, terminating the tasks. At least in theory, the project success is evaluated, lessons learned and analyzed and the project team re- or back-located (Mäkipää 2003). In practice however, Davenport et al. (2004) found no complete implementations in their study of nearly 200 organizations. Research indicates that, instead of regarding implementation as being complete, companies were implementing ERP system functionality as a continuing process. Typically, roles related to BPR or project implementation, like process owner or power user, remain after implementation. The personnel who have created the product structures in the ERP system's database continue with updating structures after the project has been implemented, even if their main assignments are elsewhere. *Exploitation and development* involves everything, other than daily use. It includes, for example, maintenance, adaptation of new modules, training new users and developing new ways to utilize the ERP system.

In order to gain full advantage from the system, Willis and Willis-Brown (2002) encourage enterprises to actively improve their ERP system utilization after the Go-Live phase. In the first step enterprises should stabilize and audit the new system. In the second step they should continue process reengineering and functionality addition. Finally, in the third step, they should extend and integrate legacy and other third party solutions. Botta-Genoulaz and Millet (2005) formed a three-step ERP system use optimization process. The steps, operational, tactical, and strategic use, depend on the maturity of software and its strategic deployment. The efficient use of the ERP system is one of the factors for companies in achieving their business objectives.

This was an ideal model of linear implementation with no obstacles and the use of unlimited resources. In the next section, the challenges of ERP system implementations are described on the basis of previous studies. The decisions that need careful consideration are discussed objectively and ERP implementation risks are briefly reviewed.

## ***2.2 ERP Implementation Challenges and risks***

Major ERP implementation challenges are the *size and scope* of the project. Parr and Shanks (2000a) have categorized ERP implementations according to physical scope, business reengineering scope, technical scope, module implementation strategy, and resource allocation. They divide implementations into three categories: Comprehensive, Middle-road and Vanilla, in which the comprehensive is the hardest with respect to its scopes and needs for resource allocation. For example, comprehensive implementation can last over 4 years, cost over \$A10M, and its physical scope can be world wide in a multi-national company. In contrast, the vanilla-type implementation may last only 6-12 months and cost \$A1-2M.

The biggest challenge might be the compromise between the company’s requirements for the ERP system, and ERP system’s requirements for the company to adjust their operations accordingly (Figure 3). The key question is: which one bends; the organization or the ERP system (Luo and Strong 2004). An organization requires a system that fully supports their business processes, and is easy to use and maintain. The system should also be flexible in exceptional cases, such as when one component of a product order is sent to a customer after the main consignment is dispatched. Initially ERP systems, before tailoring, require predefined processes and consistent behaviour, such as on-time accurate entering of production data and keeping to specified production times.

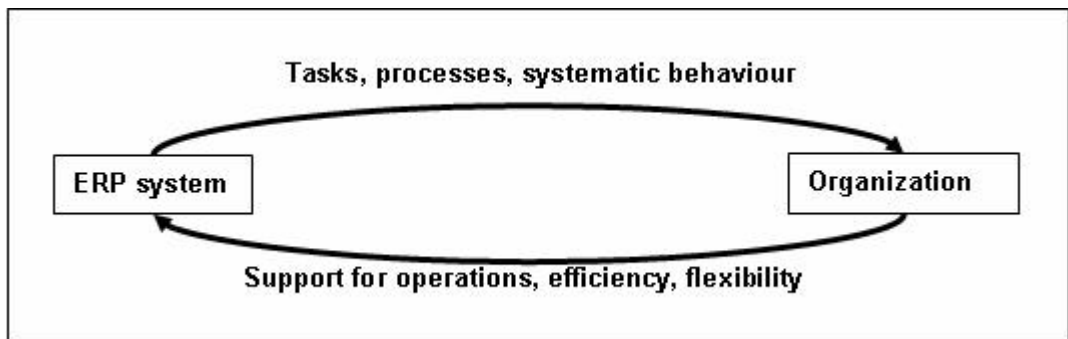


Figure 3. The Organization sets the requirements of the ERP system, but the system requires the company to reengineer business processes (Kawalek 2002).

ERP system implementation ties up a substantial number of human resources, especially at company management level. Naturally the production or customer services must be maintained at normal levels as much as possible during the project. Some companies solve this by an announcement of on-going implementation to their customers and others have increased the level of products in the stock.

A challenge is a potential source of a risk. ERP implementation projects and IS projects differ: in an IS project, the system is designed to meet the organization’s requirements, but in ERP implementation, the organization instead adjusts its way of working to fit the system (Markus and Tanis 2000). Sumner in her study (2000) makes a comparison of project risks in a traditional IS system and an ERP system. In case studies of seven ERP implementations, she summarizes 19 risk factors (Table 1), of which 9 were shared in common with IS project risks reviewed from the literature. Fortunately, the ERP implementation risks are thoroughly elucidated elsewhere, as they are studied from multiple points of view; ERP vendor’s (Taylor 2005), risk managements’ (Zafiroopoulos et al. 2005), firms’ that specialize in ERP system evaluation and testing (Wright and Wright 2002), companies’ that have various levels of IS management capability maturity (Ojala et al. 2006).

Table 1. Risk factors in ERP projects (after Sumner 2000)

<b>Risk type</b>	<b>Object</b>	<b>Uniqueness to ERP</b>
Lack of	Combined business and technology competence	X
	Recruited qualified ERP systems developers	
	Senior management support	
	Proper management control structure	
	A champion	
	Integration	X
	Full-time commitment to project management and project activities	
	Sensitivity to user resistance	



Failure to	Redesign business processes	X
	Follow enterprise-wide design which supports data integration	X
	Mix internal and external expertise effectively	X
	Adhere to standardized specifications which the software supports	X
Insufficiency in	Emphasize reporting	
	Build bridges to legacy applications	X
	Training and reskilling	X
	Internal expertise	X
	Effective communication	
	Training of end-users	
	Avoidance of technological bottlenecks	

The risks, when realized, hinder the use of a system, and first and foremost prevent the company achieving the objectives of implementation. Noteworthy is the fact that many of these risks depend on stakeholders such as project managers, champions, software developers, business analysts or external experts. Results are reported in post-implementation case studies of human factors in three ERP system implementations (Vilpola and Väänänen-Vainio-Mattila 2005)

For identification of ERP project risks Vilpola et al. (2007) suggest a company-specific approach. The risks are identified during operational analysis and contextual analysis. In the operational analysis all the processes and tasks, i.e. operations, are examined in group interviews of personnel. Contextual analysis is based on observation of the workers and groups working with them in order to find the organizational requirements for the ERP system. Although the use of common risk lists, like Sumner's (2000), could save risk identification time and resources, company-specific risks might be neglected. Companies with limited IS management capability maturity seems to have more company-specific risks than those having a higher level of such maturity (Ojala et al. 2006). The potential threat to a company's ERP project may lie in a failure to identify company-specific risks if the company considers only the common risk lists.

***Critical success factors of ERP implementations***

If risks describe the worst case scenario in project implementation, lack of them does not guarantee success. Some of the risks are the obverse of critical success factors, CSF's. For example Somers and Nelson (2001) reported 22 ERP implementation CSFs from an extensive academic literature review and a study of over 110 cases from the popular literature. Furthermore, 86 senior level IT executives evaluated each factor's importance for the implementation. The top ten CSFs are: Top management support, Project team competence, Interdepartmental cooperation, Clear goals and objectives, Project management, Interdepartmental communication, Management of expectations, Project champion, Vendor support, Careful package selection.

Human factors in ERP implementations are considered to include three fields; 1) organization, its culture and context of use, 2) ERP implementation key players, and 3) usability, e.g. fluent work processes of ERP users (Vilpola and Väänänen-Vainio-Mattila 2005). Most of the top ten CFSs are directly related to human factors. Management of expectations relate to these since only humans have expectations, but the means of managing expectations can be the arrangement of meetings or production of materials on the topic. Package selection is also decided by humans, but different tools and methods can be used in the selection process. For example, Ncube and Maiden (1999) present a PORE approach, which is a combination of COTS software selection process model, method box, and product model with semantics and syntax for modelling the COTS software.

PORE helps in the selection of a COTS system. The process starts with requirements information acquisition and ends with the selection of a COTS product.

Amoako-Gyampah (2004) was inspired to study the differences in success factors between managerial-level employees and end users. The case study concerned large-scale SAP r/3 ERP system implementation of a company with over 20,000 employees around the world. The study was conducted by sending 1562 questionnaires to the employees. Questions were structured into one to seven Likert scale questions. The 571 returned answers included 167 user managers and 408 end users. Based on the literature of technology acceptance, the differences between the two groups of seven factors were tested. Seven factors were: arguments for change, ease of use, personal relevance, satisfaction with technology, training, communication and shared beliefs. The results showed that managers have a better understanding of the rationale of implementation and they are more satisfied with the technology. Managers also perceived the communication mechanisms to be more effective than end users. However, Ifinedo and Nahar (2007) did not find differences in how business managers and IT professionals prioritize and evaluate the ERP success measures.

These studies together reveal a severe challenge for the implementation activities. Not only should the emphasis on human factors and especially in the communication and managerial issues be noted, but the differences between user groups in the content needed and the mode of interactions should also be noted. An essential part of both risks and CSFs are related to personnel, organization, users and their motivation, attitude and skills. In other words, the question is about non-technical issues. Therefore new methods are needed.

### **III User-Centered design: principles, process and activities**

User-centered design (UCD) is “*an approach to interactive system development that focuses specifically on making systems usable*” (ISO 13407 1999). Usability is defined as efficiency, effectiveness and user satisfaction with the system (ISO 9241-11 1998). The aim of a UCD process is to make the systems support users’ tasks and motivate them to learn the system which is being designed. From this it follows that the productivity and quality of work increases, and the costs of training and maintenance decrease. ISO 9241-11 presents product standard, whereas the ISO 13407 presents process-oriented standard (Earthy et al. 2001). Another standard, associated with UCD processes, is ISO TR 18529 (2000) that elaborates ISO 13407 by assessing the capability of an organization to perform user-centred activities (Earthy et al. 2001). A third UCD process model is presented by Jokela (2002). The model categorized two parallel processes: usability engineering and user interaction design. The model, therefore, fits the design process of an interactive product. Here UCD applies to the standard ISO 13407 (1999).

UCD has its principles and its processes and it provides a complementary user-centered perspective to existing design approaches, such as object oriented design (OOD) (Wieringa 1998). The role of UCD is to specify and analyse how users would optimally use the system in their real context of use, and then design and evaluate the system accordingly. In order to identify the user requirements and refine them into design, the use of usability methods are recommended. Multiple usability methods, e.g., interview, survey, task analysis and focus groups (Courage and Baxter 2005), can be used for the purpose. Some of the methods are very general, such as interviews and some are specific, such as a contextual inquiry. The aim, however, is to bind the use of usability methods and their results within the UCD process. In this section the principles and process of UCD are described and examples are given.

### *3.1 Principles of UCD*

User-centered design has four major principles that characterize the approach. The aim, in general, is to provide and integrate a human-centered perspective into design processes (ISO 13407 1999). The four principles are:

1. Active involvement of users
2. Distinction of users' tasks and the function of technology
3. Iteration of design solutions
4. Multidisciplinary design

User involvement is the key issue of user-centered design. Preece (1994, p.46) states that the principles of human-computer interaction design should involve users as much as possible. Basically, the involvement can be realized either in the way that designers meet users in the context of use, or the user participate in the design team in order to bring up their ideas for the design. Especially important is that users are involved in the evaluation phase and test or comment on the design. Real users are needed because their mental model varies from that of the designers'. However, involvement is an ambiguous term as Kujala (2003) observes in her review article. It has been used to cover the fact that the focus is on users, that users are consulted or that users actually participate the activity. A very small nuance in words, but it makes a difference in practice. In the case of UCD, the 'active involvement' should be interpreted as direct contact and common activities such as workshops, interviews or testing in which users participate.

Designing a system is more about designing tasks than designing of single displays. A task is a logical sequence with a trigger that starts the sequence, with alternative paths to perform the task and ends when the task is either interrupted or completed. A desired outcome or condition can also be predefined. In the case of an interactive computer system, a part of the user's task is performed by the system. An approach which is not recommended is to allow the system to do whatever it is capable of and then leave the rest to the user. Rather than this, the UCD design should be governed by "the importance of successful or timely accomplishment of tasks and user well-being" (ISO13407 1999) as well as factors relating to technical attributes and human capabilities. The main goal is to design user's tasks to be meaningful for the user, and then support them by functionality of technology.

In UCD, the design ideas are evaluated against real world scenarios before they are accepted as part of the system. The goal of iteration is to ensure that both user and organizational requirements are met. Evaluation of the design can be performed by users in, for example, user tests, or experts can evaluate the design in walk through sessions. The iteration means that the results of the evaluation are not simply applied to the new design but at first, the user and organizational requirements are specified in more detail. For this reason the design remains user-centered.

The design team should integrate both the knowledge and the expertise in pragmatic realization of UCD. The design should involve consideration of what the system is used for and how the system works and, hence, a variety of roles is included in the design team, e.g. user researcher or interaction designer. User researcher may focus on defining the user groups and specifying their needs, whereas interaction designer focuses more on the system side, e.g. interaction logic, user interface controls and indicators. In addition to traditional software and technical designers, the team needs representatives from any user organizations. They can represent, for example, the roles of salesmen, foremen or production planners regarding the type of system that is designed.

The principles of UCD guide the design focus towards both the users and their tasks. A design project plan should be checked to ensure that all the principles are included. If some principle is ignored the possible effects should be analyzed in advance, and corrective action should be taken when possible. However, the easiest way to ensure the design follows the principles of UCD is to plan the design project according to UCD principles in the first place. In the next section the UCD process is described at operational level.

### 3.2 UCD Process

The UCD process consists of four activities that are iterated until the design meets the requirements (Figure 4). The purpose is to plan the activities in such a way that iterations can be carried out. The process definition supports the setting of milestones for the design process. Clear definition of activities helps to allocate the necessary resources for each activity and to prepare for the involvement of appropriate users. Attention should be paid to transitions between activities, such as how the user and organizational requirements are turned into as design solutions and how the design is evaluated in the most suitable manner, while also bearing in mind the principles of UCD.

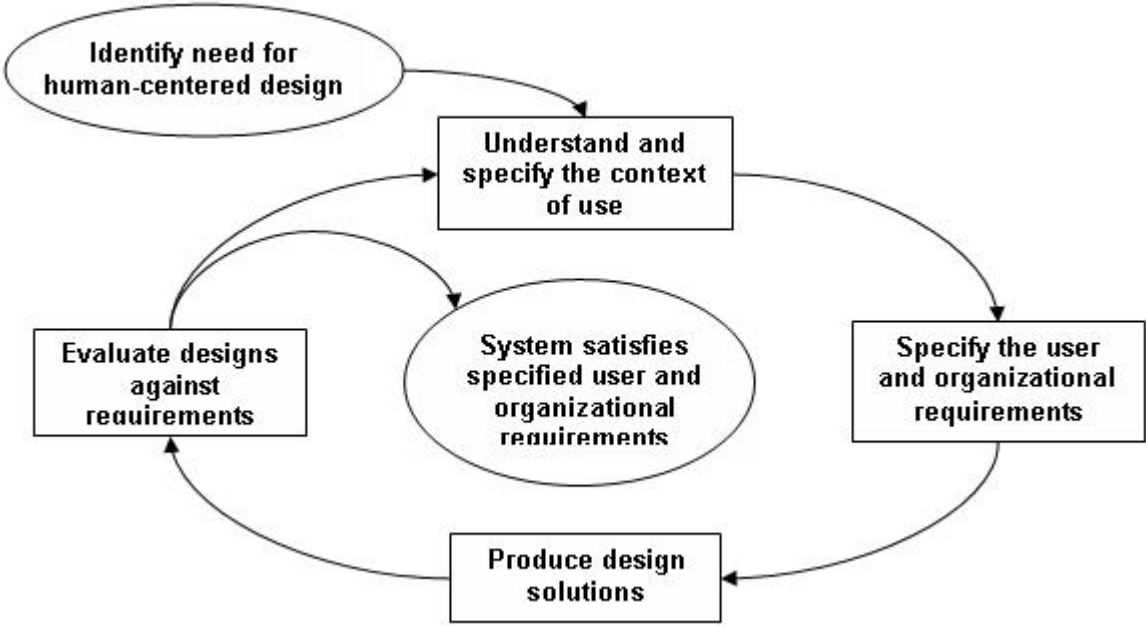


Figure 4. User-centered design activities (ISO 13407 1999)

The entire UCD process is triggered when the *need for design is identified*. The signal can be, for example, decreased sales of a product, or a need for new features in the system. At first, the designers need to *understand the context of use*, i.e., users, their tasks, the devices, and the social and physical environment (ISO 13407 1999). This understanding is best achieved by observing the user environment and operations in context. Analyzing the context identifies requirements that would not otherwise become evident in the designers’ office. For example, the designer of an electronic cashier located on buses can easily overlook the reality of the haste and stress as users wait to pay their fares. The documentation of the context of use should include users and their characteristics, their roles in the system, their tasks (frequency and duration), the goal

of using the system, the order of the tasks in the overall procedure the environment (hardware, software and material), and the physical and social surroundings.

In the next phase the *knowledge of the context is transferred as user and organizational requirements*. For example, if the task is mobile and routine, such as collecting orders for a product from stock, the requirements would be the following: wireless system, real time connection for the inventory data, order based view and easy and fast used interface. The requirements can be functional as well as non-functional. In certain cases, like usability, which is one of the main objectives of UCD, it would be misleading to label it merely as a non-functional requirement. (Leffingwell and Widrig, 2000, p 238). Usability requirements may also include functionality, such as a requirement of showing confirmation dialogues in critical actions or consistent consequences when a Cancel function has been selected (e.g. Nielsen 1993). In UCD, the requirement specification is expanded to include the context of use. For example legislation, communication, users' jobs, change management, training and maintenance are considered. The requirements provide measurable criteria to be used in design evaluation purpose. Iteration occurs on a small scale inside the requirement specification phase, when users or their representatives comment on or confirm the requirements and their criteria. The result is a well-documented requirement specification that stimulates the design together with a description of the context of use.

In the design phase, a multidisciplinary team is needed in order to provide versatile ideas. At the beginning, a number of different versions should be considered, instead getting stuck on the first idea. All kinds of means can be used for *presenting the design for users and the team*. Prototypes, for example, are suitable ways to present even rough ideas. Prototypes can vary in their size, shape, material used, scope, refinement, functionality, data model, reliability and adjustability (McCurdy et al. 2006). The best feedback is provided by the actual users, and therefore they should be allowed to simulate tasks with the design as early and often as possible. Repetitive iterations of designs and prototypes may easily detract attention from the actual requirements. For this reason the design solutions need managing. Every requirement should have a corresponding feature in the design, and every function should be traceable back to the requirements. The ideal design fulfils the requirements, but exceeds them only by non-functional features such as e.g. reliability. Reasons for accepting and rejecting solutions are documented to avoid repetition of already rejected ideas which might change a successful concept.

The design should, by and large, take all stakeholders into account. In addition to users, stakeholders include people who pay for the product, people who maintain the product, and those who gain some secondary benefit from the use of the product. For instance design of a product includes designing the installation procedure, usage, maintenance and disposal. In order to simulate the design solution, various techniques can be used. Different stakeholders can be taken into account by producing e.g. use cases of typical activity of the user group. For example a use case of maintenance personnel could include software installation for the stand alone computer and for the client computer via a network. In a more detailed simulation, ERP system configuration can be designed. This may also include user interface design actions such as renaming the labels, rearranging objects, or hiding unnecessary functions in the software.

An evaluation phase is needed to test that the design objectives have been met. In early stage of design the evaluation can be done with paper prototypes and mock ups in order to have feedback for the design. When the iteration continues and the product is about to be designed, the evaluation can be done against the user and organisational requirements. Again, evaluation of ready-made products can serve as long-term monitoring in order to collect data of usage for the production development process.

The UCD process seems never ending as the design may never fulfil all the requirements. However, there are external restrictions that guide the process towards its end. Project schedule limits, for instance, when a product needs to be released on the market, or previous systems may come to the end of their life cycle. The evaluation criteria can be selected by prioritizing the requirements so that the UCD process ends without a design that meets all the requirements. Another aspect of UCD, which affects the system usage, is following the principles. Despite not covering every requirement, the user involvement and design iterations increase the system acceptance and decrease user resistance by committing users to the system designed with their input.

### ***3.3 UCD and usability methods***

UCD is a process or framework for design activities that follow UCD principles. Practical methods are needed in order to carry out the process. For example, the standard ISO DTR 16982: Usability methods supporting human-centred design (2001), is a report of methods that can be used with the UCD process (Bevan 2001). Courage and Baxter (2005, p.21) present multiple methods in their book of practical UCD. For example interviews, surveys, wants and needs analysis, group and card sort, group task analysis, focus group and field visits.

Mayhew (1999, p.12) introduces a work reengineering method that aims at "realizing the potential of automation and more effectively supporting business goals, yet minimizing retraining and maximizing productivity". According to Mayhew the current user work is modeled at the outset. Next the model is changed. Changes in the model are iterated with users, for example, with card sorting, task scenarios or walkthroughs.

Mao et al. (2005) report a survey of 133 UCD practitioners from USA (60%) and Europe. Their analysis shows that methods like field studies, iterative design, usability evaluation, task analysis and informal expert review are widely in use. On the other hand, the methods are judged according their cost-effectiveness. Although the UCD is recognized as a key to useful and usable products and complement to traditional system-centered design, UCD still lacks measures of its effectiveness.

Kiris (2004) iteratively developed a web-based online billing system. In the design work usability methods such as prototyping, interviews, usability testing and heuristic evaluation were used. A human factors person worked in the software development project team. The biggest challenge was to choose such methods that a tight release schedule could be met. Usability testing is utilised in multiple ways. During the test quantitative data on mouse clicks were collected and users were also asked, in a survey, to rate the applications on various usability factors. Afterwards a group of test users were invited to freely discuss the application.

Macleod et al. (1997) describe the performance measurement method and its use. The focus is on effectiveness and efficiency of use in order to increase, for example, productivity of work. The method covers both qualitative and quantitative measurements. The method was developed particularly for usability engineering of interactive systems. In the development of the method the industrial limitations of timescale and costs were stressed and thus the focus was on engineering instead of research.

Edwards et al. (2003) have applied user-centred design and evaluation for the context aware infrastructure software that supports construction or operation of other software. They also used UCD for designing a file system. However, in both cases the lesson learned is to focus only on those features under design.

Infrastructure is usually evaluated by criteria of performance, scalability, security, robustness, and so on, but in their study the end-user experience was the target of evaluation. However, the usability of infrastructure software is best evaluated when it is used for application implementation within a real context. In order to include such user experience, a substantial amount of effort is needed to build the infrastructure and applications based on it. The amount of work needed for prototyping is too great in comparison to the effort of evaluation. Therefore the authors suggest using lightweight prototypes and allowing the test users to express their views on features not yet included rather than asking them to rank existing features, which they may classify as unnecessary.

The user-centered design process has the advantage that it is standardized and its principles are clearly specified. The range of methods that can be used within the UCD process is also wide and practical examples of their usage exist in the literature. However, the use of UCD is limited by constraints such as budget, timescale, resources and skills. Moreover, the planning for UCD requires assessing the capability maturity of the organization that will implement and eventually use the results of UCD process (Bevan and Curson 1998). The usability capability maturity of the organization includes stages, such as ignorance, uncertainty, awakening, enlightenment and wisdom. When the organizational usability maturity is taken into account and appropriate methods selected for UCD, the process enables design of effective and efficient system and increases the user satisfaction.

#### **IV Method that combines the UCD and ERP system implementation**

Courage and Baxter (2005, p. 17) present a typical argument against UCD: “We are introducing a different process, so don’t waste your time studying the current process.” In their book (Courage and Baxter 2005, p. 17) they state that it is necessary to study current work processes in order to foster what is good in the processes and prevent the continuation of bad practices. In particular, interactions with other sources of data, like data storage, lists, links or even work mates, are focussed on when observing the current state. This prevents, for example, designing of incompatible systems for use in the future. Okrent and Vokurka (2004) note that understanding why the current process is performed in a particular way helps to remove the non-value added phases of the work in redesign activities.

ERP system implementation changes the computer system as little as possible. In most cases, however, the implementation involves changes in work processes and other information systems. Moreover, the ERP system is implemented in order to improve business performance, and therefore using the ERP merely for routine work is not enough. The implementation investment should be fully utilized by continuous improvement after implementation (Zhang and Cao 2002). To support the implementation process and improvement thereafter, a method that combines both the user-centered design and ERP system implementation processes is introduced by describing three UCD focus iterations in ERP implementation process; *UCD in evaluation stage*, *UCD in modification stage* and *UCD in exploitation stage* (Fig 5).

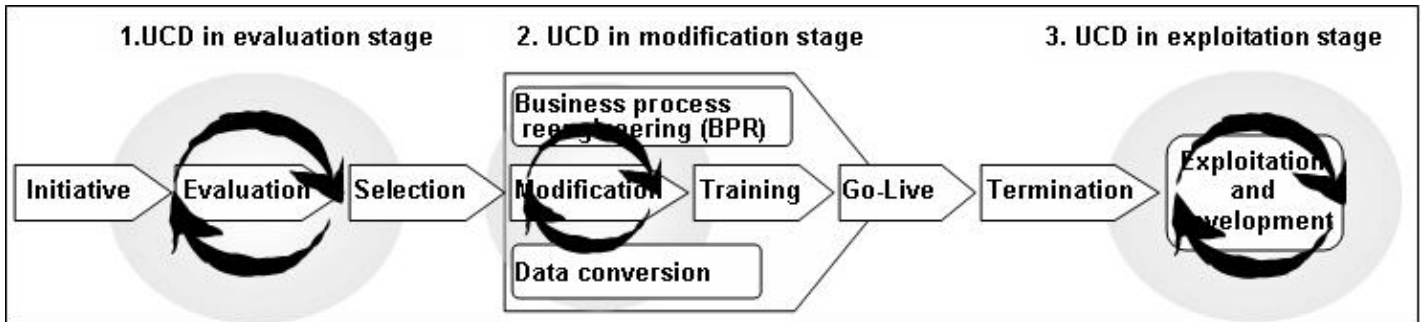


Figure 5. The method that combines three UCD iterations in ERP implementation process

The first UCD process, the UCD in evaluation stage, is for specifying the user and organizational requirements for ERP system selection and implementation. The second UCD process, the UCD in modification stage, refers to designing a balance between the ERP systems requirements for the organizational changes and organizations requirements for the ERP system appearance and performance. The third and last UCD process, the UCD in exploitation stage, aims at improving the business performance to a higher level of performance than before the implementation. This stage is seldom planned separately during implementation and thus receives minor attention, causing ineffective use of expensive investment. In the following sections each iterative UCD process will be explained in greater detail. The phases, participants and activities are explored. User-centred design methods suitable for each phase are proposed and recommended.

#### 4.1 UCD in evaluation stage

ERP systems selection is based on the ERP system requirements. A company needs to choose the best fitting software from the markets. In this case, the examination is restricted to COTS-type ERP systems, which are ready-made software packages and only reconfigured by the customer company. The essential change, compared to traditional UCD process (Figure 5), is that instead making the system from scratch, the ERP system is selected from the existing products. First, the initiative(s) actuate an ERP implementation process (Figure 6.) and a company sets up the ERP project. This includes setting up the steering committee, deciding goals and a preliminary schedule. The next activity is to study and analyze what kind of software the company needs in order to support the business and, consequently, to achieve the business goals set. Without predefined requirements, a company may select an inappropriate ERP system for its operations and business, and therefore lose its competitiveness as well as time and money.



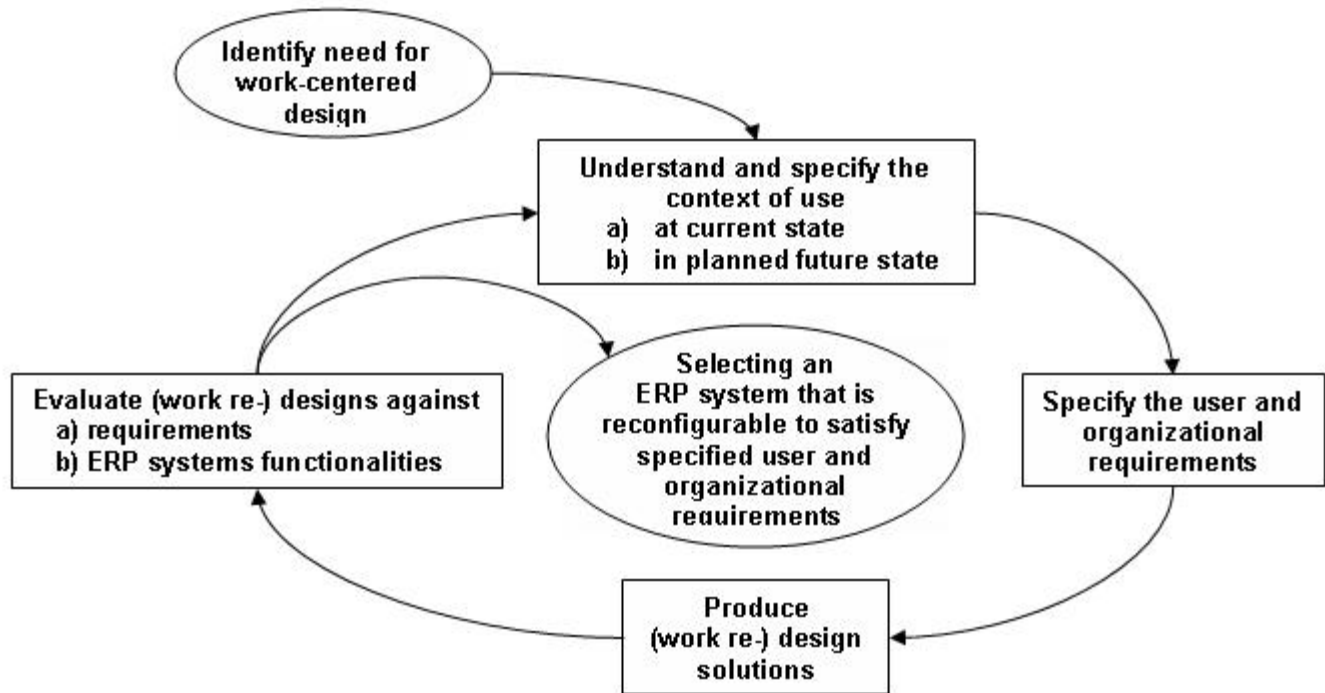


Figure 6. User-centered design process in evaluation phase of ERP implementation. The evaluation is completed before selecting an ERP system.

UCD in the evaluation stage is described as an iterative process (Figure 7.). At first, *the need for work-centered design is identified*. Indicators that help to identify a need for UCD are, e.g., planned changes in work flows, or addition of users who will use the system in their daily work. Similarly, a specific branch of business, like military or charity-related operations, indicates the need for work-centred design. By changing the original term ‘human-centered’ (Figure 6) the intention is to stress the work or task as a focus that affects the ERP system selection. No single end-user’s subjective opinion without relevance to the work should affect the ERP system selection.

The next step in the UCD process is to *understand and specify who will be the users* of a new system and for what are they using it. The physical and social environment is also considered from the system use point of view. Before ERP system implementation the company needs to decide on the scope of the ERP project. This means defining what departments or processes are covered within the ERP system, and thereby who will be the users of the system. This allows the number of users, their organizational positions and their location in the company to be defined. This information is relevant when computer locations, ERP system licenses or training are planned. The target usage also affects the order in which the ERP system needs to be available to each group of users.

After clarification of who to design for, *the user and organizational requirements are specified*. The requirements in COTS-type ERP implementation can consist of system requirements as well as the implementation activity requirements. In the specification phase, the emphasis is on understanding what and, especially, how the workers are performing their tasks in their natural working environment. Various methods to identify user-centered requirements engineering exist, for example, user observation, focus groups, and scenarios of use or task analysis. Scenarios can also be used to illustrate future work with the new ERP systems and to stimulate the users to think what is required from the system in order to complete their

tasks. The challenge for using the UCD method is to ensure that the benefit of the business or rationale of a system investment dominate the opinions of users. Typically the method is used for designing applications with limited focus. Now, however, the method needs to be enlarged to accommodate an enterprise-wide focus involving multiple processes.

*Producing design solutions* in the ERP implementation evaluation phase means defining the target work processes and illustrating how the ERP system should support them. Methods like scenarios, use cases and storyboards can be used. Process diagrams can illustrate the interaction and data exchange between the users and the system. With the diagram, the users can more easily understand their future interactions with the new system. The information that affects the implementation plan, e.g., some of the new users have no experience of using a computer, is analysed and the required changes are added to the ERP project plan. If changes are planned to a currently complicated operation, where multiple workers are involved, such as in quality assurance, the diagrams of the new operation model can be reused in the training phase later in the ERP implementation process. The before and after process flow charts can be presented in parallel to illustrate the amount and type of the changes.

The iterative nature of UCD requires *evaluation of design solutions*. At this stage the solutions are models of targeted business processes and requirements for the ERP system. The evaluation, however, is two-sided. On the one hand, a formal requirements specification document is needed for the vendors, and the documents should, at this point, be iteratively evaluated by the users. On the other hand, the designed work models and processes need to be considered in comparison with available ERP systems functionality (Figure 7.). The iterations of ERP system requirements do not necessarily focus on all requirements in more detail in every round, but various entities like making quotations or planning weekly schedule for production may be handled one at a time. For the evaluation methods like pluralistic walkthrough, card sorting or questionnaires can be used, depending on the form and scope of the design. In an ERP system implementation, the user evaluation also has another meaning. It shows the users in the early stages of implementation what changes have been planned in their tasks. In this way the user evaluation introduces the forthcoming ERP system and lets users express their opinion about the plans. At the same time the user commits to and prepares for the change.

Those parts of the design that do not meet the user and organizational requirements need to be redesigned. Due to the iterative manner of UCD and the ideology of user-centeredness, the redesign has to be started from understanding the context, i.e., the users, their tasks, the devices, and social and physical environment. Normally, the iteration of phases 2-5 of UCD (Fig 5.) are repeated until the evaluation of the process shows that the design meets the requirements. In the case of ERP implementation, other constraints such as those set by COTS-type ERP systems bring restrictions that may require compromises. Yet again, the users are fully involved in the implementation process and are thereby made aware of the need for adjustment between organizational requirements and the ERP system requirements.

#### **4.2. UCD in modification stage**

A business process is defined as “*a set of logically related tasks that use the resources of an organization to achieve a defined business outcome*” (Grover 1995 in Luo and Strong 2004). The definition shows that if the process is reengineered then changes in tasks, resources and/or outcomes occur. In order to prevent or even predict the degree of change resistance, change management is needed. User-centered design is an appropriate environment, in which to have the employees participate in the design of their tasks, and simultaneously to commit the users to the forthcoming change. An ERP system as such seldom totally fits the existing business

processes of a company. In order to have efficient business processes with the new system, a company has either to change its business processes to fit the ERP system or modify the ERP system to fit its business processes (Buonanno 2005).

Business process reengineering (BPR) is one of the ERP implementation scopes (Parr and Shanks 2000a). Davenport (2000, p. 22) recommends that a company achieves better results if they reengineer the processes and support the new processes with new systems all at the same time. Some companies might want to minimize the BPR due to the amount of time and resource needed. However, mostly the BPR is seen as the company’s adjustment for the ERP system’s processes (Parr and Shanks 2000a). If a company refuses any BPR, then again the ERP system has to be modified to fit the company’s existing business processes. Modifications, however, are prone to errors and require extra attention every time the system is updated. In a study by Mabert et al. (2003), 53% of companies that were late had included major modifications of the ERP systems in their implementation versus only 11% of the on-time companies. Modifications may continue even if the system is already in daily use, as in Diehold case presented by Rajagopal (2002).

The UCD in modification stage (Figure 8.), starts by identifying the need for change either in existing business processes or in the ERP system (or in both of them). These two balancing alternatives need to be considered in every phase of the UCD process. In most cases the limiting factors are time and resources. The design modification of ERP system might require capabilities that are impossible to recruit, or the modification is too expensive to put in practice. Alternatively, BPR may require that workers learn skills that are expensive and time-consuming to train. Besides, the skills need to be retrained every time a new worker enters the organization. Data conversion is also relevant within the modification phase of implementation (Figure 6), but it is not included in the UCD in modification stage (Figure 7). Instead, the data conversion (or migration) is considered as a separate activity and discussed in the text.

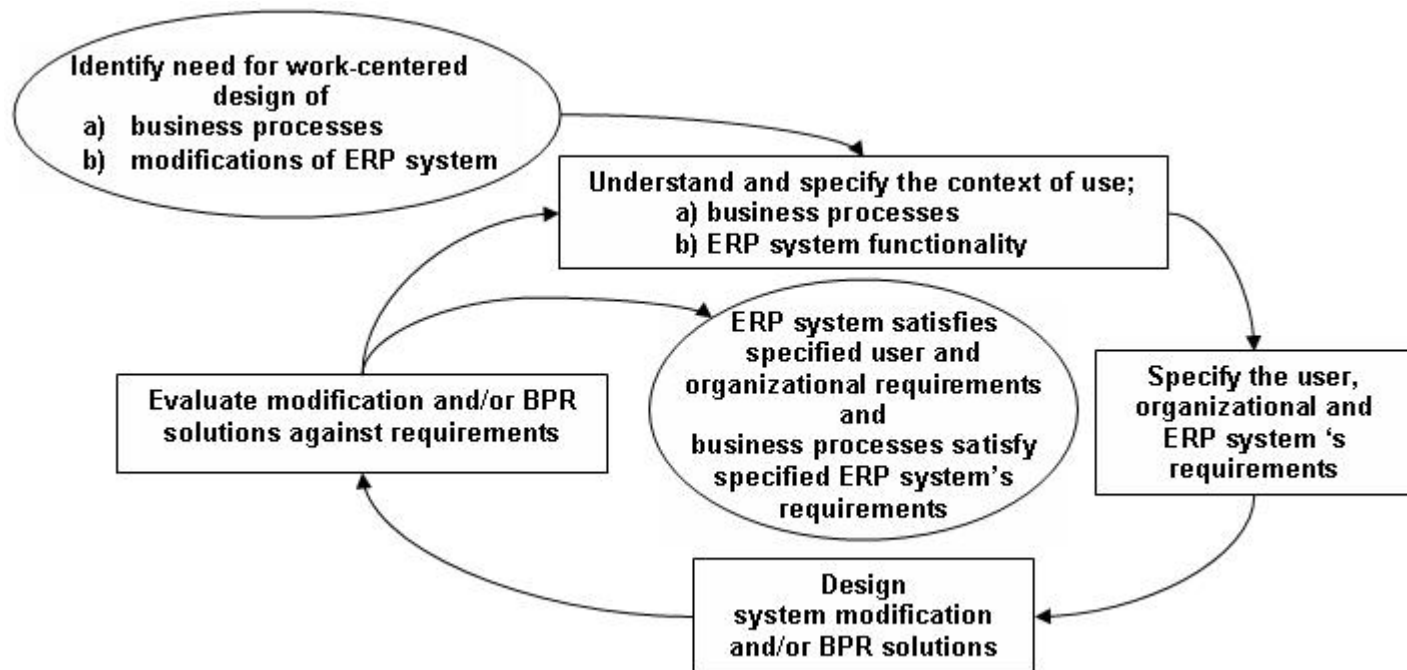


Figure 7. User-centered design process in modification stage of ERP implementation. Modification may continue even if training phase has started.

Again the context of use, i.e., users, their tasks, software and devices, and physical and social environment has to be studied carefully. If the target processes have been specified in the UCD in the evaluation stage (4.1), the same specification can be used as a basis for context of use in the UCD in modification stage. Since the ERP system has already been selected by this phase that system has to be studied as well. The description of context of use can include system topographies, organization maps, task flow charts or sequence diagrams or process descriptions. Okrent and Vokurka (2004) suggest gathering all the key participants, and asking them to bring copies of all papers and system displays used currently in the process. The copies are taped together in a single display and connected by lines to show the process order. This kind of process flow diagram could be compared with parallel process in the new ERP system displays and printouts.

Next, the requirements both of the organization and the ERP system are specified (Figure 7.). Here, especially, the end users should be closely involved with the ERP project team. At least two possible approaches occur. Either the project team interrogates the users or the users participate in the process by matching tasks. The project team can perform user observations or interviews and specify the user and organizational requirements for the ERP system. Alternatively, if the current business process and process of the new ERP system are mapped, users can participate in identifying the problem areas where processes do not match. The latter would also serve as a change management tool, if current process needs to be changed. During the team work while processes are matched, the workers can see why the process has to be changed and how single tasks together form a process.

Whatever way the requirements are identified, the design involves making the decision as to which one is changed, the process or the ERP system. For this purpose a multidisciplinary team is useful. ERP system vendor's representatives have experience of other ERP projects and thus are able to evaluate the resources the modifications may require. The management of a company can keep the goal of implementation clear and select the choice that helps to achieve the targeted business processes. Human resource managers may comment on recruiting needs and the skills of current personnel. Interdepartmental communication and cooperation is necessary when processes are built. The result can be, for example, a scenario of target business processes and the specification of required modification of the ERP system. Naturally the first round results are suggestions, which then need to be evaluated and revised. For successful BPR in a manufacturing context Zhang and Cao (2002) also suggest design of other changes, such as decreasing organizational hierarchy, shifting management goals from functional to globally-optimized, measuring business performance in a process-oriented manner and making the workers act as a team.

Designing the ERP system modifications can mean designing a selection module, a table configuration or even code modification. A spectrum of choices is available for modifications, but the effort required for ERP system maintenance and upgrades varies between the choices (Brehm et al. 2001). The simplest alternative is to configure the system. Traditionally, the missing functionality, the need for adding value to the system, user interface changes and operation efficiency are considered to be reasons for customizing an ERP system according to the needs of a company. In a study of two ERP projects, the customization reasons were further examined (Light 2005). The results expose reasons originated also from the social setting of ERP implementation. For example the implementation team can use customization to facilitate user acceptance. However, modifications that may prevent a company from utilizing system updates are user exits, ERP programming, interface development and package code modification. As a result, the modifications which are incorporated during the ERP implementation may have long-term consequences for the system's lifecycle and usefulness for the company.

Evaluation of BPR and design modifications are not as straightforward as testing, for example, an interactive software product. The BPR descriptions can vary from verbal description to diagrams. List and Korherr in their study (2006) have evaluated seven conceptual business process modelling languages: UML 2.0 Activity Diagram (AD), Business Process Definition Metamodel (BPDM), Event Driven Process Chain (EPC), Integrated DEFinition Method 3 (IDEF3), Petri Net and Role Activity Diagram (RAD). They used a framework of five perspectives as the basis for evaluation. Functional perspective describes the sub-processes and activities of a process, whereas organizational perspective describes internal and external process participants. Behavioural perspective describes how the elements of the process are performed relative to each other. Informational perspective presents the data resources. The business process context perspective includes elements such as process owner, customer, deliverables, goals and measures. Changes in the process can be evaluated with the users in, for example, a focus group session. Modifications to design can, alternatively, be evaluated with users through procedures such as walkthrough sessions using paper prototypes and scenarios to accomplish tasks.

During the specification of use context (Figure 7) some critical tasks may appear, for example a sales person needs to check or enter information on an order while talking with the customer on the phone. This sets target task times or restrictions on the amount of displays to be used for presenting the order information. The implementation plan design should be evaluated as well, by comparing the schedule and activities with the normal company operation. For example, varying seasonal sales may cause rush times when training cannot be given. Similarly, the financial department may have deadlines for financial statements, which requires that the history information exists in the ERP system. When user evaluation is carried out for the implementation plans, top management agreement is needed in addition to users' opinions. This is because during the ERP system implementation, some occasional decrease of productivity can be expected. The users need time to adapt to the new ERP system and to learn to use it.

While the potential changes in the implementation plan can be approved without user evaluation or acceptance, the evaluation activities raise the users' trust in the ERP project management and in the forthcoming system. The evaluation provides the opportunity to participate in the change instead being forced into it. Most importantly it gives the project team early feedback on the new ERP system and signals potential problems before they occur during the roll-out phase. The project team can now prepare for or even prevent the challenges and obstacles.

#### ***4.3 UCD in exploitation stage***

After implementing an ERP system, the company has the challenge of improving the business performance up to the level of and above what it was before the implementation. However, the implementation project might have taken all the efforts, and managers, not to mention that other workers may have had enough of the changes. They really want to stabilize the new processes and have some respite from the exhausting endeavour.

The main idea of *user-centered design in the exploitation and enhancement stage* is to redesign the workflow in cooperation with the workers. The initial activities include observations and interviews in the business process context of use (Figure 8) as well as some quantitative data of processes which should be collected in order to illustrate the operational challenges for the managers and workers. Data should be stored and remeasured for comparison to illustrate the improvement after activities have taken place. Due to the iterative nature of UCD process, the work redesign and empirical evaluations are conducted in close co-operation with

the actual implementers of the work. In every iteration cycle the objects for redesign are identified and development goals defined. When the redesigned processes are in operation, the results are carefully monitored and evaluated, not only in terms of productivity measurements, but also in terms of efficiency, effectiveness and the satisfaction of the organization. Improvements in the organisational work satisfaction will be shown as improvements in business results.

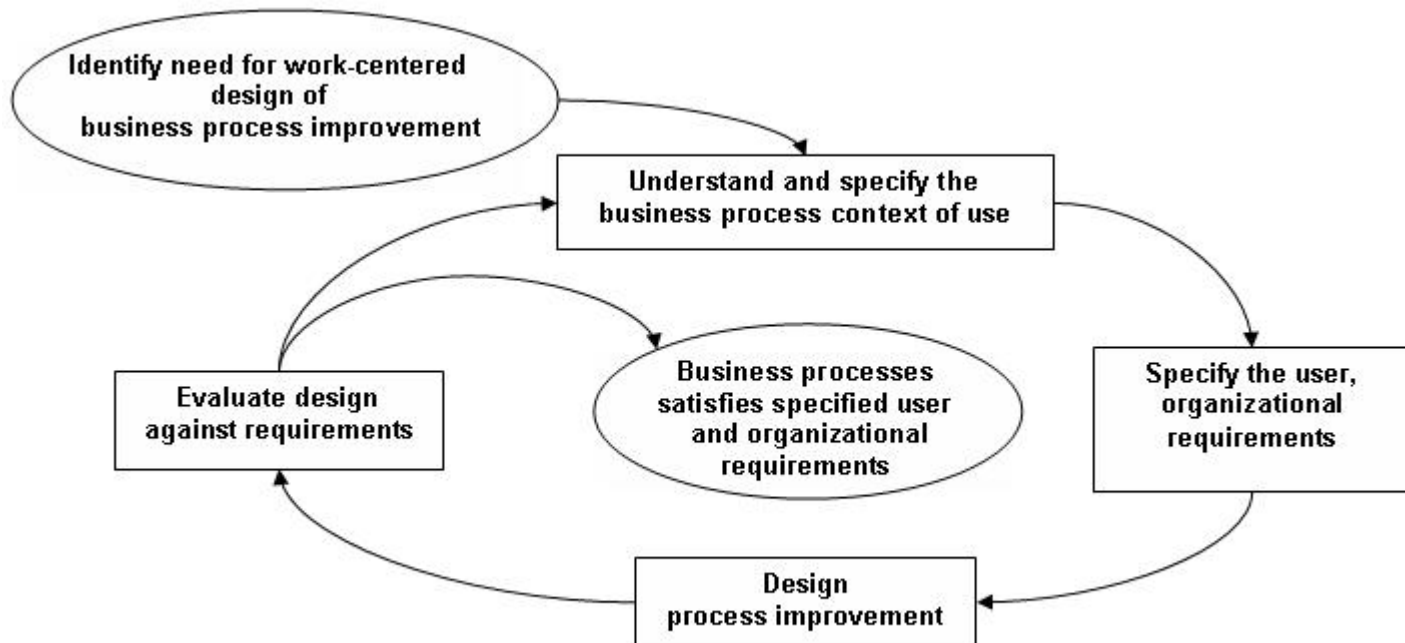


Figure 8. User-centered design process in the exploitation and development stage of ERP implementation.

It is recommended that the cycles of UCD, challenge identification, studies in the context of use, work redesign and evaluation of the results are repeated periodically. Okrent and Vokurka (2004) recommend companies to have a continuous improvement program in order to retain the benefits of business process reengineering after ERP implementation. Davenport (2000, p. 149) also argues for regular process mapping and measurement. He states that the measurements give baselines for process improvements, and mapping may reveal uncovered process problems or constraints. Some of the redesigned workflows might at first be more complicated than before, but as they become part of the routine they also become just as familiar as before and also more efficient. The improvement in the business process raises the productivity, competence and self-confidence of workers on the shop floor.

#### 4.4. Realization of principles of UCD

The commercial ERP products are not designed from scratch by a customer company, but the customization of either, the ERP system or business processes, needs to be designed in advance. Objectives of the ERP implementation process, i.e. improved efficiency and effectiveness, are similar to the objectives of UCD (See Fig. 1). Therefore, the principles of user-centered design (UCD) can be used as guidelines. The realization of principles of UCD in the combined UCD and ERP implementation process is evaluated in Table 2. However, the measurement of how objectives are achieved depends on the ERP implementation stage. A company's business objectives tend to focus on the result of ERP system usage, whereas the ERP implementation process is as crucial from the organization's perspective. The measurement of , e.g. efficiency, is different in these

two cases. From the business perspective, the efficiency of ERP implementation concerns, e.g. the implementation scope, versus the needed resources, whereas efficiency from organization’s perspective is e.g. how well the implementation project and activities are managed. During the ERP system usage, from business perspective the amount of real-time data, and thereby amount of valid reports, should be maximized with minimum user effort. From the organizational perspective more essential is, however, how the ERP system supports the workers’ tasks.

Table 2. Appearance of UCD principles in the combined UCD and ERP implementation process

Principles of UCD	Application in ERP implementation
Involvement of users	Users are observed, interviewed or surveyed to identify the context of use, users are a major source of user and organizational requirements. Users actively involved in the work and process redesign and evaluation. Users evaluate the ERP requirements and ERP system design modifications.
Distinction of users’ tasks and function of technology	From the ERP implementation’s evaluation stage until ERP system usage enhancement the distinction of users’ tasks and ERP system’s tasks are being continuously specified, designed and evaluated.
Iteration of design solutions	The design solutions produced are iteratively evaluated and then again defined during the requirements specification.
Multi-disciplinary design	The targeted business processes and ERP system requirements are designed within groups, in which the participants represent a variety of professionals, e.g. financial, production, logistics, and customer relationships. Furthermore, external expertise on ERP systems, business process reengineering and usability is useful.

Even before this method, users have been involved when requirements are gathered from the organization. What is new is that they could now participate in the design and evaluation of design solutions. Naturally resistance due to extra work may occur, but the responsibility for adequate resourcing lies with the management of a company.

Distinction of users’ tasks and ERP system functionality appears naturally, even when not specially designed. However, now there is a chance to design it purposefully. There is no point in requiring the filling in of 10 or 15 fields simply to withdraw raw material from the stock when it used to take only two; date and worker’s name. Besides, the advantage is that the required outputs and inputs for the ERP system can be specified accordingly.

Iterating requirements specification or ERP systems functionalities with users might seem pointless and time-consuming, with even the risk of causing annoyance. Nonetheless the user involvement in every part of the iteration is part of the change management. The importance of workers feeling empowered to affect decisions concerning their work cannot be underestimated.

Multidisciplinary design already exists to some extent in current ERP implementations. Company’s internal experts provide knowledge on the processes, organization and production. External experts have expertise in ERP systems or business in a specific field. Yet there could be experts in change management, project management or usability management included in the design team.

**V Discussion of UCD approach for ERP implementation process**

ERP implementation research does not directly refer to applying of user-centered design (UCD) approach, although UCD has been applied in the system development on the vendor’s side (Arnowitz et al. 2005).

Therefore, the existing knowledge of implementation approaches and activities has to be searched through by trying to find similarities with UCD principles and process. Only then it can be objectively discussed how the UCD approach can be utilized in the ERP implementation process.

Alleman (2000) proposes the use of agile methods for ERP system implementations. According to the author, the agile process has three major attributes: (1.) The process is “Incremental, Iterative and Evolutionary”, (2.) Modular and lean, i.e. the process changes according to the needs of stakeholders, (3.) Time based, meaning that the process is based on work cycles, feedback loops and checkpoints. Alleman describes the hasty project atmosphere that ensues when new functionality is being continually released for the organization to use (i.e. test in use) and feedback is collected with “war room mentality“. The UCD is a faraway country cousin to the agile process in which released versions are the initial designs, which then are evaluated with real users. However in the agile methods the context of use is not considered since Alleman stresses that no changes should be made to the COTS-type ERP software. It is also suggested that the requirements are collected by asking the stakeholders “what they want, when they want it and how much they’re willing to pay”. The point is to have as few changes in the system as possible and even to fill the gaps between the system and processes with other ready-made software solutions. The agile process has the advantage of fast phased implementation, massive stakeholder involvement with light-weight and fast specification and documentation from the company perspective.

Pollock and Cornford (2002) in their report of applying standard global ERP system to a University context, call for a “micro-sociological approach” in reflecting the adaptation of such systems to a different context. They define the approach to include anthropology and material culture, actor network theory, and the sociology of science and technology. They adopt methods such as observation, focus groups and interviews that are also common to UCD. However the purpose is to analyse, not influence, the implementation.

Staley and Warfield (2007) applied the Work Program of Complexity (WPOC) methodology for enterprise systems design project of the Ford Motor Company already in 1995. WPOC is “a collection of group work processes for large-scale system design” e.g. ERP system design. The aim was to link a collection of computer-aided design (CAD), computer-aided manufacturing (CAM), and computer-aided engineering (CAE) systems together with a product information management system (PIMS), and share the product data across a very large organization. WPOC stems from systems science, and utilizes various group activities and e.g. wall chart techniques. The participants are not described in detail, except that highly-experienced staff has done some of the work between the workshop sessions. However the WPOC is conducted in the company and the participants are members of the staff.

Kawalek and Wood-Harper (2002) analyse the IS development method that is used in multinational hi-tech manufacturer’s ERP implementation. The focus is on user participation. The case has a prerequisite of SAP r/3 system implementation, and therefore the researchers were surprised that user participation was still being valued highly by, for example, the project manager. Kawalek and Wood-Harper used the Multiview2 framework in their inquiry. The framework divides IS development into four components that affect one another: Organisational analysis, Sociotechnical analysis, Information system modelling, and Software development.

Alvarez and Urla (2002) reported how narrative analysis could be used for ERP requirements engineering. The method provided insight into organizational context. They noted that stories may not be easily adapted in formal diagrams used on ERP implementation, which is not demonstrated in the article. The strength of



stories are that they are “organized, rich, and meaningful, and convey knowledge about the information system, habitual practices, and the cultural and political environment if the interviewee”. The narrative analysis method is heavy, for example Alvarez and Urla (2002) report 32 sessions including a total of 82 participants. The result was 60 hours of tape recording that was then transcribed and further converted as line-numbered transcripts containing questions, pauses, emphasis, and overlaps.

### Applying UCD in ERP system requirement specification

A user-centered design method Contextual Design (Beyer and Holzblatt 1998) is being utilised for capturing organizational requirements for ERP implementation (Vilpola et al. 2006). The so-called ‘contextual analysis’ is a part of a three-phased construction of Customer-Centered ERP Implementation (C-CEI) (Vilpola et al. 2007). The construction includes operational and risk analyses, in addition to contextual analysis. The aim is to improve the requirement specification process by concentrating on the critical points, such as processes that need to be changed or processes that deviate from the standard ERP system logic.

During the iterative construction and validation process of C-CEI method it has been applied in three companies’ ERP system requirement specification phase before the companies select a system. The results were intended to support the ERP system selection and implementation project planning. The companies represent business branches of measurement devices, explosives and construction projects, and their turnover varies between 7 and 14 million Euros in a year (Vilpola et al. 2007). The amount of personnel is 40 person in the smallest and 150 in the largest company. Companies were selected due to their difficulties in initializing the ERP implementation project, indicated by protracted negotiations with a vendor. The three analyses of C-CEI were conducted in each company and each analysis was documented as a separate deliverable. The idea behind separate documents was to support the utilization of results in different stages of ERP implementation. The results of operational analysis became the requirements for the system. The document could be send to a vendor as an attachment of request for proposal. The results of the contextual analyses were the organizational requirements for the implementation, and they could serve as a base for the implementation plan. Finally, the results of the risk analysis, were the pre-evaluated risks concerning each phase of the implementation, and the documented risks should be repeatedly re-evaluated during the implementation process.

In order to qualitatively analyze the implementation of C-CEI method from the perspective of the users of the ERP system, five representatives from the three companies were interviewed. The focus was solely on the C-CEI method and its effect to ERP implementation, because since the original case studies their ERP implementation process had also been affected by other factors, such as company policy and ERP project resourcing. From the research perspective, this is a challenge when seeking the connection between using UCD approach in ERP implementation and ERP implementation success. The five interviewees presented various levels of organization and they all had been participating in the activities of the C-CEI method. The questions covered e.g. positive and negative impressions of the method, and usage of the resulting documents. As the main benefits of using C-CEI method, the interviewees considered the achievement of common terminology for objectives and requirements throughout a company, the conception on extent and impact of ERP implementation project within the organization, and the detailed analysis of the work. The main concerns were the adequacy of contextual analyses including five to six observees per company (Vilpola et al. 2006), the unnecessary description of the current operations in a detailed manner, and the exclusion of ERP systems and vendors from the process of applying the C-CEI method. The most used document was the requirements analysis, which all three companies had sent over to ERP system vendors. Even though the risk analysis had not been revised, the risk analysis as such was generally commented as provoking activity by the users. In one

company, the contextual analysis had elicited a new project for business process improvement. From the users' perspective C-CEI method implementation offered sufficient amount of information on ERP implementation and managed to identify the focus in their implementation.

Initial results of three case companies, in which C-CEI method has been applied in ERP system requirement specification, indicate that UCD approach has succeeded in user involvement and knowledge improvement for the whole ERP team (Vilpola et al. 2007). For example, with C-CEI, the analyses of company operations and context clarified the role of ERP system in company's future business processes. The C-CEI method was commented as diverse and inspiring, yet demanding method. Even though the C-CEI method required company resources, it revealed companies' ERP project pitfalls in advance and enlightened the project team about the potential and limitations of ERP systems.

Currently, no extensive UCD process for ERP implementation has yet been devised or applied. Previous attempts focus on a narrow scope of implementation. However, the encouraging examples of user-centered approach by C-CEI method (Vilpola et al. 2007) suggest that the principles and processes of user-centered design should be applied systematically in order to support the organization and users throughout and after the ERP implementation process.

## **VI Conclusion**

Companies implement enterprise resource planning (ERP) systems to improve efficiency of operations and thereby their business performance. However, an ERP project (i.e. implementation) is large and risky undertaking. ERP implementation risks and critical success factors have been widely studied, mostly by post implementation research. Many of the risks relate to ERP implementation stakeholders such as system vendor, consultants and the ERP project team. Critical success factors relate, for example, to expertise, competence, cooperation, and communication. This indicates that increased user involvement and multi-disciplinary interaction is needed to improve the ERP implementation success.

As ERP systems are nowadays mostly commercial-off-the-shelf (COTS) products, the challenge is to find the best fit between business processes and the ERP system. On one hand organizational requirements and on the other hand ERP system modifications need to be carefully studied in advance. This paper presents a novel method of how the principles and process of user-centered design (UCD) can be applied in ERP implementation process. The method consists of three UCD processes; *UCD in evaluation stage*, *UCD in modification stage*, and *UCD in exploitation stage*. The UCD processes are independent and, thus, they can be utilized irrespective of the stage of implementation of a customer company's ERP programme. The principles of UCD, e.g. user involvement and multidisciplinary design, support the realization of critical success factors (CSFs) in ERP implementation. For example, users such as production designers or foremen participate in requirements gathering and ERP system evaluation, which are not left solely to the company's board of executives. Even though inputs of the UCD process vary according to the ERP implementation stage, the objective in every UCD process is to increase efficiency, effectiveness and user satisfaction, in other words usability, of the target business processes and the ERP system.

In ERP implementation research the UCD approach has not been used consistently. Instead, a limited number of similar type of activities or a single principle has been applied. A consistent utilization of UCD approach needs to be further explored throughout the implementation. The competitive advance for the companies lies in the potential of how efficiently the ERP system is exploited. Future research should evaluate the applicability of user-centered design in ERP implementation with respect to implementation objectives, companies' business objectives and organizational point of view. For example, appropriate usability methods,

and composition of multidisciplinary team should be defined as guidelines for the practitioners. The ERP implementation success should also be defined from different stakeholders' perspectives so that the success could be reliably measured. This paper presented a novel UCD method for ERP implementation, and the first results of UCD applied in ERP system requirements specification processes (Vilpola et al. 2007) are promising. In order to develop this method into a useful tool for ERP implementation projects, the method should be further specified, developed and exploited, and the results measured in various real-world case studies. This method, however, already provides a systematic way to take organizational context into account in ERP implementations.

## **Appendix 1: Interview questions to C-CEI method implementation participants**

### 1. ERP project background

- 1.1 When was the ERP project initiated?
- 1.2 What were the major objectives of the ERP project?
- 1.3 What is the current status of the ERP project?
- 1.4 For how long have you participated in the ERP project team?

### 2. General comments about the C-CEI method

*The interviewer puts C-CEI documents; operational, contextual and risk analysis documents, on the table and recapitulates the dates and major phases of C-CEI.*

- 2.1 What is your main impression of the implementation of the C-CEI method?
- 2.2 Have these documents been used after the C-CEI method implementation? (If yes; for what purpose and how?)

### 3. Comments about each of the analyses

*The interviewer recapitulates the main phases within each of the analyses.*

- 3.1 What is your impression of the <operational / contextual /risk > analysis?
- 3.2 What were the implications of this analysis?
- 3.3 What are the advantages of this analysis?
- 3.4 What are the disadvantages of this analysis?

### 4. Development ideas for the C-CEI method

- 4.1 What kind of additional clarification, specification or management activities you would have needed during your ERP project?

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## **Paper VII**

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# **Development and Evaluation of a Customer-Centered ERP Implementation Method**

INKA VILPOLA

Human-Centered Technology,  
Tampere University of Technology  
P.O.BOX 589,FI-33101, Finland  
Phone +358 40 577 6308  
Fax +358 3 3115 5532

Email: [Inka.Vilpola@tut.fi](mailto:Inka.Vilpola@tut.fi)

## **Abstract**

Enterprise Resource Planning (ERP) systems are widely implemented in companies' operation management and there are already a number of commercial-off-the-shelf (COTS) ERP products on the market. However, companies often have difficulty in identifying the requirements for selecting an ERP system, and also in specifying their objectives in an ERP implementation project. Despite the available information on ERP implementations, companies need a how-to method to support them in gathering and analyzing their ERP requirements. This qualitative empirical research deals with the development of a Customer-Centered ERP Implementation (C-CEI) method for the analysis of ERP system requirements. The development is conducted using an action research approach. The C-CEI method utilizes the principles and process of *User-Centered Design* (UCD) that aims at involving end users in the early stages of the product development. The results of this research are divided into four parts: (1) the C-CEI method itself, (2) the lessons learned from four companies that participated in the development of the C-CEI method, (3) content analysis of C-CEI documents produced in the companies, and (4) interviews of the companies' personnel who had participated in the development of the C-CEI method. This research guides practitioners in how the ERP implementation can be approached employing a pre-defined method, and how the shared understanding of the ERP project objectives and activities are achieved within the organization. For academics, this study directs the research interest towards developing scientifically-based ERP implementation methodologies to complement those currently provided by ERP vendors and consultants.

## Introduction

In order to be competitive, companies need real-time information on their orders, materials, production, costs, etc. However, the information may be scattered in multiple information systems that are not connected to each other. In order to increase the efficiency of information systems, it is necessary to integrate the company's multiple systems in such a way that the data has to be entered only once in the system. This integration enables the data to be used for various purposes across the enterprise. For example, the same order ID can be used in production planning, materials order, forwarding, and invoicing.

An Enterprise Resource Planning (ERP) system is usually based on a database and includes all business processes of a company, for example, ordering, production, and logistics processes. The ERP system is utilized in planning the production and financials, and monitoring the realization. For instance, sales personnel can establish delivery time on the basis of the current production load instead of giving the total production time. SAP Business Suite (2007) and Oracle E-Business Suite (2007) are two ERP system products among many alternatives. One reason for using an ERP system is to collect the financial data related to operations automatically without the need for additional reporting work. In order to use an ERP system efficiently, all the data collection should be as automated and real-time as possible. For example, operations data can be accurately collected directly in real time from the automation systems' logics.

Since the late 90s many companies representing various sizes and types of business have taken ERP systems into use. The implementation projects have usually proven to be challenging; for instance, scheduling, budget, training, system utilization, and change resistance have been obstacles to implementation success (Shehab, Sharp, Supramaniam, and Spedding 2004). In order to understand the nature of the challenges, the implementations have been studied employing both qualitative and quantitative research methods. For example, case studies (Lee and Lee 2000, Parr and Shanks 2000, Bagchi, Kanungo, and Dasgupta 2003, Vilpola and Väänänen-Vainio-Mattila 2005), Delphi method (Bernroider and Koch 1999 and 2001, Chang, Gable, Smythen and Timbrell 2000, Huang, Chang, Li, and Lin 2004), and statistical analysis (Bagchi, Kanungo, and Dasgupta 2003, Buonanno, Faverio, Pigni, Ravarini, Sciuto, and Tagliavini 2005, Mabert, Soni, and Venkataramanan 2003) have all been used as methods in ERP implementation studies. Relatively few field experiments have been reported, comprising only 2.04 %, of the research methods in a review of 49 ERP articles, whereas field studies are fairly common, comprising 40.82% (Cumbie, Jourdan, Peachey, Dugo and Craighead 2005).

Typically, in ERP implementation studies, companies' representatives are interviewed, or the approach is survey-based. Most of the studies share two common characteristics; first, the ERP implementation has been already completed, and second, the personnel involved belong to upper management, e.g., CEO, CIO or CFO. As a result, such research provides unexplored solutions to the problems of ERP implementation since the results are more likely to describe the stages, activities, stakeholders, risks, and results of previous implementations. Moreover, the focus can be biased by the knowledge, attitudes, and opinions of upper management; non-management ERP system users, for example, may have different objectives and criteria for the success of an ERP project. There is a need for a new method to help companies tackle the problems, even before they occur. Such a method should provide a means to analyze the operations and the ERP system needs in a holistic manner, free from the influence of ERP vendors. In particular, the method should promote collaboration with the personnel in order to achieve shared understanding of the ERP project goals as well as the changes needed in the organization and operations.

The focus of this qualitative and empirical research is on the development of a Customer-Centered ERP Implementation (C-CEI) method. This is conducted by using the *action research* approach (Baskerville 1997), in which researchers are actively involved in the problem-solving process of a target company. During this research the C-CEI method evolved into a vendor-independent ERP requirement analysis method aimed at analyzing the requirements of ERP system customer companies. The method consists of three different analyses: *operational*, *contextual*, and *risk analysis*. The results of these analyses support the ERP implementation project of a company in various phases. For example, the results of operational analysis provide the ERP system requirements that can be utilized in the ERP system selection phase; the results of the contextual analysis enable the identification of areas for performance improvement in the organization; and the results of risk analysis provide a risk list for risk management purposes throughout the ERP implementation project.

This research describes the iterative development of the C-CEI method. The results are illustrated in four different sections. First, the resulting C-CEI method is described in order to give a framework to further illustrate the method development activities. Second, the iterative development, i.e., learning, is specified in each of the four companies that developed the C-CEI method. Third, an analysis is presented of the contents of the company-specific documents on the C-CEI method. Fourth, interviews of the personnel who participated in the C-CEI method development are analyzed. The interviews deal with the effects of the C-CEI method and how these measure up to the critical success factors for ERP implementation devised by Somers and Nelson (2001). The interviews consider the C-CEI method from the perspective of an ERP system end user. Finally, the applicability of a user-centered design approach to ERP system implementation is discussed, and issues for future research are proposed.

### **Contribution**

This paper is novel in enterprise information systems implementation research in several ways. The aim is to develop a how-to method for analyzing the requirements for an Enterprise Resource Planning (ERP) system. Here, a novel Customer-Centered ERP Implementation (C-CEI) method is developed through the analysis of requirements of four companies, each representing different industries. The existing literature on ERP implementations is mainly retrospective (e.g., case studies, the Delphi method, and statistical methods) and there is no attempt to affect the implementation. By contrast, the present study adopts an action research approach.

This study highlights the challenges that companies face in the ERP system requirement analysis phase. Development of the C-CEI method is described in terms of its advantages and the lessons learned. A novel aspect of this C-CEI method is that it applies *a user-centered design* methodology not previously used in ERP requirement specification. Evaluation of the results is conducted from the perspective of the companies' personnel.

The results of this research are expected to be of practical interest not only to companies implementing their own ERP systems, but also to ERP system vendors and consultants. Another aim of this study is to motivate researchers in the ERP field to improve, create, or validate vendor-independent methods that will support companies in their ERP implementations.

### **Related research**

The use of multidisciplinary methods is not new in information systems development. Soft Systems methodology (SSM) by Checkland (1981), and Multiview methodology by Avison and Wood-Harper (1990), are examples of methods employing multiple approaches. In SSM a conceptual

model of an ideal system is first developed and then compared to the current state in order to identify the needs for change (Benyon 1995). SSM is not specifically intended to support ERP system requirements analysis. Multiview employs multiple approaches, such as organizational analysis, sociotechnical analysis, information system modeling, and software development (Kawalek and Wood-Harper 2002). However, the focus is mostly on how the designers ought to work (Benyon 1995). Kawalek and Wood-Harper (2002) applied the Multiview 2 framework in an ERP system context, but only to diagnose the case and its activities after the implementation activities. They did not support the actual implementation with Multiview2 methodology.

Ncube and Maiden (1999) have promoted the idea of a software tool that could be used as a technological aid for selecting commercial-off-the-shelf (COTS) software. The approach, called PORE, consists of three components; process model, a method box, and a product model. The PORE approach, like the C-CEI method, understands the two sides of COTS-type software requirement specification. On the one hand the organization has requirements for the software, caused, for instance, by other legacy systems, tasks, or documents. On the other hand, COTS-type software requires certain processes and tasks from the organization. Ncube and Maiden (1999) did not report PORE in an ERP context, but since ERP systems are commonly COTS type, it should also be possible to apply PORE in that particular domain. One element lacking in PORE is the presence of any user-centered design principles or process, which means that user-centeredness is not directly addressed in the COTS-type software selection process.

Neto, Gomes, Castro, and Sampaio. (2005) present a process for system requirements identification. The process combines activity theory and an organizational modeling technique. The process is divided into three parts; use of an ethnographical method for determining user activities, mapping user activities to early requirement organizational models, and the use of human practice analysis for refining late requirements. The process relates to human-centered design process (ISO 13407 1999), and its first two stages involve understanding and specifying the context of use, and specifying the user and organizational requirements. However, the process by Neto, Gomes, Castro, and Sampaio (2005) does not proceed up to the design phase, nor does it relate specifically to ERP system implementations.

The related studies indicate that methods for capturing requirements from multiple perspectives, like organizational and technical, have been already introduced for systems design. However, most of the methods are not intended for ERP system requirement analysis, which differs from other information systems requirements engineering due to the nature of ERP systems as COTS products. The other novelty of the C-CEI method is that the principles and methods of user-centered design (UCD) have not previously been applied systematically in an ERP system requirements analysis.

### **Research approach**

Action research was selected as the approach because it allows the researcher to be part of the problem-solving team. Action research is well-suited, for example, to studying the implementation of a new technology in an organization (de Villiers 2005). The aim of action research is to actively develop the means to solve problems instead of merely describing them (Baskerville And Wood-Harper 1996). The following are the key characteristics of action research:

- Cyclic: the result of a previous action serves as a base for planning the next action.
- Participative: both the researcher and the object of the research function collaboratively in solving the problem.
- Qualitative: an action and its evaluation are more verbal than numeric.
- Reflective: the evaluation of the previous result affects the planning of the next action.
- Responsive: as a result of iterating and reflection, the research is constantly being adapted

(de Villiers 2005).

The iterative cycle of action research (Susman 1983) includes five phases (Fig. 1). Action research begins by *diagnosing* the problem that needs to be solved. The approach is holistic rather than a simplification of the problems. The aim is to gain an overview of the nature and the cause of the problem. *Planning the actions* to be taken in the company is the participative phase. The purpose is to reach agreement between researchers and the problem-solving team on which actions are to be taken and to solve the identified problem. *Taking the actions* is also a joint operation involving researchers and company personnel. The role of the researchers can be instructive, but also solely participative. *Evaluating the results* is based on assessing whether the actions taken are effective in solving the identified problem. If the effect on the problem is undesired, planning of a new iteration is started. Even though specifying the learning is the last of the phases in action research, this is really an ongoing action.

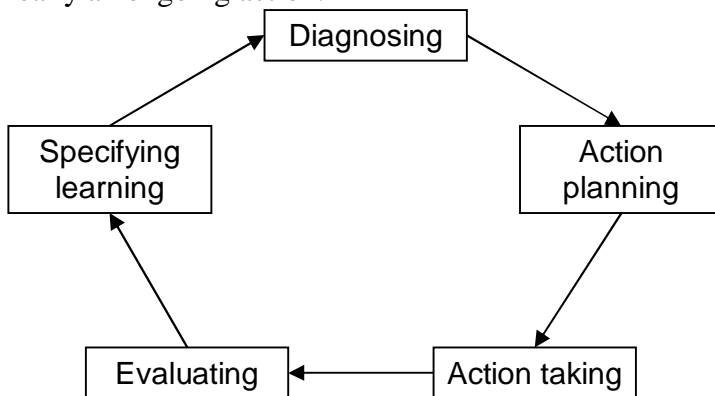


Figure 1. An action research cycle (Susman 1983).

In action research the researchers introduce changes in a complex social process, like ERP system implementation, and then observe the effects of the changes. On an abstract level, this resembles consulting; however consulting ignores “the theoretical development and rigorous empirical foundation”. Where a set of consulting projects may be reported as participative case studies, action research can be considered more accurate, more challenging, and taking more time than participative case studies. Therefore, a thorough documentation of the collaborative teamwork and iterative theory development is one of the foundations of action research. (Baskerville 1997)

The key distinctions between action research and consulting, identified by Baskerville (1997), are in the motivation, commitment, approach, recommendations, understanding, explanation, and clients’ benefits. Researchers are motivated by scientific prospects and publications, whereas consultants are motivated by profits. Both researchers and consultants are committed to the client, but in addition, researchers are committed to the scientific community. Researchers work in close cooperation with the clients’ practitioners, but consultants usually work externally, in an independent manner. Consultants base their recommendations on experience of similar cases, while researchers induct the solutions from theory and use collaborative investigation to decide on the appropriate solutions to try. Researchers base their understanding of causes and consequences on iterative and incremental action cycles, whereas consultants externally analyze the situation using their pre-existing experience as a filter. Consultants are keen to find general solutions that are applicable in every similar situation, whereas researchers limit their research focus to a particular social situation. Naturally, if a similar pattern is repeated from one organization to another, a new theory may spring up. Finally, the clients’ benefits in action research focus on contingent learning, and in consulting the benefits lie in knowledge transfer. (Baskerville 1997)

### Conducting action research on the C-CEI method development

## Participating companies

Companies that would benefit from the C-CEI method are typically those seeking a focus for their ERP implementation, for instance, their operational and organizational requirements for the ERP system. In order to iteratively develop the C-CEI method in an action research manner, the companies need to be relatively small to ensure that iteration will not take more than about half a year. Furthermore, smaller companies also tend to encounter more problems than larger companies in getting started on their ERP implementation project. This is mainly due to lack of ERP competence and limited resources committed to the project.

Four companies participated in the research (Table 1). The companies did pay a small sum to participate, though the development of the C-CEI method was mostly supported by national-level funding agencies (70% of total costs). The participative and developing nature of the C-CEI method and the forthcoming research work were explained to the companies during initial contacts.

**Table 1.. Parameters of participating companies**

<i>Company</i>	<i>Industry</i>	<i>Turnover</i>	<i>Personnel</i>
A	Measurement devices and services	\$ 2,4 M (2005)	32
B	Explosives	\$ 10,4 M (2005)	144
C	Construction projects	\$ 15,2 M (2006)	115
D	Automation design, implementation and installation	\$ 20,8 M (2006)	236

All the companies had considered having an ERP system, but none had reached the stage of selecting a vendor or system. The motivation to acquire an ERP system varied from company to company. Company A previously had an ERP system that did not support their business processes effectively. Company B could not utilize their ERP system in the way suited to their production data management. Company C had a very old character-based system that no longer received support from its vendor. Company D was part of a larger group of companies that planned to replace multiple management systems with a single common ERP system.

Action research begins with a diagnosis of the problem (Fig. 1). In this ERP implementation context a company wishes to develop its business operations and possibly acquire an ERP system, but the objectives and requirements are undefined. In this research the action planning and action taking phases relate to planning the C-CEI method development, but other methods, such as process walkthrough or prototyping could also be used. However, in the learning specification phase the recommendations for actions are considered from the stance of another company in the same situation. The cycles of action research were timed to overlap so that the specification of learning of one company could be exploited in the action research of the next (Table 2).

**Table 2. Timing of each cycle of action research**

Company	Jan'05	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan'06
A	x	x											
B						x	x	x	x				
C						x	x	x	x	x	x		
D										x	x	x	x

The research team consisted of usability and industrial management researchers. The role of the research team was that of a leader in the sense that its responsibility was to manage the C-CEI development project and document the results. Each company formed a steering group and nominated a person responsible for arrangements at the company's site. The steering group

approved the objectives of the C-CEI development and provided recommendations for the focus of actions. Other personnel variously joined in the interviews, acted as targets of observations, participated in group activities, or reviewed the results. The research resources are presented company by company in Table 3.

**Table 3. Resources of participant companies and researchers**

<i>Company</i>	<i>Company resources</i>	<i>Researchers resources</i>	<i>Duration</i>
A	18 days	47 days	2 months
B	40 days	39,5 days	4 months
C	22 days	24 days	6 months
D	33 days	42,5 days	4 months

The research work conducted in the companies was partly overlapping for a number of reasons. For example, the requirement specification document could be jointly commented on 3 to 7 times by the company personnel. The time employed in the kick-off meetings and in the C-CEI development evaluation meetings is included in the company's resources, whereas the time spent in the orientation of the researchers is excluded. The ratio of researchers to company's resources is greater in company A because this was the first time that the idea of the C-CEI method had been introduced in a company. Once the researchers had learned from the experience and evaluated the method together with company A's personnel, the ratio became smaller in subsequent implementations.

After the action taking phase, i.e., C-CEI method development, the participating companies' personnel were interviewed. Each interviewee was expected to have participated in the development of the C-CEI method. Background information on the interviewees is presented in Table 4. A total of six interviewees were considered to represent various positions such as foreman, production manager, safety quality manager, and chief executive officer. The ages of the men and women interviewed ranged from 29 to 55 years. The interviews were conducted individually, and the company's documents obtained from the C-CEI method implementation were used as a memory aid. The interviews were first recorded, and later transcribed and analyzed.

**Table 4. Information on interviewees: position, experience, age, gender, and information systems usage at work.**

Code	Position	Company	Time in the position	Time in the company	Age years	Gender	Share of using IS as part of total working time (0-20%, 21-40%, 41-60%, 61-80%, 81-100%)
A1	Chief Executive Officer	A	10 years	15 years	54	Male	21-40%
A2	Production manager	A	4 years and 1 month	4 years and 1 month	44	Female	41-60%
B1	Foreman	B	14 years	29 years and 7 months	54	Male	41-60%
B2	Production designer	B	4 years and 9 months	34 years and 6 months	55	Female	21-40%
C	Safety and quality manager	C	5 years	8 years and 6 months	37	Male	21-40%
D	Production manager	D	4 years	5 years	29	Male	0-20%



According to the interviewees the ERP project objectives were as follows: organisation of the document management so as to improve cost management (Company A); integration of data management systems to achieve paperless operations (Company B); improving project management and tender calculation practices (Company C); and system integration (Company D) (Table 5). The interviews were conducted more than a year after the C-CEI development, and thus the current status of the ERP implementations varied between companies. Companies C and D had made more progress than companies A and B, even though the ERP projects of companies A and B had been underway for three years when the interviews were conducted. At the time of the interviews Company C was the only one of the four that had actually implemented an ERP system, but initially only for financial operations. Companies B and D had already made their decisions, but Company A was still in the process of selecting a system.

**Table 5. Information on companies' ERP projects.**

Company	Objectives of ERP project	ERP project status	ERP project duration
A	Documentation management, actual cost calculation, proposals and orders in an integrated system	ERP system not selected	3 years
B	Paperless operation, data integration, application for production management	ERP system selected but investment not approved	2-3 years
C	Financials, tender calculation, project management	ERP system implemented for the financials	2 years
D	Decrease number of systems and integrate systems.	ERP system selected and vendor making specifications	1 year

The aim of the interviews was to evaluate the effects of the C-CEI method development for the organizations and their ERP projects. The interview outline comprised three sections. The first section included background information on the ERP project, its schedule, objectives, scope, and status (Table 5). In the second section, the development of the C-CEI method was discussed using copies of the result documents as a memory aid. The questions in each analysis of the C-CEI method concerned overall impression, positive or negative effects, and subsequent usage of the resulting documents. The final section of the interview sought to identify possible positive or negative effects of the C-CEI method development for the top ten critical success factors (CSF) (Somers and Nelson 2001) of ERP implementation (Table 10). The study by Somers and Nelson (2001) was selected because of its wide-ranging scope and detailed analysis. The authors had, for example, conducted an extensive literature review covering both academic journals and magazines as well as reviewing 110 case studies. The list of 22 CSFs found was then ranked by 86 practitioners. Thus the use of the top ten CSFs as a basis for the interview was well motivated.

## **RESULTS OF ACTION RESEARCH ON THE C-CEI METHOD DEVELOPMENT**

The results are presented in four different parts: (1) the resulting C-CEI method, (2) the learning specified after each action research cycle conducted in a company, (3) content analysis of company-specific documents of C-CEI, and (4) interviews of the personnel who had been involved in the C-CEI method development in their company. These results provide an overview of the impact of C-CEI for the research, for the ERP projects of the companies, and for the participants and their organizations.

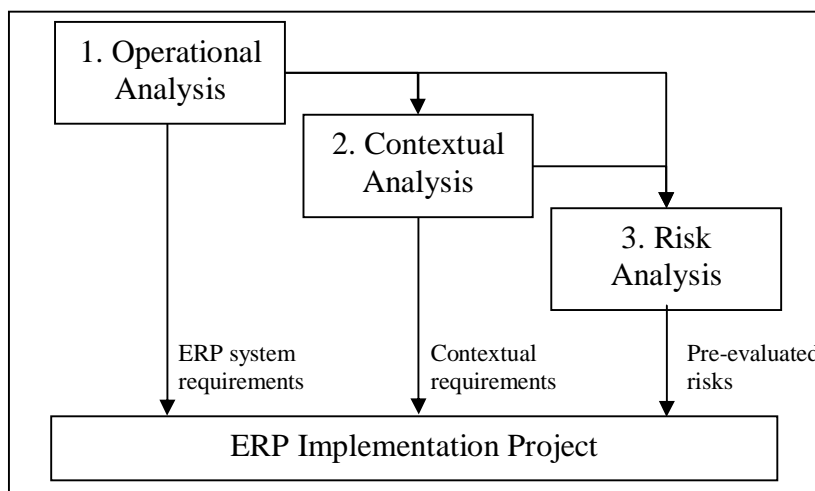
### **Introduction to the resulting C-CEI method**

Customer-Centered ERP Implementation (C-CEI) method is a multidisciplinary ERP system requirements analysis method consisting of three analyses: *operational*, *contextual* and *risk analysis*. The analyses affect each other sequentially (Figure 2). The main objective of the method

is to impact positively on the critical success factors of ERP implementation in the requirements analysis phase of an ERP project. The C-CEI method applies principles and methods of User-Centered Design (UCD) (ISO 13407). As a result of using C-CEI, an organization will have participated fully in the requirements analysis activities. The participants should represent all the functions and organizational levels (ERP users) existing in the organization. The C-CEI method produces three documents, one from each analysis, for use in ERP system selection and implementation.

C-CEI is a holistic method, in which more traditional system-based analysis is supplemented by user-centered design (UCD) (ISO 13407) process and activities. Specifically, C-CEI utilizes the main elements of the Contextual Design method (Beyer and Holzblatt 1998), which relies heavily on contextual observations of users in their work. Moreover the C-CEI method applies the principles of UCD: *multidisciplinary design team; the involvement of users in the design process; iteration of the design solutions and purposeful allocation of tasks of the users and the functions of technology*. By employing these principles, the C-CEI method attempts to bridge the potential gap between the requirements and expectations of various stakeholders, for instance, company management, ERP project team, and other personnel. The gap may be most evident between stakeholders' expectations and their understanding of ERP implementation objectives, activities, and the criteria of ERP success.

The C-CEI method consists of three analyses, each analysis producing a document that can be used when an ERP system is selected, implemented, and taken into use. Since the C-CEI method is used before a company has selected the ERP system vendor, some of the ERP implementation issues, such as training, need to be determined later. This means that some of the findings during the C-CEI method development, for example requirements of change in business processes, may still affect the overall success of the ERP implementation.



**Figure 2. Phases of the C-CEI method**

In *operational analysis* the focus is on the critical business processes of a company. The analysis is made through group interviews with the company's operations personnel. This involves discussion and planning of future business operations to ensure that the requirements of the ERP system also meet the long-term needs of the company. The resulting Operational Analysis document describes the company and its business, the volumes, and operations. The requirements are presented as a prioritized list for selection of the appropriate system. An example of a table of contents is presented in Appendix 1. The document can be utilized, for example, as an attachment in a request for proposals to the ERP system vendors.

*Contextual analysis* focuses on the organizational context; users and their tasks, devices, and the physical and social environment. The analysis applies a user-centered design method known as Contextual Design (CD) (Beyer and Holzblatt 1998, 1999). In contextual analysis only the following first four of the seven steps of CD are utilized; (1) contextual inquiry, (2) modeling and interpretation, (3) consolidating the models and building an affinity diagram, and (4) work redesign (Vilpola, Väänänen-Vainio-Mattila, and Salmimaa 2006). The next three steps of CD are (5) user environment design, (6) mock-up and test with customers, and (7) putting into practice. These steps are excluded if the C-CEI method is adopted prior the selection of an ERP system vendor. However, the last three steps can be utilized later during the ERP implementation. For example, user environment design may include scenarios of ERP system use and an implementation plan, while testing may involve a review of the ERP task sequence with the end user (Vilpola et al. 2007). A shortened version of CD can be considered as *rapid contextual design*, in which only those steps that support the focus of the design are utilized (Holzblatt, Burns Wendell, and Wood 2005). The aim of contextual analysis is twofold: to prepare the organization for and commit it to the forthcoming ERP implementation, and to ensure that the necessary business process re-engineering is properly planned and supports the ERP implementation.

The contextual analysis produces a document that can serve as an introduction for the stakeholders, as a source for process development planning, and as a basis for implementation activities planning, such as training. Appendix 2 contains an example of a table of contents. The consolidated models and their analysis provide a brief insight into an organization’s interaction, culture (Fig. 3), environment, and task sequences. The results of the Affinity diagram (Table 8) reveal the problematic areas of the context. However, most important are the proposals for action in an ERP project that are conducted from the contextual research. These are recommendations on what needs to be improved in the company context, and how the improvements can be implemented.

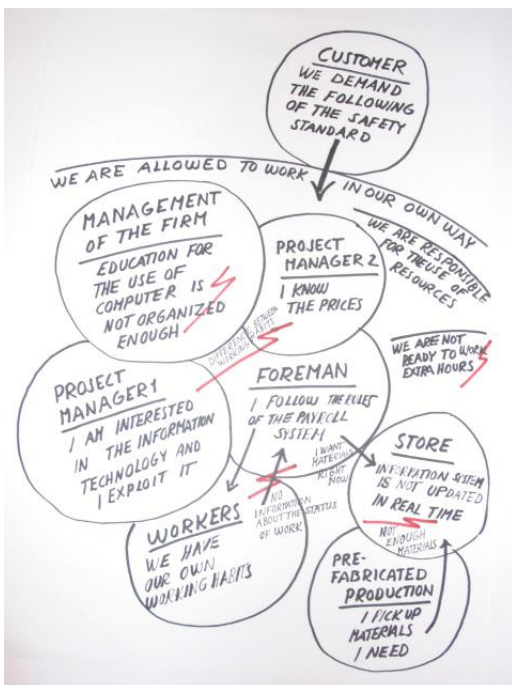


Figure 3. Consolidated cultural model shows attitudes, values, and prevalent thoughts of representatives of the personnel that have been observed during their work (circles) (Vilpola et al. 2006).

*Risk analysis* identifies, classifies, and prioritizes the company-specific ERP implementation risks (Vilpola, Kouri, and Väänänen-Vainio-Mattila 2007). The risks are identified during the group interviews of operational analysis, as well as during the modeling and consolidating activities of contextual analysis. The risks are then classified according to their possible realization in ERP project phases such as *selection*, *implementation* and *usage*. Each risk is analyzed to determine its potential cause, occurrence, consequences, and value for appropriate risk management action. Finally the company representatives evaluate each risk in terms of its effectiveness and probability. These can then be multiplied as a *risk product* for the prioritization of risks. Evaluation of risks should be closely linked with ERP project management activities, such as regular project meetings. New risks should be added, and existing risks continually re-evaluated.

Ojala, Vilpola and Kouri (2006) have compared the major risks found by risk analysis of the C-CEI method with those found in the ERP project risk factor list (Somers 2000). In the same study (Ojala, Vilpola, and Kouri 2006) the target companies were evaluated according to the IS/ICT capability maturity model (Renken 2004). The results tend to suggest that as the IS/ICT capability maturity increases, the share of common risks also increases. Therefore, if a company has low IS/ICT capability maturity and only a common risk list is used as a basis for risk analysis, the likelihood of ignoring serious company-specific ERP risk may also increase.

The C-CEI method involves three analyses, operational, contextual, and risk analysis, each supporting ERP implementation from a different perspective. Operational analysis supports the ERP system selection and the formulation of the target operational model. Contextual analysis supports the development of the organization and its practices, and risk analysis supports management of ERP implementation risks before they occur. In combination, the results of these analyses support ERP implementation from both the implementation project and organizational perspectives.

### **Specifying learning of action research cycles**

Each company served as a cycle in the action research into the applicability of the C-CEI method. As the C-CEI method consists of three analyses, operational, contextual, and risks analysis, the learning can be specified for each of the analyses individually in addition to the overall method improvement (Table 6). During the C-CEI method development activities in a company, the participants expressed themselves in subjective terms such as “in my opinion”; and such comments were noted by the researchers in order to develop the C-CEI method. There was also a final meeting in each company, in which the researchers invited feedback from the company’s representatives. This feedback was included in the company-specific final report. A third source of learning was in planning the C-CEI activities for the next company. The past experiences were then reiterated and suggestions were made, mostly by the researchers, for developing the C-CEI method,

Operational analysis appeared to have nothing to improve. An appropriate sequence for identifying the system requirements is to first conduct group interviews of company operations’ key personnel, and after that to formulate the target operational model. Then the ERP system requirements can be listed and finally the requirements can be prioritized. Operational analysis can be conducted efficiently within two weeks, although commenting and reorganizing the requirements may take months in a company. The analysis also provided an opportunity for everybody to express an opinion about the ERP system requirements. However, this often protracts the requirements formulation and introduces requirements of minor importance. Therefore, it would be useful to include vendors’ representatives to comment on the result of the operational analysis, namely, the ERP system requirement specification.

Contextual analysis, an innovative approach of ERP system requirement specification, was implemented in C-CEI for the first time and resulted in major learning outcomes. Even the results of the analysis needed reworking into a format that a company could utilize in their ERP project. Activities such as modeling the context, consolidating the models, and building an affinity diagram all developed largely during the course of the research. Finally, the contextual analysis is developed into a means for gaining in-depth insight into a specific task or process. The analysis provides relevant information about the context, (e.g. organizational culture, communication, and environment) to be used as a basis for redesigning processes in an ERP implementation.

Risk analysis has much in common with traditional risk management and is therefore well established. Certain minor issues such as the scale used for evaluating the risks and the data collection methods underwent slight modification during the course of the research project.

**Table 6. Specifying learning during 4 iterative cycles of C-CEI method development.**

Company	Operational analysis	Contextual analysis	Risk Analysis	C-CEI method
1. In company A	Must requirements could be used for reducing the amount of potential ERP systems.	Physical and interaction models can be combined. Results of affinity diagram need to be linked more closely in the planning of ERP project	Risks need to be categorized according to ERP project phase. 3-step scale is too sparse to evaluate the effectiveness and probability of risks.	Analyses need to be more tightly linked. A concrete way to demonstrate how an ERP system works (not a specific product) (interview).
2. In company B	-	Introduction of the Contextual Design method needs improvement. The affinity diagram needs to be built on a 3-level hierarchy. A tool to analyze attitude of personnel is required.	Risk interviews can be integrated into interviews for the operational analysis	-
3. In company C	-	Results need to be iterated further in order to prioritize them and plan appropriate actions. Observations should focus more on personnel who are the key users of the ERP system.	-	Awareness of risk that C-CEI method seizes on trivial problems instead of holistic understanding of business and organizational development needs (interview).
4. In company D	-	-	-	A tool and method is needed to fully explore the expectations and attitudes of personnel to the changes in operations. Method could be expanded to ERP project management (interview).

The challenge for the C-CEI method development was to maintain a holistic view across all the operations in the company and across the entire organization. On the other hand, the aim of employing the C-CEI method is to focus on company-specific operations. Those operations either need to be aligned with the ERP system or the system needs to be aligned with the operations. However, if only a single operation is considered, the overall view may dissolve. The system then becomes partially optimized with the cost of overall efficiency. For example, if the ERP system is considered to be changed, then the cost of modification and possible difficulties in the future upgradings of the system has to be compared to the possible loss of work efficiency without the modification. Therefore in the C-CEI method, the balance between overall and focused actions requires careful planning.

### Content analysis of company-specific documents of the C-CEI method

During the C-CEI method development, three documents were produced in each of the companies, one for Requirement specification (Operational analysis), one for Contextual analysis, and one for Risk analysis. The participating companies found the *requirement specification document* to be the most useful outcome of the C-CEI method. This is mainly because the problem of ERP system selection culminates in the requirements specification. Already at the beginning of the research, the operational analysis was the most mature of the three C-CEI analyses, and was thus easy to comprehend for both researchers and company personnel. Since the operational analysis also developed during the course of the research, the documents are not entirely comparable. The extent and type of requirement specification are presented in greater detail in Table 7.

**Table 7. Content analysis of companies' requirement specifications**

<i>Requirements/ Company</i>	<i>Must</i>	<i>1<sup>st</sup> priority</i>	<i>Others</i>	<b><i>Total</i></b>	<i>To be tested</i>
A	18	77	26	<b>121</b>	20
B	12	75	56	<b>143</b>	15
C	8	38	21	<b>67</b>	2
D	- *	- *	- *	<b>202</b>	- *

\* Company D forms part of a group, and the requirement specification was to be extended to cover the group.

The requirement specification was formulated to cover the following areas: technical, usability, sales, data management, product development, production management, materials management, financial, and other requirements. During the research it was decided that, in order to reduce the number of potential ERP systems and vendors, only Must-requirements should be sent to them initially. Must-requirements are the absolute essential needs of a company for the ERP system. Certain requirements were marked for testing because they were critical, i.e., that is used by many in the personnel or frequently in use.

The *context analysis document* was integrated into the C-CEI development project report in the first company, i.e., company A. The researchers quickly found it appropriate to transfer the contextual analysis document into a separate document because of the change management nature of its context. The contextual analysis document draws up visualizations of a company's culture (Fig. 2), interactions, and physical environment. It also contains the results of the Affinity Diagram built up during group work sessions. The results indicate which areas of context contain problems in the current state (2<sup>nd</sup> level headings), the nature of the specific problems (notes on the Affinity diagram) and whether the problems are to be solved by the ERP system or within the organization (linking the notes and ERP system logic). Table 8 presents the problematic areas with the number of notes for each area.

**Table 8. Results of building Affinity Diagrams**

Company	Problematic areas (number of notes total/related to ERP)	Total number of notes	Number of notes related to ERP
A	Data storage (5) Quality management (11) Schedule management (17) Pricelists (5) Production data management (14) Time management (13) Human resources (8) Order data management (13) Customer needs (9) Communication (9)	104	Not identified
B	Maintenance (23/0) Logistics (25/21) Communication (14/6) Documentation (13/13) Packing and delivery (22/10) Production management (42/26) Data logging (19/15) Production planning (22/22) Quality management (36/3) Basic data (19/13) Interest groups (7/4)	242	133
C	Project management (32/32) Material management (18/14) Proposals (20/7) Company culture (9/9) Utilization of technology (9/4) Interest groups (11/3)	99	69
D	Data utilization (35/7) Cost management (32/27) Customer (19/8) Sales and project management (31/19) Resources (40/6) Materials, construction site (28/22) Materials, Stock (24/14) Project management on site (33/28)	242	131

All four companies experienced difficulty embarking on their ERP system selection and implementation, and therefore were keen to participate in the C-CEI method development. However, the company personnel had little knowledge of ERP systems and the implementation process. Nonetheless, they expected the ERP system to solve problems in operations. This was expressed by an interviewee from the company D: “The C-CEI method had a positive effect on the management of expectations, but the news was bad; the ERP system was not coming to do our job.” Therefore, companies B and D were surprised to discover how few notes in the Affinity Diagram related to the ERP system. In contrast, there were issues that the personnel needed to discuss and agree among themselves and how these were to be managed within the organization.

The iterations of the contextual analysis evolved to provide practical proposals for changes in the companies’ ERP context of use. Some of these proposals should be undertaken before implementation, some during the implementation, and others as part of long term development towards efficient use of an ERP system. For example, company B was urged to reduce the person-



dependability of their operations, and instead invest greater effort in motivating and training the personnel, even in elementary computer skills. Company D was advised to make a plan for releasing human resources from their information systems department for the ERP implementation.

The *risk analysis document* described each identified risk by name, description, action, effectiveness, and probability. Evaluating the effectiveness and probability of each risk was carried out jointly in a group session. The contents of the risk analysis documents are presented in Table 9.

Table 9. Analysis of risk document. The number in parenthesis refers to the number of risks identified to be at least 12 of the risk product, when effectiveness and probability are in 5-step scale.

<i>Risks/Company</i>	<i>Selection</i>	<i>Implementation</i>	<i>Usage</i>	<i>Total</i>
A	10*	21*	7*	38
B	17 (7)	33 (18)	15 (8)	65 (33)
C	17 (5)	33 (17)	13 (6)	63 (28)
D	21 (5)	34 (16)	14 (5)	69 (26)

\* The scale of both effectiveness and probability was 3-step in company A, but 5-step in the other companies.

In each of the companies, the degree of risk is greatest in the implementation phase. This is partly due to the fact that as the requirements specification started to form a template, risk analysis also started to be reusable in this context. The same risks already identified in company A also seemed likely to occur in companies B, C, and D. The major difference between the companies was in the evaluation of risks. The risks with a risk product of at least 12 are not comparable across the companies. Certain risks were added to or removed from the risk list company by company. The fact that the number of implementation risks was greater than the risks in the other phases, i.e. selection and usage, is also partly due to the fact that companies were developing the C-CEI method in order to facilitate the selection. Therefore, it seemed that few risks were likely to occur before implementation. Nevertheless, the usage phase lay years ahead so it was difficult to envisage what challenges might lie ahead.

### **Interviews of personnel participating in the C-CEI method development**

The interviewees (Table 4) were asked to make general observations about the C-CEI method development, and utilization of the documents produced. They were then asked to comment on each of the analyses; impressions, implications, advantages, and disadvantages. They were also invited to suggest ideas for further development of the C-CEI method. Finally the interviewees were asked to consider the type of support they would need during their ERP project. The results of the interviews are presented below. The interviewees' assessments of how the C-CEI method development had affected the critical success factors of ERP implementation in their organizations are presented in Table 10.

General comments on the C-CEI method concerned the interviewees' opinions on how the C-CEI influenced the ERP implementation of the company. Interviewee A1 (Table 4) considered the C-CEI as "mind-changing" for the personnel in their attitude to the implementation. He also considered that gaining a common understanding of the scope and effects of the ERP project was very useful for the organization. Interviewee B2 noted, "I've got my work decompressed". However, she doubted whether the executive group could understand the operations in practice, "some [of those in the executive group] have very good, and some have a bad vision [about the reality]". Interviewee D felt that "we [in Company D] have tried to get a view of how large an entity this [ERP project] is and what kind of issues overall relate to this". He also noted that "on the basis of this [the C-CEI method] our eyes have been opened to what this [ERP project] is about, how to proceed in the [ERP] project, and what it [ERP project] requires from us".

The results were documented as reports, one for each analysis. At the time of the interviews only two companies (C and D) had selected their ERP systems (Table 5) and so the document most commonly used was the Requirement specification, i.e., the Operational analysis document. It was delivered to the vendors as an attachment to the request for proposal. The Contextual analysis document elicited a division of opinion. For example, Interviewee C doubted the adequacy of five persons being observed in the data gathering phase. However Interviewee A2 observed that “studying different functions, first individually and then combining the information, has revealed to us what we have only been partly aware of; problems concerning product data management, schedule management, resource management, and time management”. The Risk analysis document, even though it was not known to have been utilized, met with unanimous approval. Interviewee A1 said that “due to risk analysis we made two decisions: first we’ll pay two or three vendors for conducting a sort of first phase ERP implementation testing, and second....the project manager is hired full-time for this [ERP] project”. Interviewee B2 commented that the writing of the Risk analysis document was beneficial because the risks have been explicitly stated in terms of what could go wrong. Interviewee D welcomed the risk analysis, and hoped that the risks identified in the document would be considered seriously during the ERP project.

Ideas for further development, feedback and user needs were expressed throughout the course of the interviews. Widening the C-CEI method to include the selection and implementation phases of ERP implementation was suggested by interviewees C and D. The participants expressed a desire for more detailed knowledge and a “concrete feel” of how the ERP system works. For example, Interviewee A1 noted that “it is difficult to understand in advance how an ERP system works in real usage”. A major challenge is that there are numerous ERP systems and they do not work in the same way or look and feel the same. However, Interviewee C stated that before the development of the C-CEI method, he had no understanding of an ERP system. Interviewee A2 considered the amount of information to be appropriate for this stage of implementation.

Committing end users is a key objective of the C-CEI method, and realization of this principle is discussed continuously throughout the development activities. Despite this, Interviewee B2 commented that the management or steering group had communicated poorly with the workers. She felt that activities had only been explained in small pieces, and the overall perspective remained unclear. According to Interviewee C, there is an increased risk in the ERP project of focusing on trivial detail instead of the overall project.

In addition to the objective description of the company’s current operations, Interviewees C and D provided more critical observations. They believed that the current procedures could also be made more efficient and appropriate in terms of target business objectives. In the opinion of interviewee B2, it would be unwise to recruit the ERP project manager from the company’s IS organization because the role requires an overall understanding of the business processes, such as the production process. In addition, Interviewee B1 saw part-time project management as a threat to the project’s success since other activities might be distracting.

In two of the companies, C and D, the operations had been audited during or after the development of the C-CEI method. Both interviewees commented that the auditing activity could also have supported the C-CEI method. Another alternative could be to incorporate auditing in the C-CEI method since it sets the TO-BE state and reflects the current state for the objective state. It could then serve as a basis for the ERP system requirements and action planning in developing the ERP system context of use.

Finally, the interviewees were asked to comment on whether the C-CEI method development had affected any of the top ten critical success factors (CSFs) of Somers and Nelson (2001). The respondents were asked in the following neutral terms: “Did the development of C-CEI in your company have any effect on the CSFs?” The aim was to elicit a “yes” or “no” response. A “yes” response was followed up by a request for the interviewee to specify if the effect was negative or positive. The results are presented in Table N. They show that C-CEI has had a positive effect on top management support, vendor support, and on the careful selection of the ERP system (Table 10). In contrast, no effect was evident in the way the C-CEI method affected interdepartmental cooperation.

**Table 10. CSFs are in rank order (Somers and Nelson (2001). The symbols mean: ‘+’ is a positive effect, ‘-’ is a negative effect and ‘0’ means no effect.**

Critical success factor	A1	A2	B1	B2	C	D	Total of positive/negative effects
1. Top management support	+	+	+	+	0	+	5/0
2. Project team competence	+	+	0	+	+	0	4/0
3. Interdepartmental cooperation	0	0	0	-	0	0	0/1
4. Clear goals and objectives	+	+	0	+	+	0	4/0
5. Project management	+	+	0	0	0	+	3/0
6. Interdepartmental communication	+	+	0	+	0	+	4/0
7. Management of expectations	+	-	+	-	+	+	4/2
8. Project champion	-	+	+	+	0	0	3/1
9. Vendor support	+	+	+	+	0	+	5/0
10. Careful package selection	+	+	+	+	+	+	6/0

The results indicate that the C-CEI method has a particularly marked effect on issues related to the early phases of ERP implementation. For instance, C-CEI positively affects interdepartmental communication (+4), the support of the top management (+5) and support of ERP system vendors (+5). However, the means to improve interdepartmental cooperation (-1), ERP project management (+3), and selection of project champions (+3,-1) need to be developed. Indeed, these factors are critical in the later phases of ERP implementation and system usage. The total of negative (4) and positive (38) effects is clearly on the positive side. Thus it can be concluded that the C-CEI method has a positive effect on the critical success factors of ERP implementation compared to ERP implementation without C-CEI method.

### Limitations

There are certain limitations in this study. The interviews were conducted with six participants, male and female, who represented different organizational levels, different age groups and various levels of work experience. With more resources available, the number of interviews could have been increased by selecting more participants from each company. Alternatively, a survey could have been conducted of the whole personnel instead of interviewing individual representatives.

The interviews conducted in this research sought to determine the impact of C-CEI on the critical success factors (CSFs) of ERP implementation. The original list contains 22 CSFs identified in the study by Somers and Nelson (2001). To keep interview sessions compact, the top ten of the CSFs were used. In the interviews the CSFs framework provided a common and consistent measure for evaluating the C-CEI method. However, it could be possible to utilize the entire list of 22 CSFs, for example, within a survey on the impact of C-CEI.

During this research, not all the companies had finalized their ERP implementations. One company had taken a system into use, but one company had not even selected their system (Table 5). Other two companies had proceeded but not completed their ERP implementations. An ERP implementation may take years before considered completed and therefore the evaluations of the C-CEI method were conducted despite the status of these implementations. However, once fully conducted, the ERP implementations of these companies could be further analyzed by post-implementation studies.

### **Discussion and Conclusion**

The Customer-Centered ERP Implementation (C-CEI) method was developed through iterative cycles of action research. Four companies with differing starting points approached the ERP system implementation employing the C-CEI method and its three analyses; *operational*, *contextual*, and *risk analysis*. Iterations of the C-CEI method in action research cycles resulted in a continuous learning experience, especially in the contextual analysis phase of the C-CEI method. Since the application of user-centered design (UCD) (ISO 13407 1999) is one novelty of the C-CEI method, contextual analysis has the greatest development potential. By contrast, operational analysis and the risk management process have been established earlier in various contexts. Nevertheless, even if the participants found the results of operational analysis reliable and usable, the analysis methods can be developed into a more participatory and proactive direction. For example, various data collection methods such as walkthrough sessions, workshops, diaries, or surveys could be used instead of interviews for producing knowledge of the current processes.

This research differs from previous ERP research in that it is positioned at the pre-implementation stage, i.e., before the selection of the system. This research is novel in that it presents a method that applies the principles of user-centered design (UCD) and the Contextual Design method (Beyer and Holzblatt 1998) in ERP implementation requirements specification. Previous studies lack methods that could be used in the early stages of ERP implementation for enhancing implementation success. Furthermore, there are no methods that consider users and their tasks in an organization in order to specify the contextual requirements of an ERP system. The contextual analysis of C-CEI follows the principles of UCD. The principles include forming a multi-disciplinary design team, involving users actively in the design activities, allocating tasks for the system and its users, and iterative design. The C-CEI method supports multidisciplinary creation of the requirements with active user involvement, and committing the participants to the overall requirements of an ERP system. Iterations should continue during an ERP implementation process. The contextual analysis of the C-CEI is a versatile tool for various purposes in a company. In this research, the contextual analysis was applied in ERP system requirements analysis. However, the results are applicable in business process development, and thus contextual analysis can also be employed for development purposes without an ERP project.

This research documents the C-CEI method and thereby increases its reliability and applicability in future use. However, issues concerning a company's requirements for the ERP system and its implementation are highly context related. Development of a company's business operations is dependent on the type of company, branch of business, the organization, and the current status of businesses. The reliability of this research is also supported by the collection of the materials produced and the documentation of the research process. The validity of this research is ensured because the focus is the applicability of the C-CEI method in ERP system implementation. Therefore, the evaluation is confined to the challenges, advantages, and the development ideas of applying the C-CEI method.

The results are based on the following sources: The learning that is specified after each iteration; the C-CEI documents produced; and the comments and insights provided by the participants during structured interviews. Development of the C-CEI method had a major impact on the contextual analysis, which improved in its conventions and in the communication of its results. The effects of method development on the operational and risk analysis were minor. Evaluation of the results shows that the C-CEI method is perceived as a how-to method for a company facing challenges in starting its ERP implementation project. The operational analysis is seen as especially effective for approaching ERP vendors and for selecting an appropriate ERP system. Other results have still to be utilized one year after C-CEI method development. Nonetheless, the analyses were seen as important activities at the beginning of the companies' ERP project. Comparison between the results of C-CEI method development and the Critical Success factors (CSFs) (Somers and Nelson 2001) showed that the major positive effects were on top management support, vendor support, and careful package selection. In contrast, negative effects were seen to be those associated with management of expectations, although overall far more positive effects (38) were noted than negative ones (4).

This qualitative empirical research into C-CEI method development serves as an example of a how-to method for practitioners wishing to enhance their ERP implementation through a user-centered approach. In addition, it is hoped that the results of this study will prompt further research into creating, improving, and evaluating vendor-independent ERP implementation methods.

### **Directions for future research**

Directions for future research could involve a survey of the critical success factors (CSFs) both before and after applying the C-CEI method in order to compare the results. Such a survey could consider all 22 CSFs from the study of Somers and Nelson (2001). Results of the survey could also be compared from case to case. Additionally, the results could be used for other purposes such as facilitating comparisons between the responses of personnel from different levels in an organization. Furthermore, the survey could be conducted at the start of the ERP implementation project across the organization in order to identify the factors that need to be addressed in further activities.

The C-CEI method could also be applied using a case study approach in comparable companies. The common factors shared by such companies could be the type of industry, the number of personnel, the particular country or the reason for the ERP implementation. While in this research C-CEI developed from one company to another, in the future research the method could be stabilized. The C-CEI method can also be used by consultants to support the customer company of an ERP system. Consultants could gain competitive advantage by using the customer-oriented methodology.

Results of C-CEI could also be developed into a form that would make them easier to utilize in later stages of the ERP implementation. The current documents produced in C-CEI are considerably long. A more useful and motivating result from the companies' perspective could be a checklist or a computer system prompting the actions needed in the ERP implementation. Moreover, the results of the three analyses could be combined to provide a toolbox for supporting ERP implementation activities, such as ERP project planning and management.

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APPENDIX 1, an example index of operational analysis.  
ERP system functional specification of company X

1. Introduction
  - a. Scope of the document
  - b. Scope of the ERP system
  - c. Technical environment
  - d. Estimate of annual frequency of functions and volume of events
2. Company overview
  - a. Business model
  - b. Expected changes in the business model
  - c. Objectives of the business development
3. Production and the production process of the company
  - a. Customers
  - b. Products
  - c. Production processes
  - d. Materials
  - e. Suppliers
  - f. Characteristics of operations
  - g. Annual volume of routine operations
4. Specification of the target operational model
  - a. Sales and proposals
  - b. Production planning and management
  - c. Production process management
  - d. Data logging
  - e. Material management and purchase
  - f. Financial management

- g. Wages
  - h. Cost calculation and reporting
  - i. Other issues
5. A list of detailed ERP system requirements
- a. Production planning and management
  - b. Production process management
  - c. Data logging
  - d. Material management and purchase
  - e. Financial management
  - f. Wages
  - g. Cost calculation and reporting
  - h. Other issues

## APPENDIX 2

### Contextual analysis of Company X

1. Introduction
  - 1.1 Scope and objectives
  - 1.2 Company description
  - 1.3 Contents of the document
2. Contextual analysis and user-centered design
  - 2.1 Contextual Design and its application in the C-CEI method
3. Implementation of contextual analysis
4. Results of observations, modeling, and consolidation
  - 4.1 Consolidated flow model of company X
  - 4.2 Consolidated cultural model of company X
  - 4.3 Consolidated physical model of company X
  - 4.4 Consolidated sequence model of company X
  - 4.5 Results of the Affinity Diagram
5. Analysis of context of use in company X
  - 5.1 Users, tasks, and objectives
  - 5.2 Physical and social environment
6. Proposals for action in ERP project
  - 6.1 A vision of target context of use
7. Conclusion