

## DEVELOPMENT AND EVALUATION OF A CUSTOMER-CENTERED ERP IMPLEMENTATION METHOD

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### 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.*

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## 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,

## 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.

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.

## 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.

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)

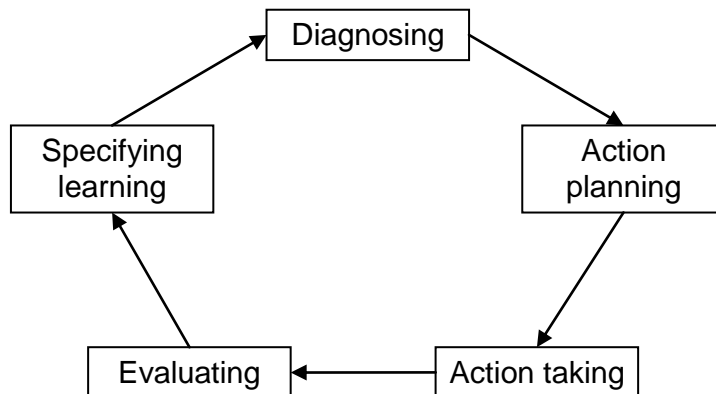
The key distinctions between action research and consulting, identified by Baskerville (1997), are in the motivation, commitment, approach, recommendations, understanding, explanation, and clients’ benefits. Researchers are motivated by scientific prospects and publications, whereas

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



**Figure 1.**An action research cycle (Susman 1983).

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.

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).

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 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

**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

**Table 3. Resources of participant companies and researchers**

<i>Company</i>	<i>Company resources</i>	<i>Researchers resources</i>	<b>Duration</b>
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.

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.

**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



### 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.

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

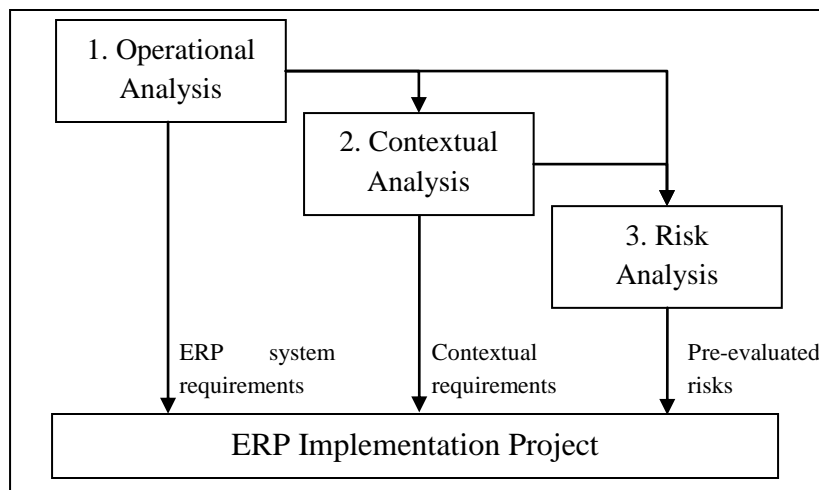


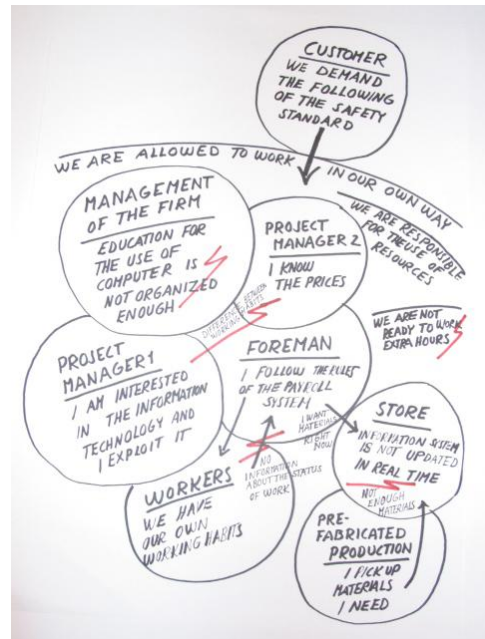
Figure 2. Phases of the C-CEI method

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

**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 scale used for evaluating the risks and the data collection methods underwent slight modification during the course of the research project.

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.

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.

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 7. Content analysis of companies' requirement specifications**

<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.

**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

**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

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