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SCIENCE DIRECT®
Advanced Engineering Informatics 18 (2004) 241–253
ADVANCED ENGINEERING INFORMATICS
www.elsevier.com/locate/aei

Improving enterprise system support—a case-based approach

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Abstract

Many organisations have implemented or are implementing large enterprise systems, like ERP and PDM, for integrating their business functions and streamlining the flow of information. Implementing such systems is very complex, however. In many companies the results envisioned have not or have only partly been achieved. In the literature many explanations can be found for insufficient or failing implementation efforts. A large part of the problems encountered appears to be human and organisational in nature, while it has been stressed that implementing an enterprise system requires and involves organisational change.

Success and failure factors and do's and don'ts, as can be found in the literature, provide necessary, but not sufficient, preconditions for starting an implementation project. The complexity of such a project makes full anticipation and control of potential problems impossible. An organisation needs to be prepared to encounter disturbances and take corresponding actions. Knowledge on the dynamics of enterprise system implementation processes is, however, scarce and scattered. Moreover, to what extent the context in which an enterprise system is implemented influences implementation is not yet fully known.

In this article, an approach is presented to gather knowledge on implementation process dynamics. The approach builds on theoretical and practical contributions in search for a structured human and organisational approach. The knowledge gathered has been analysed by means of a comprehensive reference framework. After this step a tool has been developed to support a consultant in assessing the maturity of a company to start an enterprise system implementation project. The knowledge, used directly in the tool, makes it possible to suggest improvement actions sensitive to the situation and context. Through statistical analysis, interesting context differences have been identified, which may also help in further refining the advice. Initial validation results are promising.

Keywords: Enterprise system; IT system; System implementation; Case-based approach; Organisational model

1. Introduction

Enterprise Systems are software packages, which have been developed to support many aspects of a company's information needs [1] by offering integrated solutions [2] covering many areas and tasks of a company, such as product design and production, purchasing, material management, production planning, sales and distribution, finance and controlling and management of human resources. Recently, enterprise systems also crossed organisational borders in supporting supply chain processes, sales force automation, and customer service [1]. Examples of enterprise systems are Enterprise Resource Planning systems (ERP), Product Data Management and Product Lifecycle management systems (PDM/PLM), Customer Relationship Management systems (CRM), Supply Chain Management systems (SCM), and various advanced collaboration tools offering shared workspaces for, often dispersed, parties involved in collaborative work. This list is not exhaustive. Many other integrated packages can be found under different names. All these systems and packages share the property of integrating different functions and involving different user groups and departments in and across organisations.

While enterprise systems hold tremendous promise for enhancing organisations' performance, much of this

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doi:10.1016/j.aei.2005.01.007

potential is never realized [3,4]. It appears that implementing such systems in companies is a very difficult process. Many implementation projects partly or even fail to achieve their goals [5]. There is a long history of recurring problems with implementing new technology in an organisation, not restricted to information technology only [3,4,6–8]. The past 10 years of research have shown that problems with implementing new technology are multifaceted [1,2,9–13]. Bikson and Gutek [14] have found that technical problems account for less than 10% of the problems. The other 90% are mainly human and organisational in nature.

In the literature many experiences on and theories, methods and guidelines for implementing enterprise systems can be found. A large part can be found in terms of do's and don'ts, necessary precondition and success and failure factors [15–21]. In addition, current project management methods provide much support in defining and executing projects like enterprise system implementation. Success and failure factors, preconditions, and project management methods are, however, quite general. It is often difficult for companies to understand what they need to do in their specific situation. The various problems with enterprise system implementation as reported in the literature seem to reoccur despite efforts to improve management methods.

In complex projects like enterprise system implementation projects many disturbances and diversions from initial plans occur, which cannot always be predicted. Some efforts have been made to study the dynamics of complex IT implementation projects [2,10]. These studies indicate that the context in which an enterprise system is implemented matters to the course of the project as well as to its outcomes. Also [1,22] stress that organisation and enterprise system co-develop during an implementation process. However, how context influences a project is not very clear, while results ready for use for improving implementation projects are still limited.

In this article, we present results from the FP5 IST project BEST[1] (Better Enterprise SysTem implementation). In this project, research has been performed into the dynamics of enterprise system implementation projects. In Section 2.2, we the process of implementing an enterprise system is discussed in more detail. In Section 3, the research approach is presented that has been adopted in the BEST project to study the dynamics of an enterprise system implementation project. Knowledge has been gathered on various process patterns, consisting of crucial events, their causes, interventions to repair or strengthen the impact of the event and outcomes of the interventions. In Section 4, a construct, called the CEAO chain, for capturing process dynamics is introduced as well as a comprehensive reference framework that is used to analyse and classify the knowledge captured. In Section 5, statistical analysis of the process patterns clustered in the reference framework is presented. By matching the process patterns with the context characteristics in which they have been gathered, interesting differences between contexts have been found which may help companies in further specifying the measures that need to be taken in their situation. The knowledge in the process patterns has been translated into questions and answers that have been implemented in a tool for assessing and improving the start-up phase of a new implementation project. A company can estimate what may happen in their situation. Moreover, the process patters gathered can be reused to learn from what happened in other, similar, companies. Section 6 briefly presents the readiness assessment tool developed in the BEST project as well as initial validation results. The article ends with conclusions and future directions for research.

[1] BEST (Better Enterprise SysTem implementation) is a project withing the Information Systems (IST)-domain of the fifth Framework Programme of the European Union. It started in June 2002 with a duration of 30 months (www.best-project.com).

2. The process of implementing an enterprise system

As can be inferred from the literature and practice, enterprise systems do not achieve expectations economically, organisationally, and with regard to the anticipated competitive advantage. Many enterprise system implementation projects suffer from budget and time overruns and sub-optimal, or even detrimental results. A 2002 survey of 134 organisations in US, Africa, Australia, and Europe, conducted by KPMG [5], on the implementation of programme management, a new integrated management method, shows that about 60% of the companies studied have experienced failed projects within the previous year, at an average cost of 12 million Euro each. The result also applies to enterprise system implementation projects [1,2]. Enterprise system implementation processes are very complex involving many different aspects, many people, and even different organisations. We will describe the complexity of enterprise system implementation processes in more detail below, after which we will discuss the dynamics of the process.

2.1. Complexity of enterprise system implementation

Implementing an enterprise system in an organisation is a complex process, not only because of the newness of the system to the organisation, but also because of the many different aspects that need to be considered at the same time. Besides the new technology, its impact on the organisation must be considered, involving processes, tasks, knowledge and skills, hierarchical levels and relationships with clients and suppliers. Below, we will present a number of the different aspects, which have been discussed in the literature to explain problems encountered in practice.

First of all, implementation processes are often different from the organisation's daily routines and practices.

An implementation process is mostly performed in a project, which needs an organisation that may be different from the daily way of working in the permanent organisation. Such a project cannot be organised as a routine job, because of the size and complexity of an enterprise-wide implementation project. Such a project encounters many uncertainties, which cannot all be predicted or prevented from the start of the project. An enterprise system implementation project, therefore, would need a rather organic structure [23]. An organisation with highly repetitive tasks and standard technology may lack the knowledge and skills necessary to perform an enterprise system implementation project [24]. For example, project management knowledge may be insufficient or lacking. In companies with a weak or inexperienced project manager implementation may proceed more slowly.

Secondly, enterprise system implementation processes are often considered as a mainly technical endeavour, while they should be considered as organisational change and evolution processes [1,10,22]. They are also often considered as an imperative for change, while organisational change needs to be the starting point [25]. Implementation of technology with an impact on several functions and levels of an organisation not only induces organisational change, but also requires organisational change (see also Section 2.2). The goals for change are often not very clear before implementation starts, however. Insufficient attention for organisational change may induce fear for job security making some users unwilling to accept the changes caused by the enterprise system [26].

Thirdly, implementation efforts are discontinuous. There may be a large time lag between successive implementation efforts. Knowledge and skills built in one project are often lost before the next one starts. As a result, implementation projects may suffer from the same mistakes over and over again.

Fourthly, alignment between an enterprise system and the existing technology, or the enterprise system and the organisation is an important aspect. For example, traditional functional differentiation impede IT implementation, as the enterprise system requires a cross-functional process perspective, not just a narrow departmental or divisional perspective. Centralisation/decentralisation is another aspect an implementation project has to deal with. While a centralised IT architecture increases efficiency, local profit responsibility or decision autonomy is often not supported in the ERP system [27].

Fifthly, the project organisation may not be suitable for the complex task of implementing an enterprise system. Often, the number of people in the project is insufficient. Moreover, people may be insufficiently qualified. For example, middle management is often not willing to release their best employees for the implementation team; vendors/consultants do not know the organisations well enough and have difficulties understanding the formal and informal work processes [15]; consultants often offer their knowledge on a particular field, e.g. either IT-systems, management or human resources.

Finally, the technical aspects are important as well and need to be understood by the people in the organisation affected by the system. The possibilities and benefits of the system are not always clear, though. Employees and middle management have usually very limited involvement in system definition and implementation and thus lack ownership [15].

From these explanations, we can see that problems do not only occur during the implementation process, but also after the implementation project has finished. Enterprise system implementation is a long, ongoing process for most companies that never comes to an end. Enterprise system implementation is a journey, requiring judgement and change of directions all the time. Its nature is 'Jump and you don't know where you are landing!' One best way does not exist. This means an understanding needs to be developed of the complexity of implementing and operating/running enterprise systems, while taking all the aspects touched upon above into serious consideration. To this end, a combined understanding is necessary, going beyond the merely technical aspects of implementing and operating an enterprise system. In particular, an understanding is needed of the dynamics of an enterprise system implementation process.

2.2. Dynamics of an enterprise system implementation process

All commercial enterprise system have an inbuilt general and detailed 'organisation model', together with predefined generic business processes for almost every work process in a company. The organisation model of the enterprise system has to be incorporated in or has to be aligned with the existing formal and informal work processes of the company. These include principles of design, production, workflow, management hierarchy and internal and external co-ordination. Therefore, aligning organisation and enterprise system implies that the formal and informal organisation interact with the enterprise system and its implicit organisation model. Such alignment requires organisational change.

Organisational change cannot be fully predetermined. People involved in the process of change influence the process, while also changing circumstances may require a change in the direction to go. As such, an enterprise system implementation process is a dynamic process, formed by the participating actors, their knowledge, interests and social competence, but also constrained by the existing structure, norms and rules. Organisation and technology co-develop during enterprise system implementation requiring mutual adaptation and alignment during and even after the implementation process [2,10,22]. As an enterprise system implementation process is social in nature, the social environments of participants in an enterprise system

implementation process might largely differ. For example, the social context, organisational culture and other social factors of enterprise system developers often differ largely from those of end users [28]. As such, different social contexts add to the complexity of implementing technology. Barley [28], for example, has observed that comparable starting situations for adopting and implementing new technology may lead to different outcomes due to organisational and people differences.

Social scientists have made an effort to understand enterprise system implementation dynamics from a social perspective, including theories of change [29] or structuration theory [10,30,31]. Markus and Tanis [2] have emphasised the lifecycle perspective (start-up phase, project phase, shake down phase, and onward and upward phase) and the experiences of people involved in an enterprise system implementation process. Although such studies have led to valuable insights into the problems that have been and can be encountered in complex project like enterprise system implementation projects, the results of social science research have not yet led to changes in the implementation process or tangible tools and methods ready for use. The results are still abstract and difficult to use in specific situations.

In the BEST project knowledge has been gathered on process dynamics with the goal to collect knowledge on specific process patterns and making these patterns available for new situations. Moreover, context matters as has been stressed in the literature, but it is not clear in what way context influences process dynamics. The BEST research has made an effort in identifying differences between contexts to support specification of improvement advice.

3. Research approach

Research methods like surveys and questionnaires are not very suited to gather knowledge on process dynamics and understand context influences. Instead, in-depth case studies are needed. A case study is a research methodology suitable to understand process dynamics within specific contexts [32]. Yin [33] and Eisenhardt [34] have developed systematic and rigorous approaches for developing theory through comparative case studies. In particular, Eisenhardt has developed a roadmap for building theory from case study research. This roadmap synthesizes Miles and Huberman's work on qualitative methods, design of case study research by Yin [33], and grounded theory building by Glaser [35]. It extends this work in areas such as a priori specification of constructs, triangulation of multiple investigators, within-case and cross-case analysis, and the role of existing literature [34].

The roadmap for theory building used in the BEST project proceeds as follows. The first step consists of building initial constructs from the literature. In Section 5, a reference framework is presented that forms an initial collection of construct classes. Because we want to identify not only technical, but also human and organisational problem situations, the reference framework is based on organisational and management studies. The knowledge gathered during the case studies is analysed and structured in the construct classes. In this way the construct classes are filled and specified.

Because of the time frame available in the BEST project, retrospective case studies have been chosen into perceptions of actors who have been involved in an enterprise system implementation process. In our research a case study is an enterprise system implementation project that recently has or nearly has finished. Through interviews with people involved in an ES implementation process experiences on implementing the new system are gathered. Each interview was aimed at identifying process patterns. Each interview started with identifying events that had a major positive or negative impact on the course of an implementation process. The three or four most important events were selected for further analysis. For each event one or more causes for the event were identified. After that, the actions taken were described as well as the positive or negative outcome of each of the actions. By interviewing several roles in an organisation, the perceptions of different people were identified, either confirming one another or leading to identification of interesting differences between people involved in an enterprise system implementation process. We have interviewed the following roles for our study: a senior manager, an end user, a key user, an IT person, a functional manager, a vendor or consultant.

The knowledge gathered through the interviews has been captured in a construct, called a CEAO chain (see Section 4). Causes in these chains have been analysed and structured in the reference framework. The cause part of each CEAO chain represents a situation that has led to an unexpected, unanticipated or undesired event. Early recognition of such a situation, when classified as undesired, may help to prevent potential problems to occur. The full CEAO chains act as what-if patterns or mini-cases that can be used to increase learning on what might happen if a problematic situation is not solved. The presentation of such mini-cases to people responsible for an enterprise system implementation project can take the form of:

If < situation > Then < possible event > Requiring < action > With < possible outcome >

For each cause more than one mini-case will apply with different courses of actions and situations. Presentation of mini-cases may help people understand and estimate the costs that may be incurred if nothing is done to cure the current situation. In this way the knowledge gathered through the case studies is reused in new situations. People then are triggered to think of possible problems that can

occur, estimate their costs and prepare actions to prevent the problems to happen.

The experiences gathered in CEAO chains have been used to build an assessment tool. The tool is aimed at assessing a start-up situation of a new enterprise system implementation project. The analysis has been restricted, therefore, to the causes of CEAO chains. In further research other parts of the chains will be analysed for different purposes. Each cause has been classified in one of the constructs of the reference framework. The construct classes thus formed by the causes of the CEAO chains have been translated into a set of questions and answers. For each question–answer pair a score has been assigned. A higher score indicates a better alignment between the different dimensions of the reference framework (see below). Answering all questions leads to an overall score for the company assessed. The tool incorporating the questions and answers will be explained in more detail in Section 7.

In principle, one in-depth case is sufficient for building theory on ES implementation (Eisenhardt, 2000). However, to generalise findings more than one case study is needed. To identify context differences between cases and compare cases within and across contexts, sensible sampling is needed. For this purpose, we have defined four context classes:

- Cultural region: Anglo, German, Latin, and Nordic [36]
- Size of the company: large and small and medium sized
- Type of system: PDM/PLM/KM and ERP/CRM
- Market sector: product or service.

In our case studies, we have gathered knowledge on context characteristics through a demographic questionnaire. Besides the four context classes introduced above questions address number of users, platform type, organisational form, etc. For each in-depth case study, typically about 10–15 CEAO chains have been gathered and one demographic questionnaire. In total 24 case studies have been performed all over Europe, which have led to 264 CEAO chains.

After classification of the causes into the reference framework, the cause classes have been analysed statistically to discover differences between the contexts in which the chains have been collected. The analysis has led to interesting results [37]. Results will be described in Section 5. The context differences will help individual companies to interpret the results of an assessment for their situation and to specify the measures to be taken to improve an enterprise system implementation start-up situation.

4. Gathering knowledge on process dynamics-CEAO chains

An enterprise system implementation process is a complex process in which the system and organisation co-develop. Such a process cannot be fixed from the start. People involved in an enterprise system implementation process are confronted with problems and events, which arise unexpected and unintended in the course of the process. These situations may lead to major restructuring of the process. However, as argued by Lanzara [38], most tools and techniques applied to understand the situation of a complex temporary process are focused on the products instead of the process. Examples of these tools and techniques are inspections, structured walkthroughs and reviews, as can be found in prescriptive methods. Tools are necessary that support identification of problems and solving them. Such tools need to be built on the valuable insights of and learning by members of the process, which are often ignored in current design and evaluation techniques (see e.g. [39]).

The BEST project is aimed at building theory from the interpretations and perspectives of participants in an implementation process. To achieve this a construct has been built to capture the knowledge of participants in an implementation process. Through the construct insights will be gained into positive and negative events and problematic situations in an enterprise system implementation process, which require people to intervene to change the course of the process. In addition, by identification of the situations or actions that people perceived as causes for the events and problems, the actions taken to deal with the problem or event and the positive or negative outcomes of the actions, we learn about the coherent chain of situations, actions and outcomes that occurred during the implementation process. We have called the construct the CEAO (cause–event–action–outcome) chain. This construct builds on the critical incident method [40] and resembles the diagnostic and historical maps as developed by Lanzara [38]. A critical incident is an event that can be caused by an action of an actor or a condition perceived as a cause of the event. An event may lead to further action, but can also be perceived as a cause of a future event. The assessment tool developed in the BEST project is aimed at improving new enterprise system implementation processes by reusing knowledge captured in CEAO chains gathered in in-depth case studies.

Because problems seem to reoccur over time, our hypothesis is that a large part of the CEAO chains gathered will reveal recurring patterns. Part of the work in the BEST project has been to discover such patterns within and across contexts (see Section 5). To allow comparison of CEAO chains and identify process patterns the knowledge captured in the chains needs to be codified and classified. The framework used to analyse and classify the knowledge is discussed below.

5. BEST reference framework-analysis of CEAO chains

As has been stressed above, an enterprise system implementation project is multi-faceted, incorporating not

only technical, but also human and organisational aspects. To identify the different types of knowledge captured in CEAO chains, a comprehensive model is needed. In the following sections we present such a model. The model has been tested on knowledge gathered from consultants experienced in guiding enterprise system implementation processes. We start with explaining the background of the model.

5.1. A process-based model of organisations

The model, called reference framework in the BEST project, which has been used for analysing CEAO chains is based on a Process-based Model of Organisations (PMO) [41]. The conceptualisation adopted for the PMO is centred around transformation processes in an organisation (see e.g. [42]). The definition of organisation in this conceptualisation is:

An organisation is seen as a purposeful system of people and means, which together perform certain activities or processes necessary to transform inputs into outputs that are useful for its environment, in order to achieve its objectives.

The model is a skeleton that can be refined for many different processes. After selecting a focus process, models and theories applying to the focus process are used to define the full system model. For the context of the research performed in the BEST project it is sufficient to mention the research performed by de [24]. She has specified the system model to characterised two co-existing processes: the daily production process and a continuous improvement process performed at the same time. By means of the system model she has been able to explain the interdependencies and differences between the two co-existing processes. After explaining the model into more depth, the application of the model to characterise enterprise system implementation processes will be presented.

The PMO regards an organisation as an open system, interacting with its environment, consisting of, e.g. suppliers, customers, competitors, government, and (labour) markets. Activities are needed to transform inputs into outputs. A set of activities is called a process. Processes are divided into primary, support, and management processes. Primary processes are directly aimed at achieving the goals of the organisation. The primary process can be disturbed by internal and external changes or interrupts affecting its efficiency and effectiveness. Maintenance and management processes are needed to cope with these disturbances, both pro-actively and reactively. A maintenance process supplies other processes with, quantitatively and qualitatively, sufficient people and means (tools, machines, methods, technology) to perform the transformations. Management processes consist of strategic, adaptive, and operational management processes, each with a different scope and executed on different levels in the organization.

People with the help of means perform the transformation processes. People need knowledge and skills to perform these processes. People perform processes to achieve various personal and organisational goals. The PMO recognises that people and groups in organisations may pursue different and sometimes opposing goals. Differences in power between groups and people lead to enforcement of some goals upon others. Processes, people and means are co-ordinated by means of organisational arrangements. These arrangements are the more or less durable, formal and informal, mechanisms to divide and co-ordinate the various activities. Organisational arrangements can be subdivided into structural and cultural arrangements. Structural arrangements are the rules and procedures that result from agreements made within an organisation, while cultural arrangements are the values, norms and rituals in an organisation. Structural arrangements can be designed in contrast with cultural arrangements, which can only be developed by people in interaction (see e.g. [43,44]).

The PMO can be used to study processes in different ways depending on the research methodology chosen. For large-scale quantitative studies the PMO can be used as a basis for research models underlying questionnaires (see e.g. [45]). For qualitative studies, the PMO can be detailed into descriptive or prescriptive models based on existing literature. These models can be used for theory building [33,34] or to describe, analyse, or improve practical situations. The theory-building approach through in-depth case studies is taken in the BEST project, as described above, incorporating structuration thinking [30], stressing that human actions interact with the structures humans act upon or which are changed by their actions. Such an approach is considered necessary in capturing the dynamics of a complex process like enterprise system implementation.

5.2. Adaptation of the PMO for enterprise system implementation

The process of implementing an enterprise system can be viewed as a transformation process in which an organisation is transformed from an organisation with no or a sub-optimal enterprise system into one in which a new or improved enterprise system is supporting the goals of the organisation. At the same time an implementation process is a temporary process, requiring a temporary organisation. A temporary organisation is often shaped as a project. The project may be performed not only within one organisation, but also across organisational borders, because (1) the enterprise system may be implemented in an organisation with different locations, (2) the enterprise system is implemented in a supply chain or network, or (3) one or more consultant or vendor organisations are involved. As such, an implementation process is a complex one, because it consists of several parallel and interacting processes: the business process, management of the implementation project, design and tuning of the enterprise system and aligning it with the business, and a change process. Each of

these processes put their own demands in terms of people, means, co-ordination, support, and management. At the same time these processes mutually influence each other. For example, resources needed for performing the business processes are also needed in the implementation or change process, possibly leading to conflicts with respect to availability of these resources, differences in necessary knowledge and skills and different task priorities.

In the BEST project the PMO has been adapted to incorporate the different points of view that can be taken in describing or analysing an enterprise system implementation process. For each process an organisational system according to the PMO has been specified showing the essential organisational aspects for each specific process. In a pre-study an initial model has been tested on CEAO chains gathered from consultants knowledgeable in the field of enterprise system implementation. In total 64 chains have been gathered for this purpose. The model was refined after this exercise and was applied to the first set of 12 cases gathered during the in-depth case study. The refinement into the final model is described below.

5.3. A process-based model of enterprise system implementation

For each process co-existing and interacting in an enterprise system implementation project, the PMO has been further specified. The different processes are called dimensions, while the elements of the PMO are called aspects. The dimensions are:

- The permanent business process for which the system is implemented. The focus process consists of all activities that will be supported or affected by the new enterprise system. The business processes are permanent processes, which may be subject to change continuously. The word permanent is used to distinguish the daily tasks from the temporary tasks of an implementation project.
- The design and tuning of the new enterprise system. The focus process consists of all activities that are needed to adapt or tune the system and align it with the business. Design and tuning of the enterprise system is a temporary process, but may extend beyond the implementation project.
- Project management of the implementation process. The focus process consists of all activities needed to plan and monitor the implementation process, select and perform the implementation strategy, select the system and implement it into the organization, compose a project team, manage project documents, etc. Project management is a temporary process.

Although change management is an important process co-existing with enterprise system implementation, this dimension has been left out. The argument taken to leave out the change process dimension is based on the following considerations:

- The consultant data (see Section 5.2) have shown that misalignment between the enterprise system, the implementation project, and the business is a major cause of problems in an enterprise system implementation process. Improving this alignment is part of the change process during an implementation process.
- The BEST assessment tool is aimed at analysing the preparedness of an organisation at the start of an enterprise system implementation project. An assessment needs to identify the sub-optimal situations that may lead to problems later in the process. Many of these situations can be characterised as insufficient alignment on several aspects of the different points of view. The problems identified in the cause part of the CEAO chains can lead to the identification of the need for change management activities that can be considered part of an improvement advice.

The elements of the PMO that are considered relevant for modelling the aspects of each of the dimensions, after applying the initial model on the consultant CEAO chains and the first set of 12 cases, are the following: strategy and goals, management, structure, process, knowledge and skills, and social dynamics. The last aspect, social dynamics, covers commitment, willingness to communicate and awareness. With the final framework the full set of cases has been analysed. The framework is depicted in Fig. 1.

The aspects are further explained below:

- *Strategy and goals*. Strategy and goals are the medium- and long-term goals to be achieved and the plans for realising these goals. The strategy and goals for the enterprise system and the implementation project should match the business goals and strategy.
- *Management*. The management aspect deals with setting priorities, assigning resources and planning and monitoring processes.
- *Structure*. Structure involves the relationships between elements of the organisational system, such as processes,

	Enterprise system	Project management	Permanent business
Strategy and goals			
Management			
Structure			
Process			
Knowledge and skills			
Social dynamics			

Fig. 1. The BEST reference framework for enterprise system implementation processes.

Table 1
Distribution of CEAO chains for the four selection criteria

Region	ERP							Total ERP	PDM/KM					Total PDM/KM	Total
	Large			Total large	SME		Total SME		Large		Total	SME	Total SME		
	Both	Prod.	Serv.		Prod.	Serv.			Both	Prod.	Serv.				
Anglo		51		51				51							51
China		4		4	6		6	10		4		4		4	14
German	3			3	14	4	18	21		26		26		26	47
Latin	3	15	6	24	23		23	47	7	6		13	12	25	72
Nordic		21	13	34				34			39	39	7	46	80
Total	6	91	19	116	43	4	47	163	7	36	39	82	19	101	264

people and means. Structure includes tasks, authorities and responsibilities, team structures, process structure and structure of the enterprise system.

- *Process*. Process involves the steps that are needed to perform the focus process of each dimension: the primary business process and relevant support and management processes, the project process and the enterprise system design and adaptation process.
- *Knowledge and skills*. This aspect refers to the knowledge and skills that are needed to perform the focus processes in each dimension.
- *Social dynamics*. The aspect social dynamics refers to the behaviours of people, their norms and rituals. Social dynamics often become visible in informal procedures and (lack of) communication.

The framework has not only proven to be useful in analysing the CEAO chains, but also to structure workshop processes in companies. By using a graphical presentation of the reference framework (see Fig. 1), people are enabled to assign their knowledge and experiences on enterprise system implementation to cells in the framework and discuss the results. Such an exercise leads to a shared understanding.

The CEAO chains, at least the cause parts of these chains, have been analysed and classified into the cells of the framework. The results of this exercise are presented below.

6. Analysis results

A total of 264 CEAO chains have been gathered through 24 in-depth case studies. The causes of the 264 CEAO chains have been analysed and classified into the reference framework cells. A team of BEST project partners has performed the process of coding the causes in the chains. In the following sections we present the analysis results. First, the results of the classification are presented, showing the distribution of problems in dimensions and aspects. Second, by matching the classification with context data interesting context differences have been identified.

6.1. Knowledge classification

The distribution of the 264 chains on the four selection criteria is shown in Table 1. The Chinese region has been added to the four European cultural regions. The majority of chains have been found in large production companies implementing an ERP system. The number of SME chains amounts to about 25% of the total number of chains. The ratio of ERP:PDM chains is about 3:2. The number of SME chains in the Latin region is similar to the number of chains from large companies in this region. There are no SME chains in the Anglo region. The number of PDM chains in SMEs is still limited compared to ERP chains. The coverage

Table 2
Distribution of causes in reference framework

Aspect	Dimension			
	Business	Enterprise system	Project management	Total
Knowledge and skills	24	4	11	39
Management	40	4	12	56
process		22	19	41
Social dynamics	32	7	17	56
Strategy and goals	20	2	3	25
Structure	16	27	4	47
Total	132	66	66	264

Table 3
Distribution of causes for large companies

Large companies	Dimension			
Aspect	Business	Enterprise system	Project management	Total
Knowledge and skills	15	3	9	27
Management	30	1	10	41
Process		19	14	33
Social dynamics	25	4	14	43
Strategy and goals	15	2	2	19
Structure	12	19	4	35
Grand total	97	48	53	198

of chains allows for cross-case and cross-region comparison.

The causes in the CEAO chains have been analysed and assigned to cells in the reference framework. The distribution of the causes can be found in Table 2. The majority of causes have been assigned to business management, followed by business social dynamics, enterprise system structure and business knowledge and skills. The process of tuning the enterprise system, the business strategy and goals and project management process also present a considerable number of problems. Business process is not a problem area, because this refers to the daily jobs. People have not mentioned any causes in this aspect during the interviews. Problems with the processes in terms of alignment with the enterprise systems have become visible in the structure aspect.

The results are consistent with problems emphasised in the literature (see Section 2) in terms of limited management involvement, people resistance and fear for change, difficulty to adapt the enterprise system, lack of an explicit business goal and strategy for implementing the enterprise system, and managing the implementation project. The emphasis on the problems has been made clear through our case studies. Moreover, the CEAO chains contain precise details on what really happened in particular situations. The process patterns may trigger people to better think about and anticipate potential problems in their situation. Our research has shown that the emphasis on problems is not the same for all contexts, as we will discuss in Section 6.2.

6.2. Context differences

The distribution of causes in the reference framework has been refined for different contexts, not only for the four selection criteria, but also for criteria from the demographic questionnaire that has been filled out for each company participating in the case study In Tables 3 and 4, the istribution of causes is shown for large companies and SMEs, respectively. The distributions for both company sizes show interesting differences as well as similarities.

Business management seems to be a problem for both contexts as well as enterprise system structure. Social dynamics, on the other hand, seems to be more problematic in large companies. In small and medium-sized companies, people are closer to each other than in large companies leading to easier, often informal, communication. Only when there are several small divisions of a larger company distributed over Europe, social dynamics will become more problematic because of the more difficult communication. Similarly, the level of knowledge and skills seems to be more problematic for SMEs, which can be explained from the normally heavy workload in small companies. People are not fully scheduled for implementing an enterprise system, but have to participate in an implementation project in addition to their daily tasks. Moreover, knowledge of enterprise system packages and how to implement them is often limited in small companies when compared to large companies. The project management process seems to be equally problematic for both contexts as are the business strategy and goals for implementing an enterprise system.

A statistical context analysis of the CEAO chains has shown additional differences [37]. We will present the significant ones. The differences create more questions than answers at this point in time. More research is needed to explain the differences. The results indicate that for particular context classes, either a higher or lower number of problems or situations that have required management action have been assigned to certain reference framework

Table 4
Distribution of causes for SMEs

SMEs	Dimension			
Aspect	Business	Enterprise system	Project management	Total
Knowledge and skills	9	1	2	12
Management	10	3	2	15
Process		3	5	8
Social dynamics	7	3	3	13
Strategy and goals	5		1	6
Structure	4	8		12
Grand total	35	18	13	66

Table 5
Statistical differences between contexts

Context class	Statistical value	Significant differences
Region	Chi-square(8df) = 34.4 *P*-val = 0.0	Anglo region: more business (5.2), less enterprise system (7.5) German region: less enterprise system (3.9) Nordic region: less business (3.6), more enterprise system (9.8)
Region	Chi-square(20df) = 67.3 *P*-val = 0.0	Anglo region: less process (7.9) German region: more knowledge and skills (11.8), less process (5.4) Nordic region: more process (9.0)
Line-of-business	Chi-square(10df) = 54 *P*-val = 0.0	Product: less strategy and goals (5.1), more process (4.1), more management (3.3) Service: more strategy and goals (13.9), more process (7.0), less management (3.9) Both product and service: less management (2.8)
Line-of-business	Chi-square(4df) = 32.2 *P*-val = 0.0	Product: less enterprise system (6.4) Service: more enterprise system (9.3) Both product and service: less business (4.6)
Orientation of the company	Chi-square (5df) = 14.9 *P*-val = 0.01	National company: more process (4.6), less social dynamics (4.3) International company: less process (1.9), more social dynamics (1.8)
Orientation of the company	Chi-square (2df) = 11.3 *P*-val = 0.003	National company: more enterprise system (5.3), less business (2.8) International company: less enterprise system (2.2)
Organisational form	Chi-square (10df) = 10 *P*-val = 0.03	Division form: less management (6.0), more process (6.3) Functional form: less process (2.0)
Organisational form	Chi-square (4df) = 14.7 *P*-val = 0.005	Division form: less business (4.3), more enterprise system (3.6) Functional form: more business (2.5), less enterprise system (2.4)
Implementation approach	Chi-square (4df) = 17.6 *P*-val = 0.001	Big-bang: less business (2.5), more enterprise system (5.1) Evolutionary: more business (2.1), less enterprise system (5.3)

cells than could have been expected based on the distribution of problems for the other cells. Table 5 shows the statistically significant difference between context class distributions of the CEAO chain cause dimension or aspect (see Section 5.3). The significance of Chi-square derives mainly from the discrepancy in the classes presented in the right column. The table indicates the Chi-square statistics, it is degrees of freedom and the corresponding *P*-value. Results presented in the table are all significant at the 1% level. The M-test of Fuchs and Kenett was used to identify significant differences at the cell level (see [46]).

The results above show some interesting situations. It seems that in companies with a more formal process, the problems with the process seem to be lower. A divisional form seems to encounter more problems with adopting and adapting an enterprise system, while a functional company encounters more problems in the permanent business. A big-bang approach leads to more problems with the enterprise system and not so many in the business, while the evolutionary approach seems to lead to more problems in the permanent business, while the enterprise system seems to be better adapted to the business processes. There has been no evidence of any association between system type and cause dimension or cause aspect. This is consistent with the literature that problems in implementing new technology reoccur for different types of technology.

From the results based on 24 case studies we can draw some implications, some of them listed in the tables above. The results indicate, that for different situations problems encountered may be different. Knowing about these differences helps in specifying advice for a specific company implementing a new enterprise system. The identification of differences between implementation contexts contributes to existing literature. In the literature, context-differences are recognised to influence an implementation process, but specific situations are hard to find. The results presented above are considered a first step into building more detailed knowledge on the context-sensitive nature of enterprise system implementation projects. We aim to extend and refine the knowledge by collecting and analysing new knowledge gathered in future consultancy and research cases.

7. A readiness assessement tool

The goal of the BEST project has been to develop a tool to assess a company's situation at the start of an enterprise system implementation project. Such an assessment enables anticipating problems that might potentially occur and reusing the knowledge gathered in the CEAO chains. For this purpose, the causes assigned to each cell in the reference framework have been summarised. The summaries have been translated into questions, one to three questions for each cell. The questions ask for the degree of maturity of a particular situation or the degree of alignment between dimensions. For each question, a set of answer options has been generated. The answer options reflect the degree of maturity and alignment of the situation identified by the question, ranging from an immature situation or

insufficient alignment to an optimal situation or optimal alignment. Each answer option has been given a score on a scale from 0–4, where the highest score indicates the highest level of maturity. The level of maturity indicates the level maturity or alignment between the different dimensions in the reference framework. For example, a high maturity level for the knowledge in the business of the enterprise system that is being implemented indicates that people in the business know and understand the enterprise system. Similarly, a low maturity level for the knowledge and skills in the permanent business to work with the system indicate that the people in the business are not fully ready to adopt the enterprise system.

A prototype tool has been developed with all questions, answers and scores that have been defined. After answering all questions an overall score is computed for the specific situation. The overall score is presented in a spider diagram, where the maximum score indicates the best achievable maturity level. The actual scores are presented relative to this maximum score. The spider axes are the aspects of the reference framework. An example spider is shown in Fig. 2. The dimensions have not yet been made explicit in the current prototype.

The tool is intended for consultant users with knowledge of an enterprise system implementation process. A consultant can interpret the spider diagram for the specific company assessed. He or she also knows from the questions and answers in which dimension the company has a low score. After the assessment CEAO chains applicable to the specific situation can be shown to the user. These chains show what has happened in companies that have encountered similar problems and weaknesses. The chains support learning from similar situations, trigger thinking about potential problems and estimate costs of acting now or doing nothing. Finally, a database with improvement actions supports a consultant in specifying an advice for the company.

The tool has been tested extensively by 10 experts related to the consortium, in 11 companies and by 10 external experts [47] with promising results. The overall performance, reliability, easiness to be understood, easiness to be learned have all been rated as good, while the capability to be maintained and adapted has been rated as average. The coverage of common risk elements, the logic structure, the consistency between constructs and cases and literature, classification of aspects and dimensions have been rated as good. The feeling about questions and answers has been rated as both good and average. The real-world relevance of questions and answers, the presentation of questions and answers, the scoring mechanism of questions and answers and the integration of tool components have been rated as good. Finally, attractiveness to practitioners, business value and innovativeness have all been rated as good.

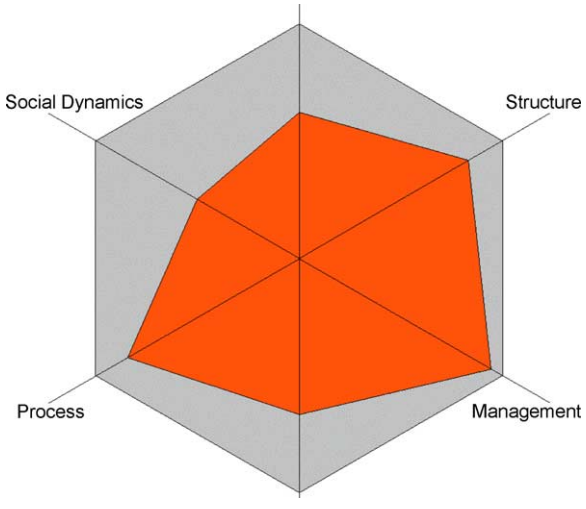

Fig. 2. Spider diagram resulting from the prototype tool.

Although the tool still requires adaptation and improvement before commercial use will be possible, the results are promising. The goal of the BEST project has been achieved by developing a tool that helps a company to understand its own situation, anticipate potential problems and decide on actions to prevent problems to occur. The knowledge captured in the CEAO chains show real process patterns, which trigger thoughts in other, similar situations. Although the problems captured are not different from those that can be found in the literature, the tool provides a means to develop a comprehensive overview of and insight into all dimensions and aspects that play a role in implementing a new enterprise system and puts problems into perspective. The collection of process patterns captured in the CEAO chains and the questions and answers for assessing an implementation situation also are useful for consultants to learn about the process of implementing an enterprise system.

8. Conclusions

In this paper a novel approach has been presented to capture knowledge on the dynamics of enterprise system implementation processes. Process patterns have been captured in a cause–event–action–outcome construct called a CEAO chain. Causes have been analysed and classified into cells of a reference framework, in which technical, organisational and people aspects have been made explicit. The analysis results have been translated into a comprehensive set of questions and answers to assess the maturity of a company to start an enterprise system implementation process.

The CEAO chains serve as mini-cases. The knowledge in the chains can be reused in new enterprise system implementation situations to help a company understand their weak areas and provide insight into what might happen if an immaturity is not improved. A tool has been developed to support a consultant in assessing a company, discussing the situation encountered and specify an advice for

the company. The tool has been validated extensively with promising results.

Analysis of the CEAO chain and classification into the reference framework cells has also enabled statistical analysis to identify pattern differences between contexts. Context details have been captured in selection criteria (company size, system type, cultural region and market). The results indicate significant differences. The differences require further investigation to better understand the reason for these differences. This will be possible by following the use of the tool in the future and by analysing other parts of the CEAO chains. In this way additional knowledge on implementation process patterns will be gathered leading to an improved understanding of the process of enterprise system implementation.

The BEST tool provides an answer to the problems listed in the introduction of this article about the complexity and dynamics of and enterprise system implementation project. The BEST approach aligns organisation and human aspects with the technical aspects of an enterprise system while taking into account differences in contexts. The tool is useful in several ways. First, a consultant can use the tool in his or her method to support a company in implementing an enterprise system. Second, the tool can be used as a learning tool for consultants. Thirdly, the tool is useful in education, both academic and industrial, by simulating different scenarios. Fourthly, the tool is useful for research because it can be used in comparative case studies.

Further research is envisioned to refine the assessment tool, increase the knowledge on enterprise system implementation processes including the context-sensitive nature of these processes. The identification of differences in implementation contexts is a novel contribution to the current literature. Incorporating these differences in the assessment tool is a major challenge. An initial attempt to handle this challenge using CBR has been proposed by Raphaeli et al. [37].

Acknowledgements

The work reported in this paper would not have been possible without the enthusiasm and efforts of many people. We would like to mention explicitly Gertine Mensink, Chaley Warne and Sebastiano Lombardo who have contributed extensively to the chain analysis and tool development. We also mention Ip-Shing Fan for managing the BEST project and focusing us on the results from the beginning. We also would like to thank the other partners in the BEST project as well as the people in the many companies for performing the case studies. Finally, we are grateful to the EU for the approving the grant that enabled us to do the work.

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