

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

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## Abstract

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

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

## Keywords

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

## Introduction

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

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

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

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

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

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

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

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

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

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

### Case studies

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

Table 1. Company details

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

The major findings of the company analyses are presented below.

#### *Current ERP system*

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

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

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

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

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

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

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

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

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

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

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

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

### **Operational analysis**

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

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

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

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

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

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

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

### **Contextual analysis**

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

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

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

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

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

### **Risk analysis**

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

### **Case study**

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

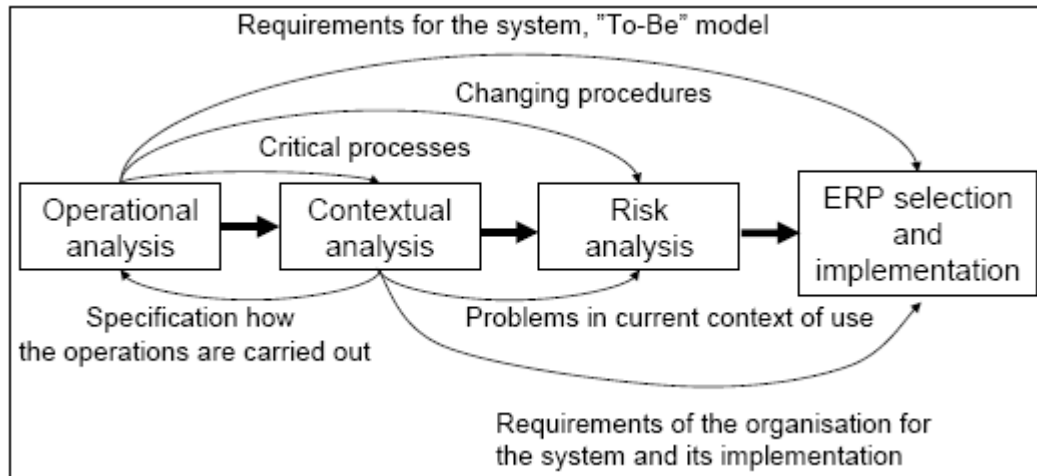


Figure 1. Flow of the C-CEI method.

### *Operational analysis*

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

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

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

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

### *Contextual analysis*

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

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

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

### *Risk analysis*

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

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

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

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

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

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

## Discussion

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

In the case study, where the method was first applied, the activities of analyses were conducted as intensive days. The company's board of executives (BOE) participated in these sessions. On some occasions this might be impossible, because in SMEs individual personnel

may have multiple roles and are often irreplaceable. The involvement of BOE members on such a large scale increases the costs of the method. However, their involvement also makes the method the most efficient one because it directly improves the skills, awareness and commitment of the key players in ERP implementation.

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

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

## Conclusions

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

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

The new method of ERP requirement specification for SME supports the organization in the ERP system and selection in many ways. Recognizing the changing business processes and analyzing them in a comprehensive way, enables the SME to target its limited resources at the most critical points of the organization. The definition and prioritization of the requirements provides a company with a solid basis for comparing various ERP systems. Without a clear requirement specification, the software is easily purchased on the basis of secondary

considerations. The risk analysis, conducted as proposed in this paper, forces the management of SME to evaluate the risks related to their ERP project.

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

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