ENTERPRISE SYSTEMS ANALYSIS AND MODELLING

IE Working Paper DO8-113-I 17 / 01 / 2004

Ángel Díaz

Instituto de Empresa
María de Molina 12, 5ª
28006 – Madrid
España
angel.diaz@ie.edu

Oswaldo Lorenzo

Instituto de Empresa
María de Molina 12, 5ª
28006 – Madrid
España
oswaldo.lorenzo@ie.edu

Abstract

In ES implementations, process modelling is a critical and often overlooked activity. This paper proposes an empirical-supported framework for process modelling of ES. The four steps method involves performing a Current Situation Analysis, deriving from this Business Process Improvements and Requirements. These, compared against the ES functionalities, result in a gap analysis that defines to-be processes, the trigger for the definition of organizational adaptation and system configuration and tailoring agendas. Outputs of the methodology are an interdependent set of organizational and system proposed changes and tailoring, and feedback loops to the vendors of ES and to the strategy of the firm. In-depth case studies and extensive literature review provides methodological support for the model. For practitioners, this study provides useful insights into one of the reasons by which organizations could be frustrated with ES implementation processes.

Keywords
Enterprise systems, ERP, process gap analysis and modelling, e-business

Depósito Legal: M-20073-2002 I.S.S.N.: 1579-4873

INTRODUCTION

Enterprise systems (ES) include intra-organizational information systems (e.g. ERP) and inter-organizational information systems (e.g. e-business). ES implementation differs from tailor-made information systems in that either the current functionalities of the ES are adapted to the organization processes, or these are adapted to the ES functionalities. This paper proposes a methodology to achieve this end.

ES impose their own logic on a company's processes, strategy, and culture. The main differentiator to traditional information systems is that when an organization adopts an ES, it does not design a new system to meet its way of working. Instead, there is more emphasis on the organization adapting its business processes to the package's functionalities. Typically this will involve process redesign, changes in roles, procedures, sequence of tasks, and organizational structure. ES can also be tailored to fit specific organizational needs, for example programming of additional reporting and applications, and interfacing to third party products (Brehm *et. al.* 2000).

The major activity for this crucial objective is process gap analysis and modelling, used as an instrument to decrease the gap between the ES and the organizational needs. Behind this porcess is a set of issues such as methodologies, techniques, and tools. This paper argues that to perform process gap analysis and modelling effectively it is necessary to have a clear understanding of organizational needs and ES business practices.

There exists limited empirical evidence on how to carry out process gap analysis and modelling in an ES environment. This paper adds to this empirical research by analysing these activities over ES implementations in five companies. The paper aims to develop a methodological framework to successfully realize process gap analysis and modelling in ES environments. The methodology that emerges encompasses four phases: current situation analysis, business process improvement and requirements, gap analysis, building the to-be process. The proposed methodology also includes the inputs and outputs related to the model. In particular, it is important to note the needs for organizational change and system tailoring to build the to-be process. The requirements for system tailoring also acts as learning mechanism for the ES vendor. The paper argues that the induced methodology could facilitate a faster and a less risky ES implementation by providing a more structured approach.

The research methodology has been theory generation from case study evidence. The theory generation consisted of inducting theory using five cases. The first author captured the process through a combination of retrospective and real time analysis. Frequent visits were carried out over a period of nine months. The primary methods of data collection were semi-structured interviews, observation and documentary review. The data analysis consisted of three iterative activities: data reduction, data display and conclusions drawing/verification.

Enterprise Systems

Enterprise Resource Planning (ERP) systems have its roots in the manufacturing industry (Escalle and Cotteleer 1999; Davenport 2000; Chung and Snyder 2000). A number of authors suggest that ERP is an extension of MRP II with enhanced functionality (Gumaer 1996; Yusuf and Little 1998; Chung and Snyder 2000). Manufacturing specialists have been always identified as pioneers in organizational integration efforts (Davenport and Short 1990; Ettlie, 1992). The integration of tasks and technologies in the manufacturing processes has been a major objective in manufacturing (Chung and Snyder 2000). The need for this integration led to the development of packaged software, from MRP (Material Requirements Planning) in the seventies, through MRP II in the eighties, to the development of ERP in the nineties (Chung and Snyder 2000). This evolution has happened in such a way that the earlier package is included inside the new one. While MRP is the heart of an MRP II, the ERP's manufacturing applications are similar to the MRP II applications (Parker 1996; Chung and Snyder 2000).

ERP systems go beyond the manufacturing domain, as they can support a much wider range of business activities (Markus and Tanis 2000). Nowadays ERP systems encompass "front-office" applications, supporting e-business, supply chain optimisation and customer relationships management (Davenport 2000, Díaz 2000). Because of this, some authors such as Davenport (2000), Markus and Tanis (2000), and Kawalek and Wood-Harper (2002) refer to ERP systems as Enterprise Systems (ES). As Davenport (2000) argues, "these systems have transcended their origins so that the somewhat clumsy ERP name is no longer appropriate." This work agrees with this position. Thus, ES is used instead of ERP systems.

The extended functionality beyond the traditional ES back-office applications can be provided from either the same ES vendor or third-party providers. ES functionalities have been extended into:

- Business intelligence applications (BI), which take data from the ES database for analysing it. These applications include data-warehouse, data-mining, and decision support systems.
- Customer relationship management (CRM) applications, which provide front-office solutions such as sales force automation or call centres.
- Business-to-business (B2B) applications, which allow the company to integrate data and information beyond its own limits (i.e. inter-organizational integration). These applications include solutions such as e-procurement (to place orders to suppliers) and e-commerce (to receive orders from clients).

ES Characteristics

The main technical differentiator to traditional information systems is that when an organization adopts ES, it does not design a new system to meet its ways of working. Instead, there is much greater emphasis on the organization adapting its business processes to the package's generic functionality. Typically this will involve the reworking of business processes through some degree of business process redesign (Markus and Tanis 2000). Software configuration takes place in conjunction to this process. The configuration process ensures that parameters are set in the package to reflect organizational models and business rules (Brehm *et. al.* 2000). Configuration is a difficult exercise, requiring that business decisions and their rationale be recorded (Markus and Tanis 2000). Business process redesign and software configuration are key spheres of activity in any ES project.

Most ES vendors have tried to design their systems to reflect best-business practices (Davenport 1998). These practices reflect the experiences of leading companies (Curran and Lad 2000). They also look to academic theory about the best way to manage some types of processes - e.g. production or inventory control (Markus and Tanis 2000). ES vendors are sometimes classified according with their strengths in business practices of specific industries. SAP's R/3 fits well to the personal computer, semiconductor, oil, gas and petrochemical industries (Davenport 1998; 2000). Baan has aimed to the aerospace and defence, transportation, electronics and discrete manufacturing industries (Sullivan 2002; Davenport 2000). Peoplesoft supports well health care, education, and government markets (Krill 2002). This concept of best practices is the logic behind non-modified ES implementions. But, as aforementioned, when a company wants to realize the benefits of the best practices embedded in these systems, it must carry out some degree of business process redesign (Markus and Tanis 2000; Brehm *et. al*. 2000).

Configuring an ES encompasses two sets of decisions (Davenport 1998). First, as most ES are modular, companies have to decide which system's modules or functionalities will be adopted. Almost all companies choose implementing the financial and accounting modules (Knapp and Shin 2001). Second, companies have to set parameters in the package through configuration tables to reflect organizational features (Brehm *et. al*. 2000). The first task in the customisation process is to establish the basic company parameters -e.g. country settings, tax settings, organizational unit's settings (Prince 1998). Then each configuration team identifies and establishes base parameters that enable the activity of each business process. For example, types of inventory accounting to be used – FIFO or LIFO (Davenport 1998), creating standard reports, and formulating available-to-promise logic (Brehm *et. al*. 2000).

Field research has shown that some companies have had to modify ES in order to meet specific business needs (Brehm *et. al*. 2000; Light 2001). That is, doing technical adaptation rather than organizational adaptation. This is labelled by Brehm and his colleagues as "tailoring" the enterprise system. This is strongly discouraged by vendors and consultants because tailoring can bring out a number of troubles in different stages of the ES life cycle. Typically, tailoring implies a longer implementation project, a more expensive maintenance, and difficulties in doing upgrading (Brehm *et. al.* 2000; Light 2001).

Analysis and modelling of processes

Business process modeling (BPM) is a common task of business process redesign (BPR) methodologies. BPM plays a key role in capturing existing processes and representing new processes adequately (Lin *et. el* 2002). BPM is usually a preparatory phase for activities that change the process such as business process improvement, business process reengineering, technology transfer, process standardization or software development (Succi *et. al.* 2000; Kawalek and Greenwood 2000). For others, like Lin *et. al.* (2002), BPM is also a main phase for process analysis, which facilitates process evaluation and alternative selection. The value of BPM is in making the knowledge explicit.

When talking about business process modeling (BPM) and business process change the literature describes three different terms, commonly misused in practical environments. They are methodologies, techniques and tools. Methodology is defined as a collection of problem-solving methods led by a set of principles and a common philosophy for solving targeted problems (Checkland 1981, Davenport and Short –1990- describe a BPR five-phases methodology). A technique is defined as a set of procedures for achieving a standard task (Hackathorn and Karimi 1988) – e.g. Lin *et. al* (2002) compare distinct BPM techniques such as IDEF, Dynamic Modelling, OO and AI. Tools are defined as instruments to perform a task (Hackathorn and Karimi 1988) -e.g. ARIS. A vast literature exists about methodologies, techniques and tools used in process analysis and modeling for BPR and software development (Succi *et. al.* 2000; Kawalek and Greenwood 2000).

When implementing ES companies attempt one of the following two implementation strategies (Curran and Ladd 2000):

- Blueprinting: is concerned with taking the ready-made templates – best practices - from the ES vendor as the basis for configuring the company processes. This implies a great emphasis on the organization adapting its business processes to the package's generic functionality;
- Modeling: is concerned with modeling company process according to the special organization needs, that cannot be met by a template, and doing mutual adaptation between the business processes and the ES functionality. This implies both organizational adaptation and ES tailoring.

For both strategies companies utilize the same modeling techniques and tools used for BPR and system development. With reference to methodologies, blueprinting presents a number of proprietary methodologies developed and used by ES vendors. For example, SAP has designed the ASAP methodology for the blueprint implementation of its ES. However, to our knowledge, there is no methodology explicitly documented for helping organizations to undertake a modeling implementation strategy. The reasons for this deficiency could be explained because the modeling strategy has been the result of the battle of organizations for reflecting their organizational needs into the ES.

In the light of the above, this study aims to develop a methodology of process gap analysis and modeling for ES implementations. The main research question to tackle in this study is: how are organizations closing the gap between the organizational needs and the ES standard functionality?

Research Methodology

The research methodology followed is that of theory generation from case study evidence. The aim is to generate a descriptive and explanatory theory of the process modelling and analysis in an ES environment. Several works of the process of theory generation from case study evidence have appeared in the literature (Glaser and Strauss, 1967; Yin, 1994; Miles and Huberman, 1994; Eisenhardt, 1989). Glaser and Strauss (1967) developed the comparative method for developing grounded theory. Yin (1994) has described the replication logic that supports the multiple-case analysis. Miles and Huberman (1994) described specific techniques analysing qualitative data in multiple-case designs. Finally, Eisenhardt (1989) outline a road map for building theories from case study research. This research has taken different elements of design from these works to undertake this investigation.

The theory generation from case study evidence approach is useful here, according to Eisenhardt (1989) and Orlikowski (1993), because it is appropriate:

1. To study procedural issues, as well as the action of players, associated with a specific phenomenon over time,
2. To understand a phenomenon in its early stages of research – i.e. when little is known, and
3. To use a new perspective that allows to achieve a better understanding of a specific phenomenon.

The selection process considers Glaser and Strauss' (1967) technique of theoretical sampling, which goal is to choose cases that are likely to replicate or extend the emergent theory (Yin, 1994; Eisenhardt, 1989). This research took the Yin's (1994) suggestion of following literal replications, selecting cases so that they predict similar results. This strategy allows to develop a theoretical framework of a particular phenomenon under specific conditions. The main issue was to choose organizations that had implemented ES under a modelling implementation strategy (i.e. doing mutual adaptation between the business processes and the ES functionality).

In addition, another research purpose was to generate theory applicable to different contexts. Then, differences between the sites were also sought. First, the research was realized in organizations adopting ES from distinct providers (e.g. SAP and Baan). Second, companies selected come from five distinct types of industries. Third, the companies are placed in two different countries. The chosen cases are describe in turn below:

Cases Background

Case 1: Chemical is in the chemical distribution business. The company operates chemical distribution facilities and sales service centres in six cities of South American country. Bulk liquids storages are maintained at the country's main ports for receipt of imports. CPC sells a broad range of high value additives and chemicals to target markets that include surface coatings, food, personal care, pharmaceuticals, oil and gas, plastics and other industrial sectors. Two presentations for the products are available: bulk liquids and liquids in drums. CPC carries out four key processes: procurement logistics, external accounting, distribution, and sales logistics. CC had implemented Baan's ERP product.

Case 2: Engineering is a corporation based on a group of companies acting as cost-benefit centres responsible for their own results, which fall under three main business units: Engineering, Procurement and Construction (EPC), Petroleum Operations (PO), and Telecommunications Operations (TO). These three business units operate independently within ESC. ESC had implemented SAP R/3.

Case 3: Coffee is in the business of processing and distributing roasted and ground coffee. CC owns a modern processing plant where these processes take place and packaged products are produced. The company buys green coffee through its procurement centres located in coffee regions. In the domestic market, CC distributes its products to 12 regional warehouses throughout the country. Then, the company sells its products to independent intermediaries, which reach final retail destinations. CC also possesses a small sales force that sells to the big retail destinations such as chains. CC had implemented Baan's ERP product.

Case 4: Telecom is the Spanish subsidiary of one of the major telecom corporations. Telecom is a market leader in mobile systems, a major vendor for mobile internet solutions, a top supplier for carrier class multi-service networks with broadband and IP capabilities, and a top player in mobile phones. Telecom had implemented SAP R/3 in 1997 and had chosen the SAP's B2B functionality to automate its procurement processes of MRO materials.

Case 5: Battery is the market leader in sales of car batteries in a South American country. The company attends three markets: automotive, industrial, and domestic. In the car market, the company sells to both the original car market and spare parts markets. The company strategy attempts to expand its market geographically to neighbouring countries (e.g. recently the company had been selected as provider of a leader car market in the nearest neighbouring country). Battery had implemented Baan's ERP product.

Data Sources

The researcher captured the process through a combination of retrospective and real time analysis. Frequent visits were carried out over a period of eighteen months. The primary methods of data collection were semi-structured interviews, observation and documentary review. The interviews included people related to ES implementation in one way or another: upper-management, functional management (key users), end users, technical specialists, project team, members of the personal department, and consultants. The researcher also carried out participant observation in monthly review meetings – each dedicated to managing and evaluating the ES implementation and lasting an average of three hours. Some training sessions were also attended. A review of documents focused on memos, users manual, procedures, system manuals, and reports of earlier implementation phases.

A total of 94 semi-structured interviews were conducted, each lasting an average of one and half hours: seventeen (17) interviews in Chemical; forty-one (41) interviews in Coffee; twenty-three (23) interviews in Engineering; seven (7) interviews in Telecom; and twelve (12) interviews in Battery.

Data Analysis

The data collection and analysis proceeded iteratively. The focus was the development of concepts, constructs, and relations to generate grounded theory. The iteration between data and concepts ended when enough constructs and concepts had been defined to explain what had been observed, a situation that Glaser and Strauss (1967) refer to as "theoretical saturation." Data were collected through a variety of techniques: un-structured interviews, semi-structured interviews, documentary review, and observation. This triangulation of data collection is advisable in theory generation because it gives multiple perspectives on an issue and allows for cross-checking (Eisenhardt, 1989; Glaser and Strauss, 1967). The analysis of data in each case followed the Miles and Huberman's (1994) techniques. The analysis consisted of three concurrent flows of activity: data reduction, data display, and conclusion drawing/verification. The main displays used in this research are matrices and graphs, which allowed the researcher to assemble and organized data into a compact form. From the outset of the analysis activity, the researcher was noting regularities, patterns, and explanations. Later, some Miles & Huberman's (1994) suggestions were followed such as noting relations between constructs and building a logical chain of evidence. Once conclusions emerged, precautions were taken to corroborate the interpretations made. Verification encompassed checking field notes during the writing process, getting feedback from third parties (an ES consultant, two scholars, and people that participated in three research seminars).

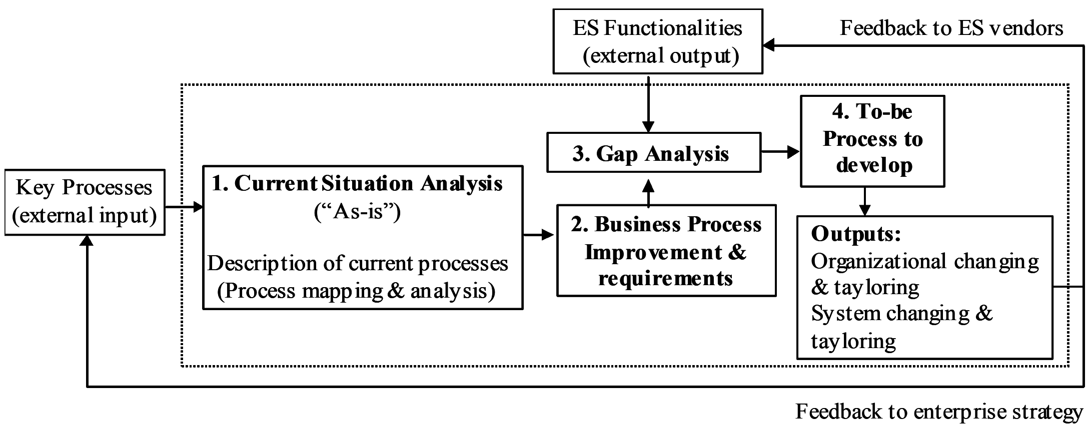
RESEARCH FINDINGS

A Methodology of Process Gap Modeling For ES

The methodology of process gap analysis and modeling for ES, developed over five cases, is shown in Figure 1, where boxes 1 to 4 represent the proposed activities.

External inputs are a definition of key processes, which derive from the strategy of the firm, and the capabilities of the current ES. Outputs of the methodology are an independent set of organizational and system proposed changes and tailoring and feedback loops to the vendors of E.S. and to the strategy of the firm.

Figure 1. Proposed methodology



The trigger of the methodology is "Current Situation Analysis" (number 1, "As-is", in Figure 1), concerned with understanding processes before modeling them. The primary reason for this is that "problems must be understood so that they are not repeated" (Davenport 1990). The ES implementation has to involve the analysis of current business processes and the chance of reengineering (Scheer and Habermann 2000). The analysis of current situation encompasses process identification (Rosemann and Stewart 2001; Davenport and Short 1990), process modelling - *as-is* (Rosemann and Stewart 2001; Davenport and Short 1990; Curran and Ladd 2000), the definition of the specific objectives of the process and the measurement of the process performance (Davenport and Short 1990), and process analysis to identify troubles (Rosemann and Stewart 2001). The process objectives are a key input into the modelling activity, guiding modelers in the subsequent activities. For example, whether the aim is to reduce the lead time, the modelling activity should be addressed to eliminate and/or automate manual tasks.

Once "Current Situation Analysis" occurs, "Business Process Improvements and Requirements" (number 2 in Figure 1) takes place. This activity is concerned with the description of process improvements and requirements, which will be later compared to the ES capabilities. The definition of process requirements is a key activity in ES implementation (Sheer and Habermann 2000; Kirchmer 1998). Although some ES providers include this step as part of the business blueprint activity (the to-be process), the emerging framework suggests that it is better to keep this step alone in order to guarantee a business-driven process modelling, instead of an ES-driven process modelling. The reengineering literature (e.g. Hammer 1990) provides frameworks that can be used to this end.

The third activity is "Gap Analysis" (number 3 in Figure 1), concerned with the reconciliation of the business process requirements with the ES functionality. Business processes and ES models must be compared and any differences determined (Kirchmer 1998).

The last activity is "Building the to-be Process" (number 4 in Figure 2). As a result of the gap analysis the ES specialists and the organizational key-users have now the necessary inputs to model the to-be process (Kirchmer 1998). The to-be process is the trigger for the definition of organizational adaptation and system configuration and tailoring agendas (Lorenzo *et. al.* 2003; Kirchmer 1998). Outputs of the methodology are an interdependent set of organizational and system proposed changes and tailoring and feedback loops to the vendors of ES and to the strategy of the firm.

Case Discussion

The application of the methodology to the first case, Chemical company, is discussed in greater detail below. For the brevity sake, part of the collected evidence from the other four cases is summarized in Table 2.

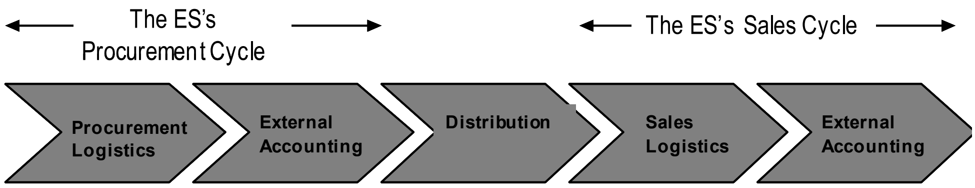
<u>Chemical</u>

In early 1996, Chemical decided to implement an ES because upper-management was convinced that this sort of application would support its business strategy. The company had two explicit business objectives: 1-cost leadership for industrial clients with requirements of high volume (bulk liquids) and low price -mainly big companies in which the Chemical's products represented high percentages of their costs; 2-differentiation in packaging (e.g., barrels, sacks and smaller containers) and giving credit to fulfil the small and medium enterprises' requirements. It is worth noting here that most goods sold by Chemical are chemical commodities. Because of this, the company competes often in a context of prices war. Given that the margin is low, Chemical has to be efficient in its own processes or has to find ways to differentiate itself from other competitors in order to sell with better margins.

The ES was aimed to support the first objective via streamlining business processes (operational efficiency). The ES would also encourage the second objective via delivering accurate and timely information that would allow the company to handle the complexity of its differentiation strategy – e.g., handling an expansion of the accounts receivable.

Firstly, the functionalities of financial accounting, sales and distribution, and materials management began being implemented in order to support the four key Chemical's processes: procurement logistics, external accounting, distribution, and sales logistics. Key-users also identified these processes as being part of the two ES business cycles: the procurement cycle and the sales cycle (see Figure 2).

Figure 2. The Chemical's Business Processes and ES Business Cycles



Procurement Logistics : is the process of buying and obtaining the products worldwide. This process involves several activities such as determining the market needs , locating supply sources, evaluating and selecting one or more suppliers, choosing a buying method, monitoring the purchase 's status, receipting, evaluating and storing the products.
External Accounting : involves key areas such as accounts payable and accounts receivable, which are closely linked to cash management and forecasting. As in any other distribution company, this is the vital business process in CPC.
Distribution : refers to replenish products (only those liquids in drums) into regional distribution warehouses from central warehouse.
Sales Logistics : involves three key sub-processes: customer request for quotation (RFQ) processing, customer sales orders (CSO) processing, and delivery processing.

This first implementation phases were undertaken under the premise that the company would follow a blueprinting strategy. Processes were modelled according to the business processes embedded inside the system rather than considering the company's specific requirements. As a consequence, no system tailoring was developed. The implementation was limited just to set parameters in the package (i.e. configuring).

Key-users became disappointed over time as they found that business practices embedded in the system did not reflect some of their organizational needs. They warned consultants and upper-management about future troubles in day-to-day operations, but the decision was to go ahead as planned. Reasons for this were that according to some users "the emergence for having the system up and running in order to fix all existing organizational troubles prompted the upper-management bets on an accelerated implementation; …but this implied doing an implementation as simple as possible." Also that "consultants did not know enough the system for answering all specific users requirements." As a consequence consultants undertook most activities (configuring, training) during this first implementation attempt. Key-users were reduced to answer the consultants' requirements. The system was running at the end of this first attempt, but the implementation was considered a failure because the system did not reflect the organizational reality. As a consequence, a second implementation attempt began later under a modelling implementation strategy, with the aims to re-modelled the processes already defined under a blueprint strategy, in order to take into account the organizational needs. The new implementation experience is described below following the process gap analysis and modelling methodology thus presented.

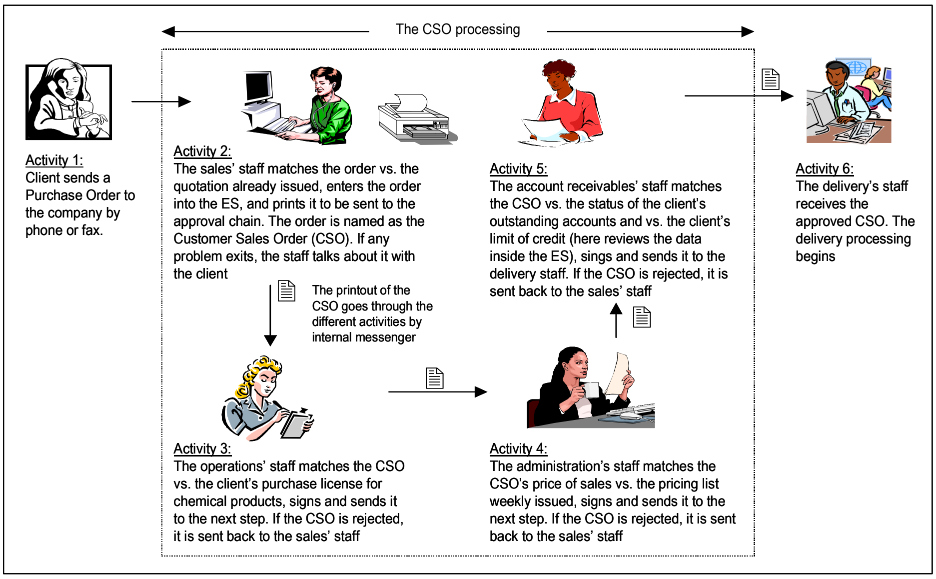
Current Situation Analysis

Once Chemical began using the ES for the sales cycle, it found that the process performance was still too poor to satisfy the client demands. The most remarkable deficiency in the sales cycle was in the customer sales order (CSO) processing, which lasted too long. The major organizational need for the sales cycle was stated as assuring a cycle of 24 hours between the reception of the CSO and the delivery of goods to the customer's warehouses. To achieve this, the company had to improve some weaknesses in the CSO processing already modelled. Some of these weaknesses were as follows: 1) As it can be seen in Figure 3, the system was not coordinating the work between distinct areas. The CSO was printed and sent through the rest of activities as a physical document. This shows a low understanding of ES integration concept from the former key users who designed the process in this way; 2) As it can be seen in Figure 3, the process has an excess of checking activities (activities 3, 4, and 5). Key users questioned all of these activities. As a result of this questioning, the activities 3 and 4 were changed. (see *business process improvements and requirements* below).

Business Process Improvements and Requirements

Once the process weaknesses were identified, a set of improvements was defined. First, the activity 3 (Figure 3) would be assigned to the sales staff, which should now match the client's purchase license (critical in the chemical industry) vs. the CSO before entering the CSO into the system. To this end, the company had asked the ES provider the register and storage of the purchase licenses within the system (see *gap analysis* below). Second, the activity 4 (Figure 3) was eliminated. Given that the company wanted to have a tight control on the sales price given by sales representatives to clients, the administration staff checked the price of each CSO vs. the listing price issued weekly (i.e. activity 4). However this procedure influenced negatively the sales cycle time. Because of this, the procedure was eliminated. Instead, a new reporting option was asked the ES provider for allowing the administration staff to match monthly the sales' profit vs. the planned profit (see *gap analysis* below). This is likely to be a similar way of checking the price of each CSO vs. the pricing list; but without hindering the speed of the day-to-day operations.

Figure 3. The CSO Processing – Current Situation Analysis



When the number of activities in the approval chain had been reduced, the aim was to improve coordination between the sales staff and the accounts receivable staff. To this end, the sales staff had not to print the CSO to be sent to the accounts receivable staff. The organization asked the ES provider to allow better coordination (e.g. viewing the CSO) between all areas by using the ES (see *gap analysis* below). Finally, to help the accounts receivable staff in its work, upper-management defined the Limit of Credit and Accounts Receivable Policy, which gave guidelines for the approval processing. The organization asked the ES provider to configure the system to follow this policy (see *gap analysis* below)

Gap Analysis

The gap analysis activity is concerned with the reconciliation of the business process requirements with the ES functionality. To this end, the business process models and the ES models must be compared and any differences determined (Kirchmer 1998). In Chemical, the key-users pointed out the key process requirements asked the system. The ES specialists matched these requirements vs. the ES functionality. This task included the definition of a gap level. That is, defining how much the ES could satisfy a specific requirement. Three-gap level was stated: 1 meant the system satisfies very well the need and implies just configuring the functionality; 3 meant the system satisfies partially the need and minor tailoring can be realized in order to close the gap (e.g. adding field to data outputs); 5 meant the system does not satisfy the need at all and major tailoring need to be realized in order to close the gap (e.g. programming further functionalities). When the last option occurred, the company could re-analyze its own processes in order to change its practices. Hence, organizational adaptation could occur. Finally, an agenda of organizational adaptation and system configuration and tailoring was agreed by key users and consultants. Table 1 shows four examples of the gap analysis carried out as part of modelling the sales process.

Table 1. Process Gap Analysis between the Organizational Requirements and The ES Functionality

Process Requirement	Possible in the ES?	Gap Level	Gap Analysis & Decision
Allow users utilizing the CSO to perform their own tasks to view, track or check the CSO in the ES.	Yes	1	To satisfy the need, the ES can be easily configured to allow these users to view, track, or check the CSO.
Allow sales staff to carry out activities 2 and 3 (Figure 4). To this end, the purchase licenses must be registered and stored within the ES to allow sales users to match the CSO vs. the license.	No	5	To satisfy the need, consultants must develop an application using the ES provider's language in order to record this information. With this information inside the system, other developments could be programmed later for allowing the sales functionality to match automatically the CSO vs. the license.
Administration staff needs to match monthly sales profits vs. planned profit.	No	3	To satisfy the need, consultants must develop a new reporting option using the ES provider's language.
Automation of the credit approval of the CSO based on the limit of credit and outstanding accounts policy.	No	5	Given that the ES did not have the workflow functionality, consultants decided to pursue the following solutions: Developing an application for sorting the CSO according to the credit policy: an application would be developed in the product's language in order to sort the CSO according to their accounts receivable status. Those CSO with outstanding accounts were blocked to be reviewed by the accounts receivable staff (see next point). Those CSO without troubles go through. Developing a special data output for matching and marking the CSO vs. the credit policy: those CSO blocked in the last point are reviewed by the accounts receivable staff to bargain a payment compromise from the client. To this end, the ES specialists would develop a special data output, which allows the staff to mark the CSO that can be delivered after the bargaining. The delivery staff could also view the same output to identify those CSO that can be delivered.

Building the to-be Process

As a result of the gap analysis the ES specialists and the organizational key-users have now the necessary inputs to model the to-be process (Kirchmer 1998). The to-be process is the trigger to the organizational adaptation activity and the system configuration and tailoring (Lorenzo *et. al.* 2003; Kirchmer 1998). A match between the business requirements and the system functionality causes the system configuration. A mismatch between the business requirement and the system functionality causes the system tailoring (Lorenzo *et. al.* 2003). Figure 5 shows the resultant to-be process. As it can be seen, a more efficient and simple process was modelled. By reducing the number of activities and by using the ES as a coordinating mechanism (instead of the CSO printout), the time had been significantly reduced.

Figure 5. The to-be CSO Processing

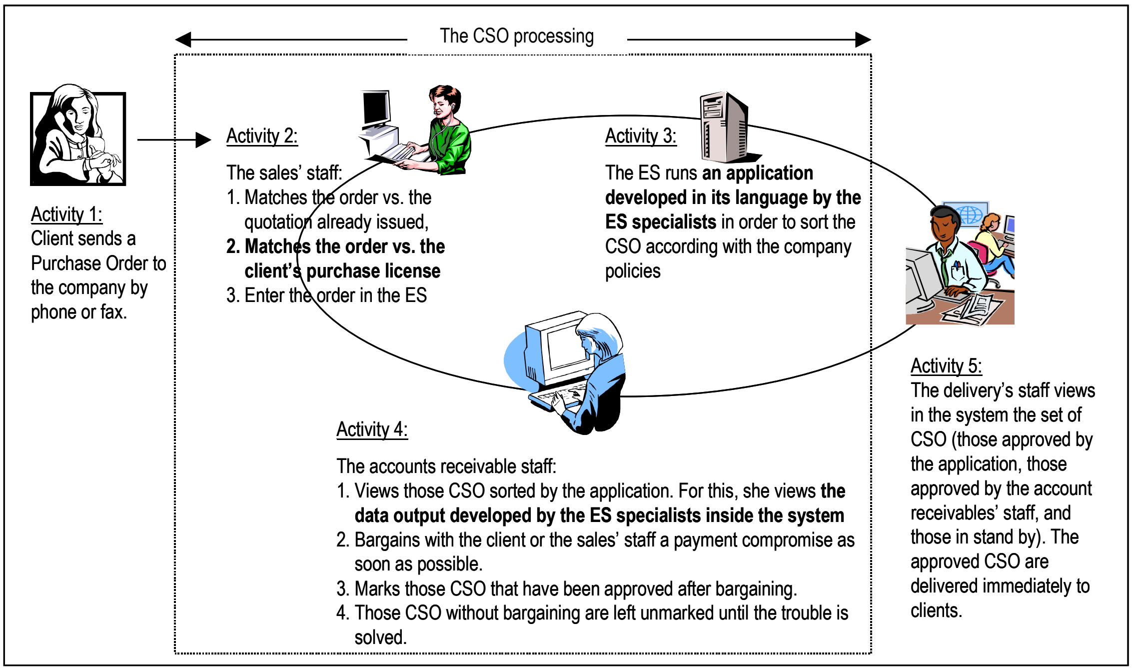


Table 2 summarizes the results of the application of the gap methodology to all five cases

Table 2. A Sample Of Evidence Collected From Each Site

Case	**Analysed Process**	**The Methodology's Activities**			
		Current Situation Analysis (as-is)	**Business process Improvements & Requirements**	**Gap Analysis**	**Build the to-be Process**
Engineering	Time recording	Long timesheets processing time and poor data quality	Easier data entry. Decentralizing the enter of the timesheets into the system. A workflow system for the approval process.	The data entry into the ES time recording functionality is long and unfriendly.	Implementing the ES time recording functionality. Easing data entry implies re-programming the system to reduce the number of options that need to be fulfilled. Implementing the ES workflow functionality.
	Billing professional services	Standalone billing application. Lack of integration between the billing application and the rest of applications cause many billing mistakes.	Billing functionality integrated to the rest of the company. Using billing schemes for professional services (different to those used for manufactured goods)	The ES billing functionality is integrated to rest of the system. The ES billing functionality does not fit to the billing schemes required by the company	Implementing the ES billing functionality. Using the company's billing schemes implies programming the ES functionality (i.e. tailoring). The entire implementation implies also organizational changes.
Coffee	Distribution and Sales	Replenishment orders into warehouses issued manually, the involved areas do not have means to share related information. Poor control and information of intermediaries' sales to final retailers.	Automating replenishment orders and sharing information in real-time.	The ES Distribution Requirements Planning (DRP) functionality fits well to business requirements	Automating the issue of replenishment orders via ES. This implies eliminating and changing organizational roles.
			Tracking downstream the sales and demand in the supply chain.	The ES functionality does not fit to this requirement at all	Adopting Hand Held Computers into third party intermediaries and developing an additional functionality in the ES to register the intermediaries' sales.

Table 2. A Sample Of Evidence Collected From Each Site (Cont.)

Case	Analysed Process	The Methodology's Activities: Current Situation Analysis (as-is)	Business process Improvements & Requirements	Gap Analysis	Build the to-be Process
Telecom	Procurement of non-production related (NPR) materials	Poor control of procurement of NPR materials. High percentage of invoices from providers without related purchase orders. High costs of ordering.	Automating the procurement of NPR materials.	The ES B2B procurement functionality fits well to business requirements	Automating the procurement of NPR materials. This implies eliminating tasks in the procurement area and empowering users (employees).
			Using electronic catalogues. Allowing categories of catalogues for different groups. Closed catalogues clearly state providers, price, lead times. Free text catalogues have only state providers.	The ES functionality does not fit quite well to this requirement	Improving the control while keeping flexibility. Using categories of catalogues implies developing additional functionality in the ES (i.e. tailoring) and organizational changes
Battery	Distribution	Replenishment orders into warehouses issued manually, involved areas do not have means to share related information.	Automating replenishment orders and sharing information in real-time.	The ES Distribution Requirements Planning (DRP) functionality fits well to business requirements	Automating the issue of replenishment orders via ES. This implies eliminating and changing organizational roles.
	Sales	Status tracking of batteries (i.e. manufactured, in distribution, in warehouse, in retailer shelves, returned, and so on) very difficult.	Use ES to track status of a battery (e.g. moving a battery through various warehouses) and share information throughout the company.	The ES does not fit to this requirement.	Improving tracking of the status of a battery. This implies developing additional functionality in the ES (i.e. tailoring) and organizational changes.

CONCLUSSIONS

The companies studied developed informal process gap analysis and modelling while implementing their ES. No formal attempt to structure this process was reported. However, the level of complexity, risks, and costs related to a modelling implementation strategy suggests that a more structured approach is needed (Kirchmer 1998; Somers and Nelson 2001). The induced methodology for process gap analysis and modelling could facilitate a faster and a less risky ES implementation by providing more structured approach.

Furthermore, the methodology could encourage an easier and deeper ES diffusion and infusion throughout an company as a consequence of the reduction of mismatches between the organization and the technology (Lorenzo 2003; Leonard-Barton 1988).

While all sites studied followed informally the process gap analysis and modelling methodology for their ES implementation, their experiences differ considerably. The comparative analysis method of grounded theory, which allow contrasting each site against each other on a common set of concepts (see Figure 1 and Table 2), suggests that these differences can be attributed to: 1) variations in the gap level of the ES functionality and the organization requirements; and 2) variations in the organization and consultant capabilities to realize organizational change and system tailoring, respectively.

With reference to “the gap level”, the comparison shows that the unmet business requirements were more visible and critical in some sectors (e.g. engineering services) rather than others (industrial distribution). This is the case of the engineering services sector in which the standard ES functionality did not fit to the required billing scheme. Furthermore, though the ES vendor had been the first one in unveiling a time recording functionality, this functionality was in its earlier stage by which it offered a reduced functionality. Both facts affected negatively the effectiveness and speed of the to-be process modelling. In contrast, companies with distribution processes had easily met their organizational needs through the standard ES functionality (see the coffee and battery companies in Table 2). Furthermore, key users recognized that the ES functionality allowed them to have a better understanding of best practices (e.g. DRP). The gap analysis have also become an input into the enhancement of ES functionality. Much evidence exists about how ES vendors have captured the process gap analysis results into their development and programming activities (Scott & Kaindl 2000; Brehm and Markus 2000). From this perspective, the process gap analysis and modelling methodology acts as a learning mechanism for both adopting organizations and ES vendors.

With reference to organization and consultant capabilities, the comparison shows that the business process requirements and improvements and gap analysis activities occurred more effectively under structured organizational approaches. This can see observed comparing the earlier modelling results in Chemical against others cases. While gap analysis and modelling activities were led by a key users committee in the Coffee company, the earlier modelling activities in Chemical was undertaken in a disordered way. Chemical had poor modelled processes. The Coffee’s Key Users Committee met monthly on a period of four hours in order to give guidelines and make decisions related to the gap analysis and modelling activities. A similar approach was observed in the Engineering and Telecom companies. Consultant capabilities were concerned with understanding the organizational needs and translating them into the system functionality. Although many consultants were available to configure and tailor the systems, the Coffee and Battery companies developed an outsourcing scheme with a single consultant in order to guarantee a stable and long-term relationship. Compared with the rest of cases, the outsourcing scheme seemed to be a more effective approach for gap analysis and modelling activities.

Implications

The process gap analysis and modelling methodology for ES implementations presented here has important implications for both research and practice. Firstly, the framework has allowed the identification of a structured methodology for modelling implementation strategies of ES. This represents an extension of existing business process redesign methodologies in IT environments proposed in the literature (Davenport and Short 1990). Further research is clearly needed to test the applicability of this methodology in other contexts and industrial sectors. Future studies can examine, for example: a) what organizational contexts and industrial sectors are more likely to follow modelling strategies, instead of blueprinting; b) how organizations and ES vendors translate the learning acquired in the modelling process into their own benefits.

For practitioners, this study provides useful insights into one of the reasons by which organizations could be frustrated with ES implementation processes. Building and fine-tuning better ES implementation methodologies imply bridging the gap between the organizational needs and the ES functionality. In doing so, ES vendors and consultants have to take organizational contexts and industrial sectors into account.

REFERENCES

Argyris, Ch. 1992. On Organizational Learning, London: Blackwell Publishers

Brehm, L. and Markus, M. 2000. The Divided Software Life Cycle of ERP Packages, Proceedings of The Global IT Management Conference.

Brehm, L., Heinzl, A. & Markus, M. 2000. Tailoring ERP Systems: A Spectrum of Choices and Their Implications. Proceedings of the 34th annual Hawai International Conference on System Science.

Checkland, P. 1981. Systems Thinking, Systems Practice, John Wiley and Sons, Chichester.

Chung, S. H., & Snyder, C. 2000. ERP Adoption: A Technological Evolution Approach, International Journal of Agile Management Systems, 2(1).

Curran, T. & Ladd, A. 2000. SAP R/3 Business Blueprint. Understanding Enterprise Supply Chain Management, USA: Prentice-Hall.

Davenport, T. & Short, J. 1990. The New Industrial Engineering: Information Technology and Business Process Redesign. Sloan Management Review, 31 (4), 11-27.

Davenport, T. 1998. Putting the enterprise into the enterprise system, Harvard Business Review, 76 (4), 121-131.

Davenport, T. 2000. Mission Critical: Realizing the Promise of Enterprise Systems, Boston, Massachusetts: Harvard Business School Press.

Díaz, A. 2000. The issues of e-business: from Demand Networks to Techno-Logistics, Supply Chain Forum, 1 (1).

Eisenhardt, K. 1989. Building Theories from Case Study Research, Academy of Management Review, 14(4), 532-550.

Escalle, C. & Cotteleer, M. 1999. Enterprise Resource Planning, Technology Note No. 9-699-020, Boston: Harvard Business School.

Ettlie, J. 1992. Organization Integration and Process Innovation, Academy of Management Journal, 15 (4), 795-827.

Glaser, B. & Strauss, A. 1967. The Discovery of Grounded Theory, New York: Aldine.

Gumaer, R. 1996. Beyond ERP and MRP II, IIE Solutions, 29 (9), 32-36.

Hackathorn, R. & Karimi, J. 1988. A Framework for Comparing Engineering Methods, MIS Quarterly (5:3), pp. 109-145.

Hammer, M. 1990. Reengineering Work: Don't Automate, Obliterate, Harvard Business Review, July – August.

Kawalek, P. & Greenwood, R. The Organization, The Process, and The Model, In Systems Modeling for Business Process Improvement, Edited by Bustard, D., Kawalek, P., and M. Norris. USA: Artech House.

Kawalek, P. & Wood-Harper, T. 2002. The Finding of Thorns: User Participation in Enterprise Systems Implementation, Data Base, 33 (1), 13-22.

Kirchmer, M. 1998. Business Process Oriented Implementation of Standard Software – How to achieve competitive advantage quickly and efficiently, USA: Springer.

Knapp, C. & Shin, N. 2001. Impacts of ERP Systems Selection and Implementation, Proceeding of the Seventh Americas Conference on Information Systems.

Krill, P. 2002. Peoplesoft increasing efforts in vertical CRM apps, InfoWorld, February,

(http://www.infoworld.com/article/02/02/28/020228hnpeople_1. html)

Leonard-Barton, D. 1988. "mplementation as mutual adaptation of technology and organization, Research Policy, 251-267.

Light, B. 2001. The Maintenance Implications of the Customization of ERP Software, Journal of Software Maintenance: Research and Practice, 13 (6), 415-429.

Lin, F., Yang, M., & Pai, Y. 2002. A generic structure for business process modeling, Business Process Management Journal, Vol. 8, Nº 1, pp. 19-41.

Lorenzo, O. 2001. Au delá de l'ERP: Internet et l'intelligence des affaires, Connaissance Action - Publication Du Group ESC Bordeaux, 12, 38-41.

Lorenzo, O., Kawalek, P., & Wood-Harper, T. Embedding the Enterprise System into the Enterprise: A Model of Corporate Diffusion, Communication of the Association for Information Systems, Forthcoming 2004.

Markus, M. & Tanis, C. 2000. The Enterprise System Experience, In Framing the domain of IT Research. Edited by Zmud, R., Cincinnati: Pinnaflex.

Miles, M. & Hubermann, A. 1994. Qualitative Data Analysis. An Expanded Sourcebook, 2nd Edition, California: Sage Publications.

Orlikowski, W. 1993. CASE Tools as Organizational Change: Investigating Incremental and Radical Changes in Systems Development, MIS Quarterly, September, 309-341.

Parker, K. 1996. The Enterprise Endeavour, Manufacturing Systems, 14 (1), 14-20.

Prince, D. 1998. Supporting SAP R/3. The Essential Guide to Supporting an SAP Business Environment, Prisma Publishing.

Rosemann, M. & Stewart, G. 2001. Process Modelling: A Teaching Approach for Developing Generic Skills in IT Students, Proceedings of the Seventh Americas Conference on information Systems, p.20.

Scheer, A. & Habermann, F. 2000. Making ERP a Success, Communications of the ACM, Vol. 43, Nº 4.

Scott, J. & Kaindl, L. 2000. Enhancing Functionality in an Enterprise Software Package, Information and Management, 37, 111-122.

Somers, T. & Nelson, K. 2001. Organizations and ERP Systems: Conceptualizing Fit, Proceedings of the Twelfth Annual Conference of the Production and Operations Management Society.

Succi, G., Predonzani, P., & T. Vernazza. 2000. Business Process Modeling with Objects, Costs, and Human Resources, In Systems Modeling for Business Process Improvement, Edited by Bustard, D., Kawalek, P., and M. Norris. USA: Artech House.

Sullivan, B. 2002. Baan rolls out new manufacturing management tool, Computerworld, June 11 (http://www.computerworld.com/ softwaretopics/crm/story/0,10801,71918,00.html).

Yin, R. 1994. *Case Study Research. Design and Methods*, USA: Sage Publications.

Yusuf, Y. & ittle, D. 1998. An Empirical Investigation of Enterprise-Wide Integration of MRP II, International Journal of Operations and Production Management, 18 (1), 66-86.