ARTICLE IN PRESS

Pergamon

Information and Organization XX (2002) XXX–XXX

INFORMATION AND ORGANIZATION

www.elsevier.com/locate/infoandorg

Implementing enterprise resource planning and knowledge management systems in tandem: fostering efficiency and innovation complementarity

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Abstract

This paper examines the simultaneous implementation within a single organization of two contemporary managerial information systems—Enterprise Resource Planning (ERP) and Knowledge Management (KM). Exploring their simultaneous deployment within an organization provides an opportunity to examine the resulting interactions and impacts. More specifically, we examine their combined influence on improving organizational efficiency *and* flexibility, two outcomes which traditional organizational theory suggests are incompatible. Through an interpretative case study, the research confirms that: (1) the two systems can be implemented in tandem to good effect; (2) complementarity between the two systems is possible, although this is not an automatic outcome, it has to be fostered. This complementarity is analyzed in relation to the four mechanisms (namely partitioning, enrichment, metaroutines and switching) proposed by Adler, Goldoftas and Levine (Organization Science 10 (1999) 43), as vital for the simultaneous development of organizational efficiency and flexibility.

Keywords: Enterprise resource planning; Knowledge management systems; Concurrent implementation; Knowledge creation; Organizational efficiency; Organizational flexibility; Interpretative case study research

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PII: S1471-7727(02)00007-6

1. Introduction

Within the field of IS/IT there has been a tendency to embrace new concepts so that the field has been populated by example after example of one fad or fashion after another (Galliers & Newell, 2001). A key problem here is that these 'latest fads' often appear to disregard past learning from the IS/IT literature. So, for example, while Davenport (1996) belatedly referred to Business Process Reengineering (BPR) as 'the fad that forgot people', so Knowledge Management (KM) has been criticized for emphasizing technology at the expense of people (Scarbrough, Swan & Preston, 1999). Moreover, these different IS/IT fashions are often conceptually rather different from one another. Indeed, it has been argued that each new fashion follows on from the last in the sense that it addresses the problems that were an unintended negative consequence of the previous one (Benders & van Veen, 2001). For example, BPR was typically associated with down-sizing, which meant that many employees were made redundant as organizations sought to improve the efficiency of their business processes and reduce costs. Many organizations subsequently found that an unintended negative consequence of their BPR initiative was a loss of organizational knowledge, which they had quite literally allowed to 'walk out the door' in the form of redundant employees. Subsequent KM initiatives were arguably a response to this problem.

What this faddishness means in practice is that many companies introduce new IS/IT concepts, often in quick succession. Indeed, two or more new IS/IT fashions may be being implemented simultaneously within a given company. Given that the implementation of multiple systems is likely to produce effects that are different than the effects of implementing a single system, research investigating the simultaneous implementation of IS/IT concepts would seem to be an issue worthy of investigation. This is so especially where the particular IS/IT concepts being introduced concurrently are rather different in their underlying philosophy. This then, is the focus of this paper. We explore the impact of the concurrent implementation of an Enterprise Resource Planning (ERP) and a Knowledge Management (KM) system within a single case company. Both ERP and KM systems are currently being widely implemented across organizations (see, for example, respectively *Communications of the ACM*, 2000 and Alavi & Leidner, 2001). In all probability they are being implemented simultaneously, or at least their implementations overlap in many companies, as in the case company described in this paper. Specifically, we examine the impact of introducing these two initiatives simultaneously within a single organization.

In this introductory section we examine the key defining characteristics of ERP and KM systems. ERP systems have been defined as enterprise-wide packages that tightly integrate business functions into a single system with a shared database (Lee & Lee, 2000). They have also been characterized as comprehensive software solutions that integrate organizational processes through shared information and data flows (Shanks & Seddon, 2000). Thus, ERP systems are marketed as a vehicle for integrating the core business activities of an enterprise, such as finance, logistics and human resources, and as a means of overcoming problems associated with so-called

"legacy systems" (*Communications of the ACM*, 2000). They are based on developing a common IT infrastructure and common business processes. Previously, especially in larger globally distributed corporations, many incompatible systems and processes co-existed, making integration difficult. The suggestion is that ERP systems can play an important part in leveraging organizational competitiveness through improving the way in which strategically valuable information is produced, shared and managed across functions and locations. ERP systems, then, have been strongly promoted, promising improved competitiveness through increasing productivity, reducing costs and improving decision quality and resource control, thereby enabling leaner production (*Communications of the ACM*, 2000). In other words, ERP systems are promoted as systems that will improve organizational efficiency through both enhanced information capture and organizational redesign around defined best practices. Thus, the hope of increasing productivity and efficiency, particularly the management of global operations (Glover, Prawitt & Romney, 1999), as a means of raising organizational competitiveness (Davenport, 1998), underlies firms' motivations for adopting ERP systems.

KM systems emphasize how firms can enhance competitive advantage through more effective utilization of their knowledge assets. This is to be achieved by allowing free flow of knowledge across organizations (Starbuck, 1992). Through improved knowledge sharing and knowledge creation, flexibility and innovation should be enhanced (von Krogh, Ichijo & Nonaka, 2000). In the growing body of literature on KM it has become clear that there are different approaches that can be adopted to the management of knowledge. For example, Hansen, Nohria and Tierney (1999) differentiate between a personalization and a codification strategy. They argue for the adoption of one or other approach (using the 80–20 rule) as it is unlikely that a firm will be strong in both. In their terms, a personalization strategy focuses on sharing and creating knowledge through face-to-face interaction; in particular relying on teams and communities of practice (Brown & Duguid, 1991). A codification strategy, on the other hand, relies on IT to transfer written documents—explicit knowledge in other words—between individuals and groups. In a similar way, Scarbrough et al. (1999) distinguish between a cognitive and community approach to KM and argue that each is relevant in different contexts. The cognitive approach, like the codification strategy, involves the transfer of explicit knowledge and is useful where senders and receivers share a common understanding. The community approach, like the personalization strategy, involves the sharing of tacit knowledge (Polanyi, 1966) and is useful where the goal is knowledge creation in the context of multi-disciplinary teams (von Krogh et al., 2000).

In many ways, this distinction between a personalization/community approach and a codification/cognitive approach to KM mirrors the distinction between organizational designs that promote either efficiency or flexibility (see below). More importantly, the literature is increasingly emphasizing the importance of the personalization/community approach, at least for promoting innovation and flexibility. For example, McElroy (2000) distinguishes between KM strategies that emphasize dissemination, imitation and exploitation (i.e. first-generation KM) and those that promote education, innovation and exploration (i.e. second-generation

KM). In second-generation KM the focus moves from the supply of knowledge to creating and maintaining the conditions required for the production of knowledge. McElroy argues that there is a need to shift the emphasis from first-generation to second-generation KM. Whether in practice such a shift is happening is more debatable. The research evidence to date on firms' KM initiatives suggests that IT solutions dominate (Alavi & Leidner, 2001). Nevertheless, in the case company to be discussed here, the KM initiative was very much within the frame of second-generation KM, focusing on building communities, training and developing staff, and on improving innovation and flexibility.

Thus, the key characteristics of ERP and KM systems suggest that they are rather different in their orientation: with ERP systems focusing primarily on efficiency and KM systems, at least second-generation KM systems, on flexibility and innovation. Yet, as we will consider in more detail in the next section, organizational theory has traditionally posited a dilemma or tension between efficiency and flexibility/innovation. In other words, traditionally it has been assumed that a company must either focus on efficiency *or* flexibility since it cannot do both (Thompson, 1967). This would suggest that there may be problems for a company attempting to introduce ERP and KM systems simultaneously. In the case company we specifically focus on the impact of this joint implementation on organizational efficiency *and* flexibility.

Before turning to the efficiency–flexibility debate, it is important to note that, in practice, any given IT/IS system has interpretative flexibility (Weick, 2001). As a result, the outcome of any IT implementation is emergent (Brown & Eisenhardt, 1997), since there will always be scope for improvisation (Ciborra, 1999) in technology and technology use. As Orlikowski (2000; 407) notes: "Through their regular engagement with a particular technology (and some or all of its inscribed properties) in particular ways in particular conditions, users repeatedly enact a set of rules and resources which structures their ongoing interaction with that technology". Indeed, in the literature on management fashions the conceptual ambiguity of new ideas is seen as a key ingredient to promote widespread diffusion (Kieser, 1997). Specifically, a concept's ambiguity means that potential users can eclectically select those elements that appeal to them and fit their current purposes (Benders & van Veen, 2001). Thus, Ortmann (1995) maintains that a concept must have 'interpretative viability' to stand a chance of broad dissemination. Within the context of adoption, therefore, the concept must be translated. Put more eloquently, it must "fight its way through a semipermeable organizational membrane consisting of existing power networks, organizational cultures and subcultures" (Doorewaard & van Bijsterveld, 2001; 55). For this reason, IS/IT implementation projects often have unanticipated and contradictory consequences (Robey & Boudreau, 1999).

We take up this issue in this paper and explore the ways in which the ERP and KM systems were interpreted by the different groups within the case company and how this impacted on organizational efficiency and flexibility. The paper is structured as follows. We first briefly introduce the conceptual foundations of this research by reviewing aspects of the literature concerned with organizational efficiency and flexibility in dealing with environmental opportunities and imperatives. This is fol-

lowed by a description of the research context and the methods employed in this empirical study. We go on to discuss the findings arising from the case study and conclude by identifying both theoretical and practical implications.

2. Conceptual foundations: efficiency and/or flexibility?

A large body of literature has focused on examining the interface between the external environment and internal organizational processes, providing theoretical explanations that pinpoint the need for efficiency and flexibility (e.g. Davidow & Malone, 1992; Wright & Snell, 1998) and, more critically, a trade-off between them (Ghemawat & Costa, 1993). Indeed, the idea of a trade-off between efficiency and flexibility is perhaps the most enduring idea in organization theory (Thompson, 1967). It can be traced back to the development of contingency approaches, in particular the work of Burns and Stalker (1961). Burns and Stalker depicted two distinct types of organizational design that they characterized as mechanistic and organic, and argued that each was appropriate to accomplish different tasks in different environmental situations. Specifically, they argued that mechanistic structures, alternatively described as bureaucratic structures, were most appropriate where the environment was stable. This is so because in such a situation the goal of the organization is the efficient production of goods and services. Here, there is no need to attempt to develop new products or services, or introduce new organizational processes, because the environment does not require it. However, where the environment is more dynamic so that the organization does need to change its products, services or processes to adapt to the changing demands, an organic structure is required. Mechanistic structures are characterized by high degrees of standardization, formalization, specialization and hierarchy; organic structures are characterized by low degrees of each of these aspects of structure. Given these diametrically opposed organizational forms it became the received wisdom that an organization either had to focus on efficiency or flexibility.

Many subsequent theories postulated a similar contrast in organization design: machine bureaucracies versus adhocracies (Mintzberg, 1979); adaptive learning versus generative learning (Senge, 1990); exploitation versus exploration (March, 1991); specialized and individual roles versus generalized and team roles (Bolwijn & Kumpe, 1990). In all these cases the premise is that flexibility can only be achieved at the cost of efficiency (Hannan & Freeman, 1989). Some writers have thus concentrated on how to improve efficiency while others have concentrated on improving flexibility and innovation. In relation to efficiency, for example, one stream of theoretical development has tended to focus on improving efficiency through the continuous accumulation of information (e.g. Epple, Argote & Devadas, 1996). Others have emphasized the importance of organizational design for improving efficiency (e.g. Galbraith, 1977; Lawrence & Lorsch, 1967). This emphasis on efficiency has been repeatedly reinforced by contemporary management theories and practices, notably the implementation of total quality management (TQM) (Zbaracki, 1998).

In relation to flexibility, the key is seen to be encouraging interaction within the

organization and between the organization and its environment. This is illustrated in approaches such as strategic choice (e.g. Geletkanycz & Hambrick, 1997), absorptive capacity (Cohen & Levinthal, 1990), adaptive processes (e.g. Eisenhardt & Tabrizi, 1995) and boundary spanning (e.g. Tushman & Scanlan, 1981). In conjunction with such approaches, some have focused on continuous organizational renewal and evolution, as reflected in the concepts of cognitive change (Barr, Stimpert & Huff, 1992), learning organization (Senge, 1990), virtual organization (e.g. Davidow & Malone, 1992), virtual teams (e.g. Lipnack & Stamps, 1997) and innovation (e.g. Brown & Eisenhardt, 1995).

While the positing of this polarity between efficiency and flexibility has a very long history, actual empirical evidence is very limited and contradictory (Adler et al., 1999). So, some research finds evidence for the tension (e.g. Hayes & Wheelwright, 1984), while other research finds no such evidence (e.g. MacDuffie, Sethuraman & Fisher, 1996). More importantly from the perspective of this paper, there are now a few writers who have suggested that it is possible to be simultaneously efficient *and* flexible or 'ambidextrous' (Daft, 1998; Tushman & O'Reilly, 1997). Adler et al. (1999) reviewed these different approaches to 'ambidextrousness' and highlighted four kinds of organizational mechanisms that the literature postulates as being important for achieving simultaneous efficiency and flexibility. These are metaroutines, job enrichment, switching, and partitioning. Metaroutines are routines to standardize internal processes that focus on flexibility or innovation (Nelson & Winter, 1982) (e.g. procedures specifying the steps that must be carried out in designing a new product in an attempt to routinize product innovation). In other words, they are routines to transform non-routine into more routine tasks. In terms of job enrichment, the motivating potential of a job is increased (Hackman & Oldham, 1980) through giving increased autonomy and responsibility, so that the person concerned can be more innovative and flexible even if the tasks are routine. Switching refers to the division of tasks so that a person is given time to spend on some non-routine tasks, but then switches back to doing routine tasks. For example, allowing routine workers to engage in quality circles would be an example of switching. Partitioning refers to the division of tasks by groups, so that some groups in an organization concentrate on routine tasks while others concentrate on the non-routine. So, the R&D department might focus on innovation while the production department focuses on efficiency.

While Adler et al. (1999) acknowledge that there are intrinsic impediments in relation to each of these mechanisms, their own empirical research at NUMMI, a Toyota subsidiary, suggests that these mechanisms were indeed central to achieving the exceptional levels of efficiency and flexibility at this plant. The research at NUMMI focused on manufacturing technologies and the ways in which these four mechanisms were enacted within this environment. In this paper, we explore how, if at all, IS/IT systems can support these four mechanisms that appear to be so central to the simultaneous achievement of both efficiency and flexibility. More specifically, we consider the ways in which the joint implementation of an ERP and a KM system influenced the enactment of these four mechanisms.

In summary, there are some who argue that efficiency and flexibility are mutually

exclusive, while others argue that they are perfectly compatible. At the same time, in practice we have companies that are implementing, often simultaneously, ERP systems that focus on improving efficiency and KM systems that focus on flexibility. In this paper we consider a company that is indeed implementing these two initiatives simultaneously. Specifically, we report on an empirical study that explored the inter-relationships between ERP, KM and organizational efficiency and flexibility. The aim is to attempt to answer the following two research questions: (1) To what extent do ERP and KM systems complement or contradict each other when they are implemented within a single organization by focusing on the different organizational needs of efficiency and flexibility? (2) To what extent do ERP and KM systems reinforce each other, mutually strengthening their respective influence, when they are implemented in a single organization? In exploring these two questions, we also discuss the different objectives and characteristics of ERP and KM systems, at least as far as they were enacted in the case company. The overall aim, then, is to explore the extent to which ERP and KM systems are complementary or contradictory.

3. Methodology

The research described in this paper adopts an interpretivist approach. The strengths of the interpretivist paradigm in IS research have been reported in a number of studies, notably Klein and Myers (1999) and Walsham (1993, 1995). Ontologically, the interpretivist paradigm suggests that meanings emerge from the interaction of social actors, and are fluid, ambiguous and context dependent (Hochschild, 1983). Specifically, in IS research, interpretivist approaches assume that meanings are shaped and reshaped by actors through the social construction and reconstruction of information systems (Mohrman & Lawler, 1984). Epistemologically, the study of any information system—ERP and KM in this instance—requires the exploration of meanings in such a way that collective actions, social contexts and processes are taken into account. In the words of Walsham (1993; 4–5), interpretivist research methods are “aimed at producing an understanding of the context of the information system, and the process whereby the information system influences and is influenced by the context”. Further explanation provided by Klein and Myers (1999; 69) states that interpretivist research “attempts to understand phenomena through the meanings that people assign to them”.

In line with the above philosophical tradition and its implications in IS research, an interpretivist case study (Gopal & Prasad, 2000; Walsham, 1995) was conducted between 1998 and 1999 as a means of understanding social actors’ meanings and actions related to the implementation and management of ERP and KM systems. The theoretical framework developed by Adler et al. (1999) was incorporated in the research analysis allowing us to examine and refine the simultaneous development of organizational efficiency and flexibility in a different context. In this instance, our case related to information systems, specifically ERP and KM systems, rather than manufacturing technology in Alder et al.’s (1999) research. Such a rationale is endorsed by Klein and Myers (1999; 75) who note that a theory can be used in interpretivist research “as a ‘sensitizing device’ to view the world in a certain way”.

As in previous empirical studies (e.g., Ngwenyama & Lee, 1997; Orlikowski, 1993), the unit of analysis was selected based on individual information systems—in this instance an ERP and a KM system. However, the research questions proposed in this study suggest the need not only to analytically investigate each system in isolation, but also to synthesize the two units of analysis during the latter stage in order to form an integrative unit of analysis. Five sources of evidence were collected from 37 semi-structured face-to-face interviews (see Table 1), interviews via telephone and email, informal dialogues with company employees without any prior arrangement, on-site observation, and examining documentation. The latter included written reports, administrative documents, archives, newsletters and the company's intranet site. Particularly, on-site observation prior to the semi-structured interviews proved useful in equipping the researchers with fundamental yet necessary technical knowledge to understand and engage with those involved. In other words, knowledge acquired during one stage helped to refine knowledge acquired at later stages, as reflected in the notion of dialogical reasoning that "the improved understanding of one stage becomes the prejudice for the next" (Klein & Myers, 1999; 76). Typically, interviews lasted more than 90 minutes and were tape-recorded, with the prior permission of the interviewee. Interview questions focused on each interviewee's background knowledge and experience (e.g. their role, their involvement in and their expectations about the two initiatives), the problems that had been encountered during the implementations, especially in relation to knowledge sharing, perceptions of the objectives and characteristics of the two initiatives, the impacts once implemented, and overall perceptions of their success, independently and together.

During the first few interviews, it was evident that some interviewees appeared to be rather uncomfortable once the tape recorder was switched on. However, they were willing to provide more personal opinions in less formal surroundings. For example, a few interviewees were happy to share their views openly in the pub nearby, in particular after one or two pints of beer! This reflects not only the value of informal dialogues, but also emphasizes the need for an environment where interaction between the researchers and the researched can be effectively facilitated (Klein & Myers, 1999). Research notes were taken during each interview, on-site observation and after the informal dialogues. A summary of each day's fieldwork was produced for the purpose of documenting the research effort and generating additional insights from each site visit.

Table 1
Interviews conducted at Company A

Role of the interviewee	1st Interview	Follow-up interview	Total
Project sponsor (Senior Manager)	2	1	3
Steering group (Head of Division)	3	1	4
Project team members	11	6	17
End user	6	3	9
Consultant (Vendor)	3	1	4
Total	25	12	37

The rationale behind adopting multiple data collection methods was not merely for the purposes of enhancing the richness of findings through the process of reflexivity (Alvesson & Sköldberg, 2000). In addition, they aided in the process of triangulation, or the need for multiple interpretations in Klein and Myers' (1999) terms, as a means of enhancing the validity of the findings (Denzin, 1988). Prior to coding, the preparation stage consisted of activities such as transcribing interview tapes, typing and filing research notes into the database, summarizing documents and clustering them based on the various sources. There were, therefore, four main clusters of data grouped during this stage—interview transcripts, field notes, photocopied documents, and information downloaded from the case company's intranet and databases. A brief note[1] that described the content of each file and potential linkages with different files was inserted in virtually every file stored in the four clusters of data to ensure that these links would not be forgotten due to the considerable amount of data collected.

Data collected from the various sources were analyzed based on the coding techniques proposed by Miles and Huberman (1994) and Strauss and Corbin (1990). Despite the fact that the purpose of this research was not geared towards theory generation, the open coding technique proposed by Strauss and Corbin was found to be useful, in particular to generate categories and concepts that were further used to refine the theoretical framework of Adler et al. (1999). For instance, the four mechanisms proposed by Adler et al. were used as four interrelated categories during the coding. Additional categories, such as the characteristics of ERP and KM systems, their relationships and the unintended negative outcomes of ERP and KM implementation (cf. Robey & Boudreau, 1999), were also generated. These categories were used as a means of comparison, not only with the theoretical framework of Adler et al. (1999), but also with the outcome of analysis based on "conceptually clustered matrix"[2] as suggested by Miles and Huberman (1994).

4. Case background

Company A,[3] a major league multinational player in the engineering industry, designs and manufactures standard and custom-built products and provides consulting services for corporate clients from over 70 countries world-wide. More than 60 000 employees across the globe generated sales turnover in excess of $8 billion during 2000 alone. Company A's employees are based in four main product divisions, namely Power Generation, Transport, Infrastructure, and Gas and Oil, each organized on a global basis. In addition and in contrast, a fifth division—the Logistics

[1] The technique used here is similar to the idea of using "concept cards" demonstrated by Prasad (1993) to outline the summary of each specific group of data.

[2] A conceptually clustered matrix is used to display evidence based on the key theme(s) of a research project, in this case organizational ERP and KM, according to the responses of interviewees. One of the main purposes of using this technique is to outline conceptual similarities and differences between the research themes.

[3] Names of the case company and IT service provider have been disguised at the company's request.

and Warehouse Division—is organized on a regional basis. In addition to the centralized head office functions, each product division has its own support functions, such as finance, accounting and human resources, that report directly to Head Office. There is a consulting arm too, which provides technological solutions to clients of all sizes. Due to its need to integrate expertise across product categories to meet differing client requirements, the consulting arm practices on a project-by-project basis and is less concerned with the formal structure.

Innovation had traditionally been viewed as the central competitive feature of the firm, differentiating Company A from its competitors. As one interviewee recalled:

> Maintaining a leadership in technology has always been our central concern and obviously that has a great impact on our strategic development. One of the main objectives of our R&D is to continuously improve our products and keep one step ahead of our customers' expectations.

However, more recently the need to improve efficiency was highlighted, leading to the decision to adopt ERP.

4.1. The ERP initiative

During 1995 Company A initiated a four-month evaluation study to look at the possibility of introducing an ERP system. A leading IT service provider conducted this evaluation. This IT service provider was a long-term strategic partner of the company. However, it was not until the second quarter of 1996 that the top management team gave the go-ahead for the ERP project, based on the business case presented by the service provider. The three-year project, which spanned all the major businesses, both Consulting and Manufacturing, in North America and in Europe, was regarded as one of the most important projects in terms of capital investment and coverage in the company's history. The project sponsors argued that the key driving forces behind the decision to implement the ERP system were the need to integrate processes and systems across the global operation and to cut costs. As one of the senior managers in the Power Generation Division explained:

> Over 25% of our products are based on technologies, which are mature and have little margin for improvement. For example, we could put in three years' hard work on an engine and only improve performance by 3–4%, that's hardly recognizable and not at all cost efficient. So that over the past few years, we have shifted our focus to work on our cost-base, in particular production and testing costs. We know this is a place where we can gain added competitiveness from, and SAP (the selected ERP system) is what we have to put in place to allow us to work on our cost-base more effectively and strategically.

A key issue here in relation to costs was that the ERP system would provide systematic and similar information across all units. This would allow for evaluation of the cost base of production in different Divisions and countries, making it possible

to compare performance, at either individual or group level, across the Production Division.

In order to create a common infrastructure across the Divisions, the ERP system replaced a number of the existing legacy systems. Different units had developed these legacy systems over time and so they were very different, meaning that the sharing of information across Divisions had been very difficult. In order to allow the entire organization to operate on a common platform, more than 7000 tables of the ERP software were painstakingly configured. Such configuration was undertaken to ensure that decision switches of each table were correctly set up to represent a specific part of the business process. More importantly, this configuration ensured that links between these decision switches led the software to the intended decision path, which would integrate separated business systems and processes and connect the flows of information across the organization. For instance, the implementation permitted the translation of information from various systems into the ERP system. One such system was the product data management (PDM) system used primarily by the Operation Engineering Unit for engineering drawings. However, it should be noted that this translation was only effective one-way. That is, the PDM information could be translated into the ERP system, but the ERP information could not be translated back into the PDM system. The engineers were not happy with this, as discussed in the section that follows, which deals with research findings.

The ERP project was also used as a basis for restructuring processes within the Production, Logistics, and Warehouse Divisions. This included outsourcing aspects of component production, reducing the number of warehouses (from 144 to 51 worldwide), and organizing Logistics on a regional rather than product basis. Moreover, the procurement of parts and components was centralized, and the number of suppliers and service providers[4] was considerably reduced. In particular suppliers were removed if they had small and infrequent transactions with Company A. The centralization of procurement, enabled by ERP, allowed the firm to more closely monitor and systematically evaluate the various suppliers and service providers' performance and cost efficiency. Various training programs were organized not only for equipping end users with the necessary skills to use the new system, but also for transferring knowledge from external consultants to internal personnel. Following the implementation of the ERP financial module, the production and logistics modules were completed and implemented at the end of 1998.

4.2. The KM initiative

During this ERP implementation, late in 1997, another critical company-wide initiative—knowledge management (KM)—was started. One interviewee from the Consulting Division noted the rationale behind the implementation of KM:

[4] Here, suppliers refer to the providers of tangible goods, such as components and raw materials, while service providers refer to individuals or organizations that provide Company A with intangible products, such as consultancy services or training courses.

> As I am sure some of my colleagues have already told you, trying to start knowledge management is more than just catching up with the latest managerial fashion. The people at the top are constantly going on about how critical innovation is to us and how desperate they are to develop an innovative culture. But innovation has to come from somewhere. We may have the most brilliant people in the industry, but I don't think we have done the right things to maximize their potential… Personally, I believe KM is the philosophy that provides the inspiration to create that innovation.

Interestingly, while one goal of the KM initiative was to improve innovation and flexibility through encouraging knowledge sharing, another was to actually selectively *prevent* knowledge sharing across the organization. As one project manager from the Consulting Division explained:

> It might sound crazy, but while most firms seem to be busting a gut trying to promote sharing between their employees, we are doing our level best to avoid it, well at least in my Division (*Consulting*) we are… We are paid by our clients to come up with technological solutions that are pattern-registered under their names. Legitimately, they can sue us if the same or even similar solutions are provided to different clients… KM for us means more than just saving time and effort, it is a means to prevent potential legal disputes.

The implementation of KM encompassed various initiatives, including forming a project team that later became the basis of the Corporate Knowledge Center (CKC), appointing a steering group which consisted of nine senior managers, identifying stakeholder groups and, most importantly, setting up learning and innovation communities. In addition, the project team set up a web-based corporate-wide knowledge directory, called "K-bank", on the firm's Intranet. The format of K-bank is similar to a telephone yellow pages, which has each member of staff's contact details, job title and a brief description of tasks performed by them. Moreover, the K-bank hosted more than 11 000 personal homepages during the first quarter of 1999. While each homepage was set up based on a standard template, each homepage owner was allowed to provide any information in the personal information column, in addition to standard information, this included working experience, educational background and training. For example, some interviewees suggested that K-bank was particularly useful for specialists who might be working in a different location or for different product categories. Also, K-bank had become a valuable database which archived pattern-registered technological solutions. Additionally, the team organized training courses, both conventional and on-line, to disseminate the concepts of KM, product-based learning and innovation communities to the various stakeholders.

Each learning and innovation community was focused on a particular product range and had both internal and external members with a range of expertise, such as design, raw material processing, engineering, production and product testing. When asking members of the CKC about the number of innovation communities formed in the company, answers varied from "more than 50", "around 60" to "just

above 100". According to the secretary of the CKC, the answer depended on whether the community had been approved, had been through a training program, or had a website in the K-bank. More than 100 applications were approved and sanctioned by the steering group, while around 60 communities had been through the workshop and training programs organized by the CKC. However, there were only around 50 communities that had websites that were continuously updated. Despite the fact that there were no official rules in terms of how community members should be selected, two principles were found to apply across all communities. First, there was no overlap between internal community members' specialties, with the exception of common experience of working on the same product. Overlaps of specialties were created mainly between internal and external members. Second, none of the communities had members from the same unit of the Production Division. According to interviewees from the Production Division, internal competition across different units of the Division had gradually replaced the collaborative tradition. Hence, to avoid members of staff from different units of the Division participating in the same innovation community was, in the words of one interviewee, "politically correct". An unusual feature of the innovation communities was that they also included retired engineers. In each community there were three or four retired engineers who acted as part-time consultants, inputting their experience and expertise as required. With the exception of a small number of communities that had members located on the same site, the majority were geographically dispersed across the globe, and connected through information and communication technologies (ICT), in particular email and video-conferencing facilities.

One of the main purposes of organizing these communities was to allow employees involved in aspects of development and testing of specific products to have the opportunity to share their learning. For instance, engine failure during testing might be due to the way in which raw material used to build the engine was not accurately processed according to the original specification. With the assistance of one or two members from the CKC, minutes of each community meeting were taken and compared with previous meetings to identify what lessons had been learned. Some communities' websites had sections which outlined their learning processes in a systematic and structured manner, while some emphasized more the quantifiable improvement made rather than how the result was achieved. In terms of sharing knowledge within each community, the majority of interviewees suggested that the communities provided an environment where engineers from different parts of the organization, such as R&D, raw material processing and testing, were able to effectively exchange ideas and articulate valuable lessons. These lessons, or "best practice" in interviewees' terms, were critical for production and process improvement. However, in terms of knowledge sharing across different communities, two interviewees from the CKC indicated that more efforts were needed to maximize the benefits arising from innovation communities. As one member noted:

> We believe that communities won't share what they have learned, unless they see a need for such sharing. To recognize this need and to benefit from knowledge sharing can be a long process. It took us more than five years to put our total

quality management program in place. I wouldn't be surprised if it takes us another five years to learn why this process took so long and then how to share with others what we learned from the whole process.

In conjunction with the ERP initiative, developing long-term strategic partnerships with the firm's major suppliers and service providers became one of the key issues underlying the KM project. In addition to the increasing involvement of external parties in various learning and innovation communities, a growing number of R&D projects were initiated involving collaboration with some of the suppliers and service providers.

In summary, the main objective of the ERP initiative was to improve productivity and product efficiency through the effective management of data and information, as well as to provide a means of more closely monitoring production. In other words, the adoption of ERP in this case mirrors other empirical studies that emphasize holistic improvement of efficiency through cost reduction, enhancing decision quality and increasing productivity (e.g. Scott & Kaindl, 2000; Soliman & Youssef, 1998). Conversely, the KM initiative focused on improving the intra- and inter-organizational integration of knowledge, allowing the firm to develop a continuous cycle of innovation (Grant, 1996). In comparison with ERP's production orientation, KM in Company A concentrated on the utilization of knowledge needed for product and process innovation. Particularly, the emphasis on continuous learning and benchmarking at the individual and departmental levels was attempted as an alternative and complementary approach to improving productivity and efficiency, and a critical source for organizational renewal (Barr, Stimpert & Huff, 1992). Table 2 provides a summary of the main objectives and characteristics of the ERP and KM initiatives as enacted in the case company.

5. Research findings

As indicated, our research focused on two main questions: (1) To what extent do ERP and KM systems complement or contradict each other when they are

Table 2
Objectives and characteristics of the ERP and KM systems in Company A

Objectives and characteristics of ERP	Objectives and characteristics of KM
Replacing diverse legacy systems, so creating a common IT infrastructure	Creating innovation communities including suppliers and retired staff
Creating a common productivity measure	Continuous learning and training
Restructuring production, logistics and warehouse divisions	Creating an intranet for storing and sharing information and knowledge
Centralized procurement	Building strategic partnerships with suppliers
Efficiency improvement through improved information sharing	Improving innovation and flexibility through improved knowledge sharing and creation

implemented within a single organization by focusing on the different organizational needs of efficiency and flexibility? (2) To what extent do ERP and KM systems reinforce each other, mutually strengthening their respective influence, when they are implemented in a single organization? This section is structured on this basis, with discussion centering, in line with our introductory remarks, on the unintended as well as the intended affects of the two initiatives.

5.1. The complementary or contradictory nature of the ERP and KM systems

Both systems were judged by organizational members to be successful in their intended aims and objectives. Thus, the findings suggest that the implementation of ERP had drastically improved the time to produce and gather critical information for strategic decision-making, particularly in relation to financial performance and productivity on a global scale (Davenport, 1998). Moreover, it was evident that the availability of ERP had helped to effectively coordinate activities, which required contributions from different Divisions. For example, to provide a quotation for a custom-built engine to a potential client typically requires information from different Divisions, such as R&D, Engineering and Production, to calculate the time and cost which may be involved. One of the managers in the Marketing Division explained that:

> It used to be problematic having to give our clients a quotation without knowing exactly how much a project would cost. We couldn't tell them three months into a project that we had to charge more because our original estimation was incorrect. Now, with our new system, we know precisely that X amount of components are in the warehouse and that Y amount of components need to be ordered. Knowing this allows us to determine how much a project will cost and how long it will take.

In addition, the implementation of KM was found to facilitate the effective and systematic exploitation and exploration of knowledge (March, 1991), both intra- and inter-organizationally, and improve continuous learning from past actions (Fiol & Lyles, 1985). In particular, the organization of innovation communities, with the involvement of retired engineers and suppliers, created an environment where products and processes required to produce such products were constantly under evaluation and improvement.

Within Company A, then, the ERP and KM initiatives had distinctive foci and orientations. In this sense, the two initiatives were complementary rather than contradictory. Each system was designed and implemented for a distinctive and clearly defined managerial purpose, notably managing organizational information to improve efficiency or knowledge to improve innovation. As the leader of the CKC noted:

> Before we started in 1997, a couple of people in the team had attended different conferences and workshops to learn the concept (KM). We were told by the consultants that knowledge is more important than information: knowledge, rather than information, is something that will make a business more competitive. I

> disagree with that. In our business, knowledge and information provide different values and each requires different methods of management. SAP is useful in integrating information but is not a solution for our knowledge management program. We haven't adopted SAP's knowledge management module because we don't believe that a 100% IT solution exists. I am not suggesting that a KM program will work without the support of IT. Rather, it would be more appropriate to say that the objective of our KM philosophy is to strike a balance between the use of sophisticated technology and the organization of our people."

We can understand this complementarity, by considering the impact of the two initiatives on organizational flexibility and innovation, using the framework of Adler et al. (1999).

5.1.1. Organizational efficiency and flexibility

As discussed in the introduction, Adler et al. (1999) suggested four mechanisms that can allow a company to be both efficient and flexible: metaroutines, enrichment, switching and partitioning. According to them, metaroutines, defined as "standardized procedures for changing existing routines and for creating new ones" (*ibid*.: 50), are vital for enhancing the efficiency of non-routine operations. The concept of enrichment underpins a learning mechanism by which non-routine tasks are continuously integrated and embedded into standardized activities. Switching refers to the process whereby employees sequentially perform routine and then non-routine tasks. Partitioning suggests the creation of organizational subgroups that "specialize in routine or in non-routine tasks" (*ibid*.: 50).

Let us consider how the ERP and KM initiatives in Company A impacted on these mechanisms, starting with partitioning. There was clear evidence of partitioning in Company A that pre-dated either initiative. Compared to the Production Divisions with highly standardized activities, tasks performed by the Consultancy Division were highly diverse and non-routinized, coinciding with other empirical accounts (e.g. Fincham, 1999; Martiny, 1998). In this sense partitioning pre-existed in Company A and had not really been influenced by the ERP and KM initiatives. Different Divisions specialized in either routine or non-routine tasks. Thus, efficiency *and* flexibility were achieved simultaneously by different Divisions specializing in one or the other of these processes. However, the KM initiative had opened up opportunities for improving flexibility even in the Divisions where efficiency was the primary goal. The other three mechanisms help us to understand how this was achieved.

Both ERP and KM appeared to promote the enactment of metaroutines. The adoption of ERP had led Company A to standardize the activities of information processing and management. More critically, new organizational processes were designed and implemented to maximize the potential of ERP. For instance, prior to the implementation of ERP, components were often mistakenly delivered to the Production Divisions by the Warehouse, because some of them were virtually identical in terms of their shapes and sizes. This was so notwithstanding the fact that the materials and processes employed to produce them were often different. All components and parts were therefore relabeled, and the information relating to each compo-

nent and part was codified during the ERP implementation. To make information on all parts and components available was vital not only to overcome limited knowledge possessed by staff in the Warehouse, but also to enable more effective inventory control. Similar arguments can be employed to conceptualize the role of KM, since this allowed the company to systematically externalize and codify knowledge, thereby acting as a catalyst for innovation. For example, within each learning and innovation community, less experienced members were asked to present their ideas to experienced members. Meetings, often chaired by the retired engineers, were particularly useful in discussing possibilities and difficulties in commercializing the ideas, as well as in identifying whether similar ideas had been applied and pattern-registered in the past.

Thus, to some extent, both the ERP and KM initiatives encouraged the enactment of metaroutines. However, there was a fundamental difference between the process of metaroutine enactment in relation to the ERP and KM initiatives. Both systems transformed non-routine work into routine work, but the KM initiative permitted the continuous transformation of non-routine into routine, while the ERP initiative stopped this process once the system was implemented and so solidified routines around the agreed work processes.

In terms of enrichment, the design and orientation of the ERP system had tended to inhibit this process. This was because it encouraged dependence on pre-defined and pre-selected routines, as discussed above. The ERP system assumed routine activities and did not take into account the occurrence of non-routine activities. In other words, ERP was installed to maximize organizational efficiency at the cost of flexibility. However, the KM initiative encouraged new knowledge generated by the learning and innovation communities to be further applied in different tasks. In particular, various pilot teams, based on the learning and innovation communities, were formed as pioneers for process and product innovation. For example, a device which was installed into the gas chamber of an engine to reduce noise was developed by the innovation community in the Transportation Division. This device was not only widely used in this Division, but also used in the Power Generation Division to reduce the noise caused by the generator. This suggests that the KM initiative in Company A was critical, particularly in complementing some of the limitations of ERP and embedding non-routine tasks into existing organizational routines.

Differences between ERP's and KM's influence on the phenomenon of switching were evident in Company A. Within the Production Divisions, for instance, where the impact of ERP was observed, there were a large proportion of standardized activities and very little if any evidence of switching triggered by ERP. The rationale behind putting a large proportion of standardized activities in place is reflected in the design of ERP, which requires clearly defined procedures and links between the procedures to ensure that a high degree of predictability and feasibility can be achieved. In other words, efficiency enabled by ERP lies in the minimization of switching activities, so that the degree of predictability and feasibility can be enhanced. In contrast, the initiation of KM was found to encourage switching, in particular through involvement in training and participation in innovation communities. Through switching, community members were able to exchange, reassess and refine what they

had learned during their routine work with other specialists. Hence, even though members of staff might be involved in highly standardized activities, such as those in the Production Divisions, they were able to enrich their work through switching between routinized and non-routinized work.

The impacts of the ERP and KM initiatives on the four mechanisms suggested by Adler et al. (1999) are summarized in Table 3. Thus, the ERP initiative focused on improving efficiency and did this through routinization, standardization, and predictability. The KM initiative's focus on flexibility, learning, and new experiences provided a complement.

5.2. The mutually reinforcing nature of the ERP and KM systems

While the two initiatives in Company A did complement each other by focusing on the different organizational needs of efficiency and flexibility, as suggested above, there was also evidence that the two initiatives were in some respects mutually reinforcing. Moreover, this mutual reinforcement impacted in negative ways on the organization, and created unintended consequences.

5.2.1. The creation of internal boundaries

Both the ERP and KM initiatives aimed to break down formal Departmental and Divisional boundaries. In fact, the implementation of the two systems in Company A led to an unanticipated consequence in that internal boundaries were actually reinforced. The ERP implementation led to an emphasis on measuring physical output across the Production Divisions. Rather than increasing collaboration as intended, this crystallization of individual and Departmental performance in the Production Divisions led to increased internal competition. Consequently, boundaries between different production units were reinforced, even though information flowed freely across units. This reinforcement of boundaries between units within the Production

Table 3
Impact of ERP and KM initiatives in terms of Adler et al.'s four mechanisms

	ERP initiative	KM initiative
Metaroutines	New set of routines introduced, but once created routines stabilized	Learning communities created a new routine to continuously stimulate innovation
Enrichment	Inhibited by standardizing processes and routines	Learning communities allowed employees opportunity to reflect and learn from their experiences
Switching	Minimized to enhance predictability	Learning communities provided opportunity to periodically switch from ERP-defined routines
Partitioning	Pre-existed in company with production divisions focused on efficiency	Pre-existed in company with consultancy division focused on innovation

Divisions meant that knowledge sharing and integration across the Divisions was often problematic, even though information was shared. As one team leader noted:

> Of course, we all agree that we should work like one big happy family. But there is no way you can expect everyone to live happily together when everyone is constantly compared with everyone else.

While the creation of learning and innovation communities could have, to some extent at least, overcome these reinforced boundaries, this did not actually happen in Company A because these communities were consciously organized so that any given community did not have representation from more than one production unit. This was a political decision invoked with a view to reducing conflict. One of the KM team members explained:

> Realistically we know nobody can get on with everybody, there will always be clashes of personality. Sometimes people just don't get on. When that happens we just have to be sensible, or you might call it politically correct if you like, and make sure they don't bump their heads against each other too often.

As a result, however, both the ERP and KM initiatives helped to create a new boundary layer within the Production Divisions. This impeded, to some extent, the sought after knowledge sharing and creation across the Divisions. In this instance then, the ERP and KM initiatives were mutually reinforcing, but in a negative and unintended way.

5.2.2. The reduction in social capital

One of the key issues emerging from the case analysis was the change of relationships with suppliers and service providers. Following the adoption of ERP and the strategic consideration of cost reduction, the number of suppliers and service providers was drastically reduced, removing in particular those with whom Company A had small and infrequent transactions. There are benefits from consolidating purchasing power and improving supply-chain management through having fewer suppliers and service providers (e.g. Anderson, Britt & Favre, 1997). At the same time, however, relationships with some smaller suppliers and service providers had been vital since these organizations had been actively involved in developing new products. With the reduction in the number of suppliers, relationships with these smaller suppliers had been terminated, thus curtailing their participation in new product development that used to be a critical source of external knowledge for innovation. This was foreseen by the R&D Division, but ignored by the majority of ERP stakeholders, mainly the board members and those from the Production Divisions. The tendency to reduce the number of suppliers and service providers was reflected in the new process enabled by ERP, and reinforced by the KM initiative. According to the KM project team leader:

> Economically, we won't benefit from our diversified procurement unless our purchase power is consolidated … How we do that? The only way is to reduce the

> number of suppliers and service providers. That way we know exactly who we are dealing with and have our bargaining power with.

Moreover, as the team leader added, the benefit of having a smaller number of suppliers and service providers was to:

> … develop a long-term strategic partnership with them and then make sure we capitalize on that relationship.

Despite these benefits, however, this reduction in the number of suppliers and service providers led to the loss of some valuable "social capital" (*ibid.*), which had been developed over time.

5.2.3. The creation of inter-group conflict and resistance

One other unintended negative consequence of the ERP implementation was that there was a shift in information ownership. This in turn negatively impacted involvement in the KM initiative. For example, it was found that converting engineering and R&D information into the format necessary for the ERP system shifted information ownership to the Production Divisions. This occurred because there was no system available which could perform a two-way translation between information produced by the Engineering and Production Divisions and between ERP and other systems, such as the product data management (PDM) system. In other words, information produced by the Engineering and R&D Divisions was made available to the Production Divisions through ERP, but not from the Production Divisions to others. As one engineer explained:

> Traditionally, Production is a dominant Department in our company, because they are the people making most of the profits. Prior to ERP, we would have the overall project control before we passed the engineering drawing to them. Now, all PDM information is converted into an ERP version. So, they get what we have, but we do not have the legitimacy of benefiting from what they have. Unfortunately, a gradual transfer of information ownership from R&D to Engineering to Production has been replaced by a radical change so that Production has the overall control at a very early stage.

The result was that some engineers resisted the ERP initiative. Moreover, this subsequently led to a reluctance to get involved in, and indeed total disengagement from, attempts to encourage their sharing and integration of knowledge in the learning communities. The effect of resistance to ERP was also found in a small number of innovation communities where debates between members from the Engineering and Production Divisions about information ownership were continued.

6. Discussion

This paper has explored the simultaneous implementation of two contemporary managerial IS/IT systems—ERP and KM—and their combined influence on organizational efficiency and flexibility. Despite the dangers of generalizing from a single case, insights generated by this interpretivist study can serve as useful theoretical and conceptual foundations for future research.

The comparison of the ERP and KM initiatives in Company A highlights the different orientations and objectives of these two systems. Similar to other empirical studies (e.g. Al-Mashari & Zairi, 2000; Pereira, 1999), the implementation of ERP in Company A concentrated primarily on the efficiency of producing, gathering, integrating and managing information. Efficiency improvements were sought through enhancing the information processing capability of the company, enabled by the systematization and centralization of information management and the adoption of standard approaches to the codification and processing of information. In other words, through a common integrative IT infrastructure, information that used to be functionally concealed became available throughout the organization in a predefined format (Wagle, 1998).

Meanwhile, KM in Company A concentrated on the mobilization of knowledge through the organization of innovation communities as a means of sharing and creating tacit knowledge (Brown & Duguid, 1991; von Krogh et al., 2000). The case company's specific emphasis on knowledge exploitation and exploration (March, 1991) and distribution (Huber, 1991) suggests that the firm's creation of knowledge largely depends upon the processes of exchange and combination (Nahapiet & Ghoshal, 1998). The exchange and creation process was facilitated through the organization of communities of practice (Brown & Duguid, 1991; Wenger & Snyder, 2000)—in this case, learning and innovation communities—and the availability of a corporate-wide expertise database (i.e. K-bank).

The results indicate, then, that in Company A the ERP and KM initiatives were complementary rather than contradictory allowing the organization to improve both its efficiency and innovation capability simultaneously. This contradicts the traditional received wisdom that it is not possible for an organization to focus on both efficiency and flexibility and supports those who argue that it is possible to be 'ambidextrous' (Adler et al., 1999; Daft, 1998; Tushman & O'Reilly, 1997). Using the empirical account of Adler et al. (1999), it appears that this was possible because the IS/IT initiatives that were implemented facilitated the enactment of the four mechanisms that they defined as vital for the simultaneous development of organizational efficiency and flexibility. In particular, the ERP initiative encouraged improved efficiency in the Divisions where efficiency was important. It did not do this at the expense of flexibility, however, because the concurrent KM initiative encouraged an on-going focus on flexibility. The KM initiative did this through setting up metaroutines, in particular the innovation communities, which allowed employees to switch periodically from their routine tasks to enriched tasks where they could focus on innovation and continuous improvement.

One interesting point to note is that partitioning pre-existed in Company A,

specifically to allow those in the Consultancy Division to specialize in innovative solutions while those in the Production Divisions concentrated on efficiency. However, the problem with this mechanism alone is that it may be important to stimulate innovation within Divisions specializing in routine, just as it may be important to stimulate efficiency within Divisions specializing in non-routine. Thus, the Production Divisions needed to adapt to changing circumstances and new opportunities. Relying solely on the Consultancy Division for this adaptive capacity is likely fail, given the problems of cross-departmental knowledge transfer (Newell, Pan, Galliers & Huang, 2001). Rather, it was the three other mechanisms, enabled by the KM initiative, which provided the innovation complement to the ERP's focus on efficiency within the Production Divisions. This discussion suggests that the four mechanisms identified by Adler et al. (1999) should not necessarily be viewed as individually effective. In particular, partitioning alone may well not be sufficient for the simultaneous fostering of efficiency and flexibility *within* a Division or Department.

Given the pre-existing partitioning within Company A, the implementation of the KM initiative, by facilitating the switching, enrichment and metaroutine mechanisms, enabled continuous learning to take place in two different forms. On the one hand, this was achieved through embedding non-routine tasks into standard activities, particularly in the Production Divisions. On the other, this was achieved through applying lessons learnt from non-routine tasks to other non-routine activities in the Consultancy Division. The two approaches to learning contribute to an organization's dual needs for knowledge exploration and exploitation (March, 1991), and counterbalance the limitation of ERP in coping with embedding non-routine activities into routine practice. The above discussion pinpoints that organizational structure, nature of task and learning approaches influence the need for and significance of the four mechanisms identified by Adler et al. (1999) in relation to the simultaneous development of efficiency and flexibility.

In reflecting on why the two systems may be complementary we can consider how the organization's information processing capability is influenced by the manner in which knowledge is created, exploited and captured (Tenkasi & Boland, 1996). Specifically, the distribution and availability of knowledge determines the way in which information is interpreted and made sense of by organizational members (Huber, 1991; Weick, 2001). In other words, information has to be interpreted and this interpretation will depend on one's pre-existing knowledge (Galliers & Newell, 2001). Knowledge, in turn, will be influenced by the information one has. The design of ERP systems imposes a universal frame of coding and interpreting information as a means of enhancing consistency and efficiency. As such, information is detached from its context. However, in translating information into knowledge the context is crucial, since an attempt to detach knowledge from its context and conceptualize it in an abstract form will lead to a loss in meaning (Blackler, 1995). This is because of the socially embedded and context dependent nature of knowledge (Nonaka & Konno, 1998). For instance, the decision about which material to select to make an engine's blades will depend on how the engine will be used (context dependent) and the technology of processing such raw material. The rationale behind the choice of

material cannot be detached from its context and applied to all types of engine, simply because of their different usage. Therefore, the distinctiveness of information and knowledge not only suggests different implications and values for organizations, but also suggests that both ERP and KM systems are needed in order to release and leverage the respective values of information and knowledge. Thus, the knowledge-based view of the firm argues that competitiveness depends on the effective integration and management of knowledge (Grant, 1996). Conversely, the information processing view suggests that enhancing performance depends on minimizing internal and external uncertainty by improving information flow (Galbraith, 1977). While both views have their limitations, these were ameliorated in Company A by the complementary combination of the ERP and KM initiatives.

While the two initiatives were, then, in some ways complementary, the results also provided evidence of ways in which they were mutually reinforcing rather than complementary. Moreover, these mutual reinforcements were unintended consequences, negatively impacting social relationships across the company and with its suppliers. Thus, they both reinforced the creation of boundaries within the Production Divisions. This reinforcement of boundaries by systems that supposedly create the 'boundaryless organization' has been noted previously (Newell, Pan, Galliers & Huang, 2001). They both also led to a reduction in the number of suppliers and service providers, which led to the loss of some valuable social capital (Nahapiet & Ghoshal, 1998). Social capital is vital for knowledge sharing within and across social networks, and critical to the creation of new knowledge. One could therefore argue that both the ERP and KM initiatives were more focused on efficiency in terms of supplier relationships and that this had had a negative impact on innovation potential. Finally, changes to the balance of power were created by the introduction of the ERP system and this, in turn, influenced involvement in the KM initiative. This problem underpins the notion that an unbalanced power distribution between Divisions can lead to a breakdown in the social process (Brooks, 1994), thus hampering the flow of knowledge across functions (Brass & Burkardt, 1993). Such resistance to the loss of information ownership has been observed in other empirical observations of organizational change (e.g. Hutt, Walker & Frankwick, 1995; Kirkman & Shapiro, 1997).

In some ways, then, in the case company, the advocacy of ERP in relation to productivity and cost cutting had overshadowed the need to take into account the complexity of social processes and their importance in triggering and fuelling collaboration. Despite the fact that the importance of social processes was recognized in the KM system design in the case company, the approach taken seems to have laid greater emphasis on the creation of another layer of boundary to conceal inter- and intra-group conflicts, rather than solving the conflicts fundamentally. The implementation of ERP had set up an integrative track on which information could travel freely across functional boundaries. However, the way in which the landscape of the social network was reshaped (influenced by the implementation of ERP and KM) had formed a disconnected track, separated from the one for information flow, which inhibited the mobilization, sharing and integration of knowledge.

This discussion of the potential for ERP and KM systems to be both complemen-

tary, and mutually and negatively reinforcing suggests there are some important issues that a practitioner needs to consider. It is clear that complementarity between ERP and KM systems is not an automatic outcome arising from their respective characteristics and objectives. IS/IT systems have interpretative flexibility (Weick, 2001) so that any complementary of outcomes must be fostered. For organizations planning to adopt and implement ERP and KM, it would appear critical to consider the different potential orientations and foci associated with each initiative. More importantly, it would be judicious to evaluate and prioritize the co-relation between organizational efficiency and flexibility that will fit the design and long-term development of the organization. Again, the significance of social capital and social networks (Nahapiet & Ghoshal, 1998) should not be underestimated here. In relation to the growing need for organizational revitalization and transformation, future research could usefully place emphasis on broadening our understanding of how different initiatives can be integrated and how different approaches to integrating these initiatives can maximize their potential and leverage competitiveness. Furthermore, future research could critically evaluate how different organizational initiatives can be prioritized to avoid potential innovation overload (Herbig & Kramer, 1994).

7. Conclusions

We have noted the tendency in the field of IS/IT to embrace new concepts and technologies without due regard to past learning, and in isolation one from another. BPR was one such fad (Davenport, 1996); ERP and KM are in danger of being the latest in a long line of similar examples. This study has attempted to counter this trend in two respects. First, by considering the implementation of ERP and KM systems simultaneously, it has demonstrated how a particular organization was able to promote both flexibility/innovation as well as efficiency. Second, it reinforces the point that IT initiatives work best in contexts where there are socio-political process initiatives taking place in tandem (Markus, 1983). Rather than arguing on the side of the personalization/community approach as against its codification/cognitive counterpart (Hansen et al., 1999; Scarbrough, Swan & Preston, 1999), we have attempted an interpretation of a particular case example that tends to demonstrate that a balanced perspective can assist in exploiting explicit knowledge and in exploring, sharing and creating tacit knowledge simultaneously. With careful and astute management, we interpret the experience of Company A as giving some optimism in "squaring the circle" of the long-standing efficiency-flexibility trade-off (Clark & Staunton, 1989) through the strategic implementation of potentially complementary IS/IT initiatives.

More specifically, the discussion of similarities and differences of ERP and KM initiatives has revealed that the two systems can be implemented in tandem to good effect. Thus, while ERP emphasizes the improvement of information processing efficiency, KM can facilitate the simultaneous development of organizational knowledge exploration and exploitation capability. The distinctive orientation and focus of each system has indicated how a specific set of managerial issues can be addressed

through the implementation of either ERP or KM. More critically, their distinctiveness surfaces the potential to implement simultaneously the two systems based on their complementary characteristics, thus leveraging their respective strengths. As is evident from the analysis, playing to the respective strengths of ERP and KM in tandem enables a process by which organizational efficiency and flexibility can be simultaneously developed. Moreover, overcoming their limitations can be enabled by the alignment of organizational capabilities in information processing, knowledge exploration and exploitation. Notwithstanding, there will doubtless be unexpected, and at times negative outcomes resulting, in addition to the positive and planned for benefits.

References

Adler, P., Goldoftas, B., & Levine, D. (1999). Flexibility versus efficiency? A case study of model changeovers in the Toyota production system. *Organization Science, 10*, 43–68.

Al-Mashari, M., & Zairi, M. (2000). Supply-chain re-engineering using enterprise resource planning (ERP) systems: An analysis of a SAP R/3 implementation case. *International Journal of Physical Distribution & Logistics, 30*, 296–313.

Alavi, M., & Leidner, D. E. (2001). Review: Knowledge management and knowledge management systems: Conceptual foundations and research issues. *MIS Quarterly, 25*, 107–136.

Alvesson, M., & Sköldberg, K. (2000). *Reflexive methodology: New vistas for qualitative research*. London: Sage.

Anderson, D., Britt, F., & Favre, D. (1997). The seven principles of supply chain management. *Supply Chain Management Review, 1*, 31–41.

Barr, P., Stimpert, J., & Huff, A. (1992). Cognitive change, strategic action, and organizational renewal. *Strategic Management Journal, 13*, 15–36.

Benders, J., & van Veen, K. (2001). What's in a fashion? Interpretative viability and management fashions. *Organization, 8*, 33–54.

Blackler, F. (1995). Knowledge, knowledge work and organizations: An overview and interpretation. *Organization Studies, 16*, 1021–1046.

Bolwijn, P. T., & Kumpe, T. (1990). Manufacturing in the 1990s: Productivity, flexibility and innovation. *Long Range Planning, 23*, 44–57.

Brass, D., & Burkardt, M. (1993). Potential power and power use: An investigation of structure. *Academy of Management Journal, 36*, 441–472.

Brooks, A. (1994). Power and the production of knowledge: Collective team learning in work organizations. *Human Resource Development Quarterly, 5*, 213–235.

Brown, J., & Duguid, P. (1991). Organizational learning and communities of practice: Toward a unified view of working, learning and innovation. *Organization Science, 2*, 40–56.

Brown, S., & Eisenhardt, K. (1995). Product development: Past research, present findings, and future directions. *Academy of Management Review, 20*, 343–378.

Brown, S., & Eisenhardt, K. (1997). The art of continuous change: Linking complexity theory and time-paced evolution in relentlessly shifting organizations. *Administrative Science Quarterly, 42*, 1–34.

Burns, T., & Stalker, G. (1961). *The management of innovation*. London: Tavistock.

Ciborra, C. (1999). Notes on improvisation and time in organizations. *Journal of Accounting, Management and Information Technology, 9*, 77–94.

Clark, P., & Staunton, N. (1989). *Innovation in technology and organization*. London: Routledge.

Cohen, M., & Levinthal, D. (1990). Absorptive capacity: A new perspective on learning and innovation. *Administrative Science Quarterly, 35*, 128–152.

Communications of the ACM (2000) Special issue on Enterprise Resource Planning (ERP) Systems, 43.

Daft, R. (1998). *Essentials of organization theory and design*. Cincinnati, Ohio: South-Western College Publishing.

Davenport, T. (1996). Why reengineering failed: The fad that forgot people. *Fast Company, Premier Issue*, 70–74.

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

Davidow, W., & Malone, M. (1992). *The virtual corporation, structuring and revitalizing the corporation for the 21st century*. New York: Harper Business.

Denzin, N. K. (1988). *The research act*. New York: McGraw-Hill.

Doorewaard, H., & van Bijsterveld, M. (2001). The osmosis of ideas: An analysis of the integrated approach to IT management from a translation theory perspective. *Organization, 8*, 55–76.

Eisenhardt, K., & Tabrizi, B. (1995). Accelerating adaptive process: Product innovation in the global computer industry. *Administrative Science Quarterly, 40*, 84–110.

Epple, D., Argote, L., & Devadas, R. (1996). Organizational learning curves: A method for investigating intra-plant transfer of knowlge acquired through learning by doing. In M. Cohen, & L. Sproull (Eds.), *Organizational learning* (pp. 83–100). London: Sage.

Fincham, R. (1999). The consultant-client relationship: Critical perspectives on the management of organizational change. *Journal of Management Studies, 36*, 335–351.

Fiol, C. M., & Lyles, M. A. (1985). Organizational Learning. *Academy of Management Review, 10*, 803–813.

Galbraith, J. (1977). *Organizational design*. Reading, MA: Addison-Wesley.

Galliers, R. & Newell, S. (2001), Back to the future: from knowledge management to data management. Proceedings of the *9th European Conference on Information Systems*, ECIS, Bled, Slovenia, June, Moderna Obganizacija, 609–615.

Geletkanycz, M., & Hambrick, D. (1997). The external ties of top executives: Implications for strategic choice and performance. *Administrative Science Quarterly, 42*, 654–681.

Ghemawat, P., & Costa, R. (1993). The organizational tension between static and dynamic efficiency. *Strategic Management Journal, 14*, 59–73.

Glover, S. M., Prawitt, D. F., & Romney, M. B. (1999). Implementing ERP. *Internal Auditor, 56*, 40–45.

Gopal, A., & Prasad, P. (2000). Understanding GDSS in symbolic context: Shifting the focus from technology to interaction. *MIS Quarterly, 24*, 509–546.

Grant, R. (1996). Prospering in dynamically-competitive environment: Organizational capability as knowledge integration. *Organization Science, 7*, 375–387.

Hackman, J., & Oldham, G. (1980). *Work redesign*. Reading: Addison-Wesley.

Hannan, M., & Freeman, J. (1989). *Organizational ecology*. Cambridge: Harvard University Press.

Hansen, M., Nohria, N., & Tierney, T. (1999). What's your strategy for managing knowledge? *Harvard Business Review, 77*, 106–116.

Hayes, R. H., & Wheelwright, S. C. (1984). *Restoring our competitive edge: Competing through manufacturing*. Chichester: John Wiley & Sons.

Herbig, P., & Kramer, H. (1994). The effect of information overload on the innovation choice. *Journal of Consumer Marketing, 11*, 45–54.

Hochschild, A. (1983). *The managed heart: Commercializtaion of human feeling*. London: University of California Press.

Huber, G. (1991). Organizational learning: The contributing processes and the literatures. *Organization Science, 2*, 88–115.

Hutt, M., Walker, B., & Frankwick, G. (1995). Hurdle the cross-functional barriers to strategic change. *Sloan Management Review, 36*, 22–30.

Kieser, A. (1997). Rhetoric and myth in management fashion. *Organization, 4*, 49–74.

Kirkman, B., & Shapiro, D. (1997). The impact of cultural values on employee resistance to teams: Toward a model of globalized self-managing work team effectiveness. *Academy of Management Review, 22*, 730–757.

Klein, H., & Myers, M. (1999). A set of principles for conducting and evaluating interpretive field studies in information systems. *MIS Quarterly, 23*, 67–94.

Lawrence, P., & Lorsch, J. (1967). *Organization and environment: Managing differentiation and integration*. Boston: Harvard University Press.

Lee, Z., & Lee, J. (2000). An ERP implementation case study from a knowledge transfer perspective. *Journal of Information Technology*, *15*, 281–288.

Lipnack, J., & Stamps, J. (1997). *Virtual teams: Reaching across space*. time, and organizations with technology, Chichester: John Wiley & Sons.

MacDuffie, J. P., Sethuraman, K., & Fisher, M. L. (1996). Product variety and manufacturing performance: Evidence from the International Automotive Assembly Plant study. *Management Science*, *42*, 350–369.

March, J. (1991). Exploration and exploitation in organizational learning. *Organization Science*, *2*, 71–86.

Markus, L. (1983). Power, politics and MIS implementation. *Communications of the ACM*, *26*, 430–444.

Martiny, M. (1998). Knowledge management at HP Consulting. *Organizational Dynamics*, *26*, 71–84.

McElroy, M. (2000). Integrating complexity theory, knowledge management and organizational learning. *Journal of Knowledge Management*, *4*, 195–203.

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook*. London: Sage.

Mintzberg, H. (1979). *The structuring of organizations*. Englewood Cliffs, NJ: Prentice-Hall.

Mohrman, A. M., & Lawler, L. L. (1984). A review of theory and research. In F. W. McFarlan (Ed.), *The information systems research challenge* (pp. 135–164). Boston: Harvard University Press.

Nahapiet, J., & Ghoshal, S. (1998). Social capital, intellectual capital, and the organizational advantage. *Academy of Management Review*, *23*, 242–266.

Nelson, R., & Winter, S. (1982). *An evolutionary theory of economic change*. Cambridge: Harvard University Press.

Newell, S., Pan, S., Galliers, R., & Huang, J. (2001). The myth of the boundaryless organization: Limitations of collaborative technologies in global firms. *Communications of the ACM*, *44*, 74–76.

Ngwenyama, O., & Lee, A. (1997). Communication richness in electronic mail: Critical social theory and the contextuality of meaning. *MIS Quarterly*, *21*, 145–167.

Nonaka, I., & Konno, N. (1998). The concept of "ba": Building a foundation for knowledge creation. *California Management Review*, *40*, 40–54.

Orlikowski, W. J. (1993). CASE tools as organizational change: Investigating incremental and radical changes in systems development. *MIS Quarterly*, *17*, 309–340.

Orlikowski, W. J. (2000). Using technology and constituting structures: A practice lens for studying technology in organizations. *Organization Science*, *11*, 404–428.

Ortmann, G. (1995). *Formen der Produktion; organization und Rekursivität*. Opladen: Westdeutscher Verlag.

Pereira, R. E. (1999). Resource view theory analysis of SAP as a source of competitive advantage for firms. *Database for Advances in Information Systems*, *30*, 38–46.

Prasad, P. (1993). Symbolic processes in the implementation of technological change: A symbolic interactionist study of work computerization. *Academy of Management Journal*, *36*, 1400–1429.

Polanyi, M. (1966). *Personal knowledge*. Chicago: University of Chicago Press.

Robey, D., & Boudreau, M. C. (1999). Accounting for the contradictory organizational consequences of information technology: Theoretical directions and methodological implication. *Information Systems Research*, *10*, 167–185.

Scarbrough, H., Swan, J., & Preston, J. (1999). *Knowledge management and the learning organization*. London: IPD.

Scott, J., & Kaindl, L. (2000). Enhancing functionality in an enterprise software package. *Information & Management*, *37*, 111–122.

Senge, P. (1990). *The fifth discipline*. the art and practice of the learning organization, London: Century Business.

Shanks, G., & Seddon, P. (2000). Editorial. *Journal of Information Technology*, *15*, 243–244.

Soliman, F., & Youssef, M. A. (1998). The role of SAP software in business process re-engineering. *International Journal of Operations & Production Management*, *18*, 886–895.

Starbuck, W. (1992). Learning by knowledge intensive firms. *Journal of Management Studies*, *29*, 713–740.

Strauss, A., & Corbin, J. (1990). *Basics of qualitative research: Grounded theory procedures and techniques*. London: Sage.

Tenkasi, R., & Boland, R. Jr. (1996). Exploring knowledge diversity in knowledge intensive firms: A new role for information systems. *Journal of Organizational Change Management*, *9*, 79–91.

Thompson, J. (1967). *Organizations in action*. New York: McGraw-Hill.

Tushman, M. L., & O'Reilly, C. A. (1997). *Winning through innovation*. Boston: Harvard Business School Press.

Tushman, M., & Scanlan, T. (1981). Boundary spanning individuals: Their role in information transfer and their antecedents. *Academy of Management Journal*, *24*, 289–305.

von Krogh, G., Ichijo, K., & Nonaka, I. (2000). *Enabling knowledge creation*. Oxford: Oxford University Press.

Wagle, D. (1998). The case for ERP systems. *The McKinsey Quarterly*, *9*, 130–138.

Walsham, G. (1993). *Interpreting information systems in organization*. Chichester: Wiley.

Walsham, G. (1995). The emergence of interpretivism in IS research. *Information Systems Research*, *6*, 376–394.

Weick, K. E. (2001). *Making sense of the organization*. Oxford: Blackwell.

Wenger, E., & Snyder, W. (2000). Communities of practice: The organizational frontier. *Harvard Business Review*, *78*, 139–145.

Wright, P., & Snell, S. (1998). Toward a unifying framework for exploring fit and flexibility in strategic human resource management. *Academy of Management Review*, *23*, 756–772.

Zbaracki, M. (1998). The rhetoric and reality of total quality management. *Administrative Science Quarterly*, *43*, 602–636.