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KNOWLEDGE INTEGRATION AS A KEY PROBLEM IN AN ERP IMPLEMENTATION

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Abstract

While previous studies have focused mainly on the potential benefits and critical success factors associated with ERP implementation, very few have explored the important issues of impediments encountered, especially from a knowledge integration perspective. We have adopted a knowledge integration view that focuses not on the distribution and adoption of particular technological artifacts (ERP systems), but on the knowledge integration processes involved in implementation. The focus of this case study is to understand the nature, structure and process of knowledge integration that occurs during ERP implementation. The paper has identified the integration of knowledge as a key problem in ERP implementation. We discovered four reasons: (1) knowledge is embedded in complex organizational processes; (2) knowledge is embedded in legacy systems; (3) knowledge is embedded in externally based processes; and (4) knowledge is embedded in the ERP system. Based on our analysis, we further suggest that to overcome these impediments to knowledge integration requires the development of interpersonal relations (one-to-one based) and community relations (group-based).

Keywords: ERP implementation, knowledge integration, case study.

INTRODUCTION

The rate of diffusion and implementation of ERP systems across a range of industries has been extremely rapid over the last few years (Bancroft et al. 1998). Since the early 1990s, ERP systems have become the *de facto* standard for the replacement of legacy systems in large and multinational companies (Holland and Light 1999a, 1999b). In particular, an increasing number of multinational enterprises (MNE) have adopted ERP systems in the hope of increasing productivity and efficiency as a means of leveraging organizational competitiveness (Davenport 1998; Wagle 1998).

Implementation of an ERP is an extensive, lengthy, and costly process, typically measured in millions of dollars. The investment is both in the software itself and in related services such as consulting, implementing, training, and system integration (Parr et al. 1999). The hope of increasing productivity and efficiency, particularly the management of a global operation (Glover et al. 1999), as a means of raising organizational competitiveness (Davenport 1998) underlies the rationality behind firms' motivation for adopting ERP.

In this paper, our first aim is to complement the existing critical success factors and risk approaches that are common in ERP studies (e.g., Holland and Light 1999a; Markus et al. 2000b; Parr et al. 1999; Slooten and Yap 1999; Sumner 2000). Secondly,

we strive to contribute to the existing information systems implementation literature by highlighting the impediments encountered in the ERP implementation process and structures from a knowledge integration perspective (Grant 1996). This is important because most of the literature on information systems, both academic- and practitioner-orientated, appears to imply that adopting an information system (ERP in particular) more-or-less automatically leads to the integration of the different knowledge embedded within various cross-functional business processes. This view fails to consider the difficulties of knowledge integration encountered during the ERP implementation process. To shed some light on this, we build upon the definition of knowledge as "justified true belief" (Nonaka 1994); knowledge integration is thus defined by as an on-going collective process of constructing, articulating, and redefining shared beliefs through the social interaction of organizational members.

While previous studies have focused mainly on the potential benefits (Shanks and Seddon 2000) and critical success factors (Wilcocks and Sykes 2000) associated with ERP implementation, very few have explored the important issues of impediments encountered, especially from a knowledge integration perspective. In striving to understand these impediments, we have adopted a knowledge-integration view (Grant 1996) that focuses not on the distribution and adoption of particular technological artifacts (ERP systems) but on the knowledge integration processes and structures involved in implementation.

LITERATURE REVIEW

There is a great deal of literature conceptualizing the phenomenon of how firms implement new IT systems. This study draws upon research in three interrelated areas, including models of ERP implementation stages, critical success factors of ERP implementation, and knowledge integration literature, which were reviewed to identify factors that potentially affect ERP implementation.

ERP systems are commercial software packages that, purportedly, enable the integration of transaction-oriented data and business processes throughout an organization (Markus et al. 2000a). In other words, ERP is sold as an enterprise-wide package that will tightly integrate all necessary business functions into a single system with a shared database (Lee and Lee 2000; Shanks and Seddon 2000).

In a study of risk factors in enterprise-wide implementation, Sumner (2000) identifies the major risk factors associated with ERP projects and then compares these with the risk factors associated with implementing traditional management information systems projects. Based on her findings, risk factors associated with ERP projects include the danger of customization, the challenge of using external consultants, and the investment in recruiting and re-skilling technology professionals and business analysts.

A number of phase models have also been developed to suggest that a different focus is needed for various stages of the implementation. For example, Markus et al. (2000a) develop a three-phase process model of ERP implementation consisting of the project phase, the shakedown phase, and the onward and upward phase in order to identify the implications and success indicators of each phase. They conclude that success depends on the point of view from which it is measured and also when it is measured. Parr and Shanks (2000) focus on the actual implementation process and present a project-phase model (PPM) which provides a useful template for organizations planning ERP implementations. This particular framework is concerned with the concept of project success. According to them, "the objective of a process model which extends over the life of the implementation enterprise, extending beyond the project and into refinement and organizational transformation and which incorporates the project as only one of several phases, is aimed towards a concept of success that involves the contribution of the ERP to the performance of the implementing company" (Parr and Shanks 2000, pg. 291).

Taking a reengineering perspective, Parr et al. (1999) observe that ERP systems are more complex because of the need for user involvement during the reengineering that will be necessary to make the system work. They identify adherence to time and budgetary constraints as key factors that are necessary for success. Similarly, Bancroft et al. (1998) conclude with a list of critical success factors for implementation, including top management support, the presence of a champion, good communication with stakeholders, and effective project management.

Soh et al. (2000) argue that a common challenge in successfully adopting ERP has been related to "misfits": the gap between the pre-written functionality offered and that required by the adopting organization. In their study of Singaporean hospitals, Soh et al. found different types of misfits, resolution strategies employed, and related impacts on the adopting organizations. According to them, the knowledge gap between the three parties (end-users, IS department personnel, and the ERP vendor) was the cause of unsuccessful implementation. While Soh et al. have cautioned about the difficulties and importance of integrating the knowledge of all parties involved in implementation, they fail to explore the process of knowledge integration in detail. As a result, they do not identify impediments which prevent people from integrating their knowledge successfully.

Thus, building on the findings by Soh et al., we argue that the critical challenge of integrating knowledge at implementation lies in the ability to bring the key parties together. In this case, knowledge integration in the implementation process applies not only to multiple sources of knowledge (Pisano 1994), but also to solving conflicts between the different parties involved. This integration process is often met with obstacles, as knowledge is frequently tacit and embedded within routines of which few are stand-alone (Blackler 1995). Tacit knowledge within the system and within the organization makes knowledge integration in these implementations slow and painful (Nonaka 1994).

To understand the difficulties of integrating knowledge faced during the implementation, this study draws upon the stream of research that emphasizes the need for a more radical management approach to the implementation of new IT systems. For example, the need for redesigning business processes to enable system implementation can be traced back to work, such as Leonard-Barton (1988) and more recently Markus and Keil (1994). One of the underlying assumptions shared by these authors is the need to integrate the design of new technology with business processes and radically renew an organization as a basis for leveraging the strategic value of the technology. However, while the need for a radical approach may be clear, there are relatively few accounts which explore the processes, structures, and dynamics underlying such an approach, in particular from the focus of cross-functional knowledge integration.

This study is also informed by the notion that what firms do is integrate their functionally specific knowledge (Grant 1996). This is no easy task as knowledge is often dispersed, differentiated, and embedded. While earlier studies have examined the impact of knowledge integration (Pisano 1994) and its implications (Boland and Tenkasi 1995), there are few studies that have explored the processes of knowledge integration (Hauptman and Hirji 1999). Therefore, the need for understanding knowledge integration processes can be seen as a theoretical gap in the existing literature on IT implementation, especially in the ERP implementation.

RESEARCH METHODS

We have adopted a participant observation-based case study method in order to investigate the relationship between phases in the implementation process and impediments encountered by various stakeholder groups during the implementation. The unit of our analysis is the implementation process where knowledge integration activities, related to ERP implementation are central. At the same time, the broader organizational context is taken into account. A period of six months was spent by one of the authors, an employee of the organization, documenting and participating at the research site during ERP implementation. Data collection was done through 30 hours of semi-structured interviews, workshops participation, and brainstorming sessions. Additionally, informal conversations, discussions, and meetings also added to the quality of data collected. This allowed the researchers to build a picture of the organization using a joint construction of descriptive accounts of the situation and provided excellent access and openness in terms of rapport and information. Field notes of daily observations were taken as well as recording of events. This provided a deep understanding of the social and organizational context of the study.

As part of the data analysis, the main themes found in the early stages were fed back into sessions during the later stages of the implementation as part of the iteration process. In this way, the researchers were able to simulate exploration of the emerging issues and create a more in-depth analysis. This further created collaborative verification and ensured that these data were contextually meaningful. For additional validation, method and data triangulation (Yin 1984) were used as internal checks on the validity of the findings. The data collection stage was concluded when repeated themes became evident and the information appeared to reach saturation (Glaser and Strauss 1967). After the completion of data collection, we identified common themes, summarized the findings, and iterated the case study research until specific findings had shown a strong relationship to the specific theme area.

CASE DESCRIPTION AND ANALYSIS

The case company is a multinational organization whose business spans various products and services such as financial services, oil, transportation, and manufacturing from semiconductors to power plants in 190 countries. The organization began to realize during the early 1990s that its existing systems were no longer keeping up with the pace of e-commerce development worldwide. Management at the headquarters then decided to adopt ERP as the core new business strategy in order to integrate the diverse needs of its fast changing and growing business worldwide. The project was to be rolled out across the entire global operation, upgrading the infrastructure throughout. The estimated budget for this was U.S. $32 billion. Due to the size of the implementation and the existence of different corporate practices across the different global regions, the project was divided into three separate entities: Europe, U.S., and Asia. Given that the management of the organization was highly distributed and decentralized, the result was that implementation processes differed significantly across different business units (BUs) and geographical areas.

While, due to limited time given, this research only concentrates on reporting the implementation process in one particular regional area (Asia Pacific region), we argue that the findings and lessons learned are useful and applicable to other implementations within the company, and indeed outside the company.

IMPEDIMENTS OF ERP IMPLEMENTATION: EMBEDDED KNOWLEDGE

Knowledge Is Embedded in Complex Organizational Processes

An ERP implementation is, in essence, an integrative mechanism connecting diverse departments so as to establish an integrated process (Hammer 1999). However, in the case organization, due to its decentralized organizational structure, there were an abundance of highly adaptive and effective logistic and financial systems within individual BUs. The autonomy given to these BUs has created diversity of interest and competencies (Teece et al. 1997) in specific knowledge areas (Pisano 1994). This made the ERP implementation difficult in a matrix-based organization structure since, during the implementation process, conflicting interests and knowledge among various BUs surfaced and had to be overcome before their respective knowledge could be integrated.

This suggests that the implementation of ERP not only had to consider knowledge that differentiated one BU from another, but also needed to take into account how the diversity of knowledge could be effectively integrated when the demand for cross-functional business processes increased. To this end, standardization and transparency of knowledge throughout the organization was essential. This meant that before the ERP system could leverage the knowledge integration process across the organization, "common knowledge" (Demsetz 1991) across BUs, or "knowledge redundancy" in Nonaka's (1994) terms, would need to be developed and disseminated.

Knowledge Is Embedded in Legacy Systems

While some knowledge was embedded in the complex organizational processes, there was also some problem created as knowledge was embedded in legacy systems. This began to emerge as a critical issue. We realized that most of the users were interested in comparing how consistent and similar the new ERP system was with the legacy systems. This concern stemmed partly from users' awareness of failures encountered in earlier ERP implementations in other regions. This had resulted in additional workloads and high duplication of effort and global inconsistency in routine practices which interviewees described as "undesirable innovation."

This tendency of "benchmarking against the legacy systems" illustrates users' reluctance to change and re-learning. The concern about users preferring old procedures and not adapting to the new environment was prevalent (Soh et al. 2000). The team saw this as a technological constraint as well as a social issue from a mindset change perspective. On the other hand, the slower response to the ERP systems could also be due to the fact that the users are relying on relevant prior knowledge (i.e., what they know of the legacy system) to try make sense of the new knowledge (i.e., the new system). In other words, users may not be resisting change; rather they are trying to make sense of the change (Cohen and Levinthal 1990).

In order to overcome this problem, the team put effort into making the ERP system look outwardly similar to the legacy system. What the team did was to customize the ERP system so that it looked similar to the legacy systems. They did this by integrating knowledge through mapping the information, processes, and routines of the legacy system into the ERP systems with the use of conversion templates.

Knowledge Is Embedded in Externally Based Processes

Another problem the team encountered was in integrating the organization's internal knowledge with externally based knowledge. Linking internal processes with externally based knowledge was found to be difficult as the ERP system was designed to be internally focused, yet it needed to integrate and interface with external systems, for example, those of suppliers, consultants, and contractors. In the words of another informant, "there seems to be fragmentation in the processes linking external organizations [suppliers, consultants, and contractors] which made full integration of knowledge difficult."

In order to overcome the difficulty of integrating the internal processes with externally based knowledge, the team began to make use of some of the existing personal/working relationships. These relationships were utilized during the implementation process

to facilitate the necessary knowledge integration as well as post implementation. However, having said that, in some cases, especially after ERP was implemented, informants also cautioned against taking for granted that these pre-existing personal relationships could get the job done. Instead, some of the knowledge was embedded in the ERP system, especially after it was implemented.

Knowledge Is Embedded in the ERP System: Post-implementation

After the ERP was implemented, the team realized that much knowledge was now embedded within the newly created ERP system and was inaccessible from existing personal networks. Yet, in order to continue to develop and fully accommodate the ERP system, this embedded knowledge needed to be integrated with internal and external knowledge. To overcome this unexpected surprise, the team began to implement what they called "knowledge-enabling structures." These were electronically based knowledge sharing forums set up by the organization with the aim of encouraging formal knowledge sharing and movement toward systematic organizational memory accumulation. These knowledge-enabling structures were created around existing information systems in order to enable intra-organizational knowledge-based activities (Harrison and Leitch 2000). While useful in most situations, we identified through our own observation that paradoxically these structures actually both facilitated and inhibited knowledge integration in the post-implementation process.

The establishment of these knowledge enabling structures triggered "structural integration," which helped to create the needed innovation and flexibility in the cross-functional ERP implementation project (Kanter 1988). In a way, this points to the importance of a particular contribution made by the ERP system in facilitating the development of an organizational memory and improved structural integration across the organization which is likely to support improved innovation in the future. To us, this can also be seen as the outcome of successful integration during an ERP implementation.

Moreover, in the process of creating these enabling structures, in the post-ERP implementation stage they sometimes became barriers, which could actually hinder future cross-functional knowledge integration. This occurred because these new structures created boundaries around the various groups and boundary penetration was difficult making the exchange of tacit knowledge almost impossible. This occurred because, without having developed prior personal relationships, users in this organization were not very comfortable in using these electronic knowledge-sharing forums and so they were not really making good use of them. Instead, they were creating electronic-based boundaries around their groups (BUs) which prevented the smooth flow of knowledge needed to enable the implementation to work properly.

RELATIONSHIP-BUILDING AS THE KEY SOLUTION TO IMPLEMENTATION IMPEDIMENTS CAUSED BY EMBEDDED KNOWLEDGE

As suggested above, a key problem of an ERP implementation lies in the fact that knowledge integration is difficult as most knowledge is embedded in the various organizational (inter- and intra-organizational) systems, structures, and relational processes. In particular, we argue that attention to understanding and sharing this embedded knowledge is crucial for ensuring successful knowledge integration. In the case organization, those involved determined early that they needed to foster and create a set of supportive working relationships for the implementation to work. However, fostering such relationships was not that straight-forward as the organizational culture was one of autonomy and independence. Hence, based on the case data, we argue that relationship development is one of the most critical issues during the implementation process and has to be done at two levels: interpersonal relations (one-to-one based) and community relations (group-based).

DEVELOPMENT OF INTERPERSONAL RELATIONS (ONE-TO-ONE BASED) AND COMMUNITY RELATIONS (GROUP-BASED)

In the beginning, when the implementation team was created, almost everyone was a stranger to each other as they were chosen to represent their respective groups in a multi-functional team. The ERP team then instigated a process of relationship building through increased information sharing and an increase in social interaction among users and the implementation team members. As pointed out by one of the informants,

> The documentation and participative discussion between the team and various BUs helped us to understand the different work practices and processes which various BUs have in common. We found that a lot of the differences are perceptional and have been ongoing between functions that we do not openly discuss. In other words, the requirement determination and analysis helped us to see things which we have in common.

In doing this, the organization managed to encourage participating users to identify tacit knowledge within the work processes. This was done through informal discussions and numerous brainstorming sessions. As a result, stronger common knowledge links were found, fostering social relationships among the users and the team. These relationships were crucial as the team used them to determine implementation requirements later. Based on our findings, we agree with Markus and Keil (1994) that user participation is not the total solution in ERP implementation. However, we would argue that it is crucial to have a "relation-based knowledge link" among the active users that help to ensure that the implementation requirements are appropriately identified. This was because, as shown in this case, having such links provides a governance structure through which meaningful user discussions can take place and the conflicts, which Markus and Keil discussed, can be significantly reduced.

On the other hand, through this process of consulting users about their knowledge of the workflow, the implementation team came to understand the knowledge embedded within organizational practices and processes are difficult to unearth and integrate. More importantly, as time went by, these individuals, who were being consulted informally, formed strategic groups to facilitate and enhance the value of their co-existence. These groups could be described as "communities of practice" (Wenger 1999), which were found to be able to share insights of the organization routines. As explained by an informant,

> The knowledge-based communities evolved as a result of knowledge sharing needs and were used informally to coordinate activities across different regions. In a way, we found that members of these communities provide valuable expertise of the global workflow and insights of how the global information systems infrastructure functions. They not only provided the expertise but also helped increase knowledge integration during regional ERP implementation.

This type of community differs from formal organizational arrangements in that they are linked through common interests and practices (Storck and Hill 2000; Wenger 1999) and not only by mere socialization. Members of these communities were critical to the implementation process as they, more than others, understood some of the complex knowledge embedded in the systems, especially when knowledge and events within one part of the organization was contextually foreign to other parts of the organization. The study found that the communities were very useful as they helped develop and spread better ERP practices faster by connecting "hubs of knowledge" and facilitating the processes so that they became self-organizing, knowledge sharing networks of collaborative learning communities.

CONCLUSIONS

The central message of the study is that knowledge integration is a key problem in an ERP implementation. The need for knowledge integration continues even after implementation, if the system is to be fully appropriated. Moreover, our study finds that knowledge integration does not happen automatically as the implementation of ERP is not merely a technological task influenced by users' perceived usefulness, but a cross-functional knowledge integration process structurally enabled by the establishment and maintenance of knowledge-based social relationships intra- and inter-organizationally.

For this study, an implementation process of six months' duration was examined to explore the impediments encountered. While the inherent limitation of a single case is noted in the study, findings show that there are significant impediments in the implementation process and that the process is strongly influenced by, the socio-technical, structural, and relational constructs found in the organization. Managerially, the findings provide managers with possible guidelines that suggest important barriers to overcome during enterprise system implementation in various project phases. Theoretically, this paper made two contributions by offering a knowledge integration perspective that sees enterprise system implementation as a process of collective social construction (Berger and Luckmann 1967) which can be influenced by internal participants such as the implementation team, IS staff, users, and top management, as well as external participants, such as suppliers and project consultants. Secondly, the findings provide insights into the nature and dynamics of various complex impediments that underlie many ERP implementations.

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