Global Co-Operation in the New Millennium
The 9th European Conference on Information Systems
Bled, Slovenia, June 27-29, 2001

KNOWLEDGE INTEGRATION PROCESSES WITHIN THE CONTEXT OF ENTERPRISE RESOURCES PLANNING (ERP) SYSTEMS IMPLEMENTATION [CASE STUDY]

Jimmy C. Huang

Department of Management Studies, University of Aberdeen,
Edward Wright Building, Dunbar Street, Aberdeen,AB24 3QY U.K.
Tel.: (44) 1224 273318, Fax: (44) 1224 273843
j.huang@abdn.ac.uk

Sue Newell

School of Management, Royal Holloway, University of London, Egham, Surrey, TW20 0EX U.K.
Tel.: 00 44 1784 414366, Fax: 00 44 1784 439854
Susan.Newell@rhul.ac.uk

Shan L. Pan

Department of Information Systems, School of Computing,
National University of Singapore, 3 Science Drive 2, Singapore 117543
Tel.: 00 65 8746520, Fax: 00 65 7794580
PANSL@comp.nus.edu.sg

Robert D. Galliers

Department of Information Systems, London School of Economics and Political Science,
Houghton Street, London WC2A 2AE, U.K.
Tel.: 00 44 207 9556019, Fax: 00 44 207 9556565
R.D.Galliers@lse.ac.uk

Jimmy C. Huang , Sue Newell , Shan L. Pan, Robert D. Galliers

ABSTRACT

The empirical findings from an organization, which adopted and implemented ERP, are presented. The focus of this empirical research was to understand the nature and processes of knowledge integration that occur during ERP implementation. While one objective of this paper then is to develop a conceptual framework of knowledge integration, a second objective is to focus on the methodology and demonstrate the various steps involved in adopting a grounded theory approach. In particular this paper takes the reader through the various stages of data analysis, moving from open coding, through axial coding through to selective coding, which leads to the development of the theoretical framework. The theoretical framework suggests that generating ERP awareness prior to adopting the technology, sustaining support from various hierarchical levels throughout the implementation process, and reinforcing the process innovation through the

introduction of new technology are all vital to ensuring the knowledge integration that is necessary for ERP implementation.

1. INTRODUCTION

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). While some are starting to harvest the benefits from their initial investments, others are still struggling to release the promised potential of their ERP systems. This can be seen as an illustration of the "productivity paradox"(Fitzgerald, 1998), that is that firms face a significant problem in measuring the return on their IT investments. While there have been several accounts that have examined the adoption of technology, including ERP, few of these accounts have considered this from the perspective of cross-functional knowledge integration (Grant, 1996). Against this backdrop, a case study was conducted as a means of exploring and theorizing the dynamics of knowledge integration underlying the process of ERP implementation. In this paper we focus not only on presenting the theoretical framework but also on describing the stages that were undergone to derive this framework.

2. CURRENT DEBATES AND PERSPECTIVES

There is a great deal of literature conceptualizing the phenomenon of how firms implement new IT systems. This study draws upon research in four distinctive areas, including (1) the development of technology, (2) the process of technology implementation, (3) enabling and inhibiting factors, and (4) management of process innovation.

Firstly, addressing the process of technological development in an organizational context, one of the major contributions made by the social construction of technology (SCOT) perspective is to discard technological determinism's linear model in explaining the technology development and diffusion processes (McLoughlin, 1999). In particular, emphasis is placed upon the social dynamics that influence the development of technology, and upon unveiling the complexity that can be regarded as a "seamless web" (Woolgar, 1991). In addition, Latuor's (1987) actor-network theory perceives the process of introducing new technology as a "black box". Opening up this "black box" involves exploring the changes in social and technical networks which follow from this introduction. These research traditions provide a persuasive rationale for exploring the dynamics of technological development which take into account the importance of the social context.

The second stream of studies focuses primarily on the process by which new technology is implemented. Much of this literature highlights the critical influence of managerial actions on end users acceptance of new systems, as well as the need for understanding the dynamics underlying the social interaction between managers and end users (Kwon and Zmud, 1987). Additionally, Attewell (1996) argues that the process of new IT implementation can be considered as a phenomenon of communication and uncertainty reduction, and understood by investigating the information flow between participating parties. Major contributions made by this stream of research are twofold. First, they provide an alternative conceptualization to conventional project management studies that perceive the implementation process as a sequential series of steps. Second, they address the on-goingness and interconnection of implementation processes that cannot be studied in isolation.

In terms of enabling and inhibiting factors related to the implementation process, there is a wide diversity of findings. This diversity demonstrates the difficulty of providing a holistic account and also emphasizes the depth and width of issues related to the success of technology implementation. It is possible to cluster the identified factors into two distinctive but interrelated categories, namely internal factors and external factors. In terms of the internal factors, research has tended to focus upon issues such as organizational culture (Holfman and Klepper, 2000), user-friendliness (Markus and Keil, 1994), and managerial influence on end

users (Leonard-Barton, 1987). Also, organizational innovation characteristics are explored by Rogers (1962), and further extended by Tornatzky and Klein (1982) who emphasize the "compatibility" between technology and the nature of the task, as well as by Davis (1989) who proposes the importance of "perceived usefulness" by end users and stakeholders. In terms of external factors, Swan, Newell and Robertson (1999) suggest that understanding technology diffusion relies on investigating the roles of central agencies, namely professional associations and technology suppliers, and their influence on firm's technological decisions.

Finally, this paper 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 Lenoard-Barton (1987) 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 and dynamics underlying such an approach, in particular from the focus of cross-functional knowledge integration. This is the focus of the study examined in this current paper.

Both Lawrence and Lorsch (1967) and Grant (1996) argue that what firms do is integrate their functionally specific knowledge. This knowledge is often dispersed, differentiated and embedded. However, while studies have examined the impact of knowledge integration (e.g. Pisano, 1994) and its implications (e.g. Boland and Tenkasi, 1995), there are few studies which have explored the processes of knowledge integration (Hauptman and Hirji, 1999). The need for understanding knowledge integration processes can be seen as a theoretical gap in the existing literature on IT implementation. In other words, the investigation of knowledge integration processes in the context of technology implementation, in particular the implementation of ERP systems, is the main objective of this study. However, in addition this paper focuses on illustrating the research method through which these knowledge integration processes were investigated. The following section thus outlines research methodological issues, namely research design, data collection and data analysis.

3. RESEARCH METHODOLOGY

The research methodology is based on grounded theory (Glaser and Strauss, 1967; Orlikowski, 1993; Strauss and Corbin, 1990; Turner, 1983) with an objective of generating a theory that depicts the process of knowledge integration in the context of ERP implementation. The rationale behind adopting this approach is twofold. Firstly, the inductive and theory discovery characteristics of grounded theory can help us to develop a theoretical account in a research area where there has been no or very little previous examination (Eisenhardt, 1989). Thus, as seen, despite the fact that there have been numerous previous accounts which conceptualize IT implementation, less emphasis has been placed upon the dynamics and processes of knowledge integration in the implementation of ERP. Secondly, the ground theory approach takes into account the complexity of organizational context and, can therefore, lead to an in-depth analysis (Orlikowski, 1993). As seen from the earlier discussion, it is clear that the significance and complexity of the organizational context has often been neglected, in particular when considering the issue of knowledge integration.

Orlikowski (1993) notes that, "the methodology of grounded theory is iterative, requiring a steady movement between concept and data, as well as comparative, requiring a constant comparison across types of evidence to control the conceptual level and scope of the emerging theory" (pp. 311). To enable this iterative comparison, various sources of data were collected through semi-structured interviewing, on-site observation and documentation. The rationale of using multiple data collection methods is not only for the purpose of triangulation (Bryman and Burgess, 1999; Denzin, 1988) through cross checking (Eisenhardt, 1989). Also, it ensures the richness of the emerging theory by obtaining various perspectives on an issue through iteration (Orlikowski, 1993; Strauss and Corbin, 1990). As will be seen, the data that were collected were coded and analyzed iteratively, following Glaser and Strauss (1967). This allowed the authors to flexibility adjust the data collection process, in particular in relation to the critical selection of interviewees.

The research started with a 3-month on-site observation. In addition, 25 semi-structured and 12 follow-up interviews, as shown in Table 1, were conducted each lasting on average 90 minutes. Further on-site observation was spread over an overall period of 15 month so as to acquire first-hand knowledge of how ERP was implemented through social interactions between organizational members, consultants and the software vendor. Documentation about the company and the ERP project were examined through reviewing letters, written reports, administrative documents, newspapers, archives, as well as the company Intranet.

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

Table 1: *Type and number of interview conducted at Company A*

Prior to the coding, the preparation stage consisted of activities, such as transcribing interview tapes, typing and filing research notes (taken during and after interviews as well as on-site observation) into the database, summarizing documents and categorizing them based on the sources. There were, therefore, four main categories of data grouped during this stage - interview transcripts, research notes, photocopied documents, and information downloaded from the case company's Intranet. A brief note that described the content of each file and potential linkages with different files was inserted in virtually every file stored in the four categories of data. This data served as the foundation for open, axial and selective coding. The initial stage of analysis -- open coding (Strauss and Corbin, 1990) -- aimed to reduce the amount of data. This stage of analysis was open-ended and generative (Orlikowski, 1993). Themes emerging from the open coding were used as a basis to proceed to the axial coding stage. Here the primary aim was to generate interconnections between these themes. Finally in the last stage of selective coding, similarities and differences between categories and concepts were further explored. This coding technique enabled the authors to identify richer concepts and more dynamic relations between these concepts. These coding processes fulfilled the requirement of multi-level analysis in the study of the dynamic relations between processes and contexts. Findings generated from the different stages of the coding processes are outlined in the following section

4. RESEARCH RESULTS

4.1. Open Coding

The critical categories and concepts that emerged from the initial open coding are outlined in Table 2. In particular this first stage of coding focused on identifying the various contexts which can help to offer an explanation in terms of "an interaction of contextual conditions, actions, and consequences, rather than explain variance using independent and dependent variables" (Orlikowski, 1993, p. 311).

Categories	Concepts	Data from the research site
Environmental context	Customers Competitors Technologies	• Custom built engines and components for power generation related purposes and functions • Some offer standardized engines and solutions at relatively low price • Increasing number of firms adopt ERP systems
Organizational context	Organizational structure Culture and subculture Corporate strategies	• Project-based structure with the majority of staff in R&D, engineering and production working in various projects • Innovative culture enhanced by working closely with clients and suppliers • Providing world class solution and products by continuous innovation
IS context	Role of IS in firm IS-related staff IS and user relationships	• In addition to the intensive use of ICT for dispersed project team members and divisions, IS has long been aligned with strategic business development • A decentralized and dispersed IS division had over 400 staff in total among 6 main sites worldwide • An increasing number of members of staff attended courses (over 1900 staff in 1998) and on-line forums (over 4100 staff in 1998) organized by the IS division.
Project context	Project scope Overall cost Internal project participants External project participants	• Estimated project length 36 months (excluded evaluation study) • ERP system was implemented globally and covered all major divisions • Estimated saving over £116 millions over five years • Software cost: £2.2 millions • System implementation (including evaluation and training): estimated cost £17.8 millions and actual cost over £19 millions • Internal man hour cost: estimated at £13.5 millions • 6 project sponsors consisted of senior managers • 11 steering group members formed of division heads • 18 project team members (7 from IS division, and one representative from each division) • SAP software, evaluation study, business case, and implementation services were all provided by firm X
Internal Conditions for ERP Implementation	Awareness of ERP Support for adopting ERP	• A reasonable number of staff in IS, HR, accounting, production, and R&D are aware of ERP system • From various hierarchical levels, in particular engineers, accounts, and procurement managers
Implementing ERP Systems	Analyzing Planning and design Implementation	• A consultant team from Firm X carried out the evaluation study and proposed business case was accepted • Decisions were made to implement the ERP with global coverage • Co-led by the external consultant team and internal participants

Table 2: *Research outcomes generated from open coding*

Environmental Context

The increasing popularity of using ERP systems in the engineering industry was found to be one of the main drivers influencing the case organization to adopt ERP. As noted by the Chief Operating Officer (COO), "ERP has become more or less an industrial standard in our business. Given the dynamics and complexity of our environment, we need a system that is capable of not only efficiently providing information for decision making, but also effectively integrating all systems in our company". In addition to this rationality for adopting ERP, the evidence also suggests that the adoption of ERP was seen as inevitable because of the need to manage very large quantities of information and data both intra- and inter-organizationally. As explained by the Procurement and Logistic Director: "the sheer amount of suppliers we get has driven the department into chaos. Given each project leader the autonomy to select their own suppliers and process their

orders, we have wasted enormous amount of money which can be otherwise saved by having strategic partnership with fewer suppliers".

Organizational Context

Internally, the need for an integrative system, such as ERP, to effectively manage information and support decision-making was found to be another source influencing the adoption of ERP. Sustaining technological advancement was reflected in the case organization's culture that strongly emphasized continuous process and product innovation. With a great emphasis on innovation, the case organization had a strong record in keeping up with the latest technology. For instance, the case company had introduced a common IT infrastructure in 1992, had undertaken a major system upgrading in 1993, and implemented company wide videoconferencing in late 1994. To enhance product innovation, project teams were intensively used. Three interviewees argued that the use of project teams was to stimulate creativity through pooling together different expertise dispersed around the globe. In addition to that, they also indicated that on-going process innovation was also critical, in particular in relation to the way in which product-related information and suppliers were managed. The ERP system was adopted to simplify the process of project management by reducing some of the project leaders'responsibilities, such as recruiting new members and dealing with suppliers.

IS Context

As illustrated in Table 2, the role of IS in the firm was critical for managing client-related information and enabling continuous process innovation. In addition to the management of software and hardware, the IS division was also responsible for proposing and planning various IS investments and developments. The involvement of the IS division was not only reflected in the Head of IS participating in all major ERP-related decisions, but also in the fact that other IS staff were involved in collecting information and acquiring knowledge related to ERP. According to an internal document, more than 70% of IS staff had attended IS-related conferences or seminars in the past two years, including more than 20% of staff who had attended ERP-related ones. Positive relationships between IS staff and end users were evident in the company survey that indicated a growing level of satisfaction from end users. This was also seen as a critical element in implementing new technology. In particular, such relationships were seen to be beneficial in changing the way information was disseminated and acquired within the organization. For instance, there was an increase in the number of users who used the company Intranet to obtain information. For example, the ERP site on the Intranet was visited more than 4,000 times two weeks after the project was launched. This depicts not only the increasing popularity of the Intranet as an information distribution tool, but also how ERP awareness was generated during the early stage of the project.

ERP Project Context

In addition to the initial ERP evaluation conducted by external consultants, the availability of capital for investing in new technology was found to largely influence how the project scope was defined. For instance, in the last 5 years, there had been an average of £12-15 million per annum budgeted for IT/IS investment. This was sufficient to support the on-going adoption of new technology. Also, the availability of capital permitted the implementation of new technology that reached an organization wide coverage. In terms of internal participants, the project structure was composed of the ERP team and the steering group – which included representatives of different stakeholder groups and end users. The composition of the ERP team and steering group reflected not only the variation between different divisions' involvement, but also the power differences in managing and controlling the project. Even though the IS staff argued that project ownership was equally shared, it was evident that the IS division played the leading role together with the external consultant team.

Internal Conditions for ERP Implementation

As elaborated in Table 2, individuals' awareness of and support for adopting ERP were identified as the two main internal conditions influencing the process of technology implementation. Despite the fact that the acquisition of ERP-related knowledge from the external environment was paramount, the mechanism used to diffuse such knowledge internally was equally critical. In particular, this first level of analysis identified the importance of the diffusion mechanism used to raise ERP awareness across various organizational levels. For instance, IS staff played the pioneer role in introducing the concept of ERP to the organization. ERP-related knowledge was further diffused across the organization through the Intranet, written memos, and newsletters. It was found that staff's awareness not only influenced how the usefulness of the new technology was perceived, but also affected how ERP was implemented. The case analysis suggested that user support was generated depending on their awareness of the new technology, their past experience, as well as their relationships with the IS division, which was generally positive as indicated earlier.

Processes of ERP Implementation

The ERP project began with an evaluation study conducted by an external consultant team. Following this, the analysis identified three processes of the ERP project - analyzing problems and opportunities, planning and design, and implementation. The evaluation study suggested the need for a global implementation project over 3 years and proposed a potential cost saving of £116 million (including £56 million saving due to the improvement of management) over 5 years. The business case was sanctioned while some minor adjustment was made. However, the main discussions at this stage centered on the issues of system integration and defining responsibility. During the planning and design stage, cross-departmental debates and conflicts emerged. These emerged due to the ambiguity of information ownership and the integration of the product data management (PDM) system with ERP. These two interconnected issues were reflected in the difficulty of converting data between the ERP and PDM systems because of the differences in orientation, as well as the difficulties of ensuring the free flow of information across functions. As explained by one engineer, "both ERP and PDM have different ways of storing, translating and managing data. ERP is more engineering orientated, while PDM is more manufacturing oriented. Even though you can find an overlap between them, like product structure management, it does not necessarily mean that when we release a PDM product definition to manufacturing, they can automatically convert such information into a version for ERP". Further conflicts between departments, mainly between engineering and production, were also found during the implementation stage. Even though a translator that converted PDM data into ERP was developed to solve the integration problem, the Engineering Department was still dissatisfied with such a one-way translation, because of losing the ownership and control of information generated by this department. As another engineer recalled, "it [the one-way translation] means that they get what we have got, but we do not have any legitimacy of benefiting from what they have got".

In the following sections, this first level open-coding is developed using axial (Figure 1) and then selective (Figure 2) coding to explore more specifically the knowledge integration processes underlying the implementation of ERP.

4.2. Axial Coding

Derived from the analytically iterative coding processes, this section highlights various aspects of knowledge integration, namely its nature, processes, and implications.

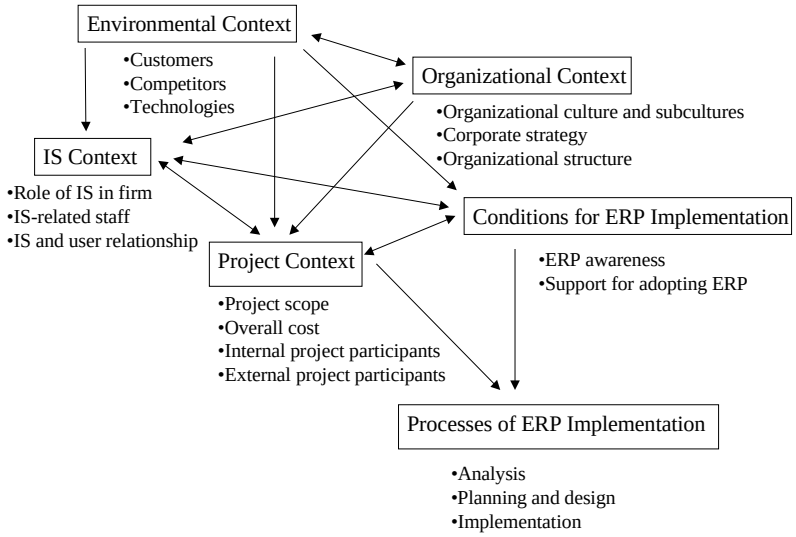

Figure 1: *Dynamics of ERP implementation*

The Nature of Knowledge Integration

Evidence abstracted from the analysis suggests that the nature knowledge integration can be conceptualized based on four distinctive but interrelated dimensions, namely structural, technological, intellectual and socio-emotional. The nature and philosophy of ERP illustrates the technological dimension of knowledge integration. As elaborated earlier, the adoption of ERP was aimed at installing an integral system that promoted the use of common language in interpreting information generated by different divisions. Also, it was aimed at facilitating and enabling cross-functional knowledge integration through the advancement of technology.

As can be seen in Figure 1, the dynamics of knowledge integration in the context of ERP implementation are not limited to within the organizational boundary. Instead, knowledge integration is an ongoing process which takes place intra- and inter-organizationally. In particular, the decision to adopt ERP is triggered through integrating knowledge from the environment. The way in which the awareness of ERP was generated in the case echoes the findings of Swan, Newell and Robertson (1999) who depict the influence of professional associations on the diffusion of new technology. However, it is evident that the availability of mechanisms, such as an Intranet and newsletters, to disseminate the acquired knowledge, to various organizational levels is equally critical.

The transmission of knowledge further surfaces the intellectual dimension of knowledge integration. It is necessary to create "common knowledge" (Demsetz, 1991) through synthesizing differentiated expertise (Lawrence and Lorsch, 1967), such as the expertise of ERP implementation possessed by the external consultant team. In addition to the above three dimensions, it is found that knowledge integration is also a socio-emotional process since support from end users and stakeholders had to be generated through developing trust (Nahapiet and Ghoshal, 1998; Newell and Swan, 2000). The socio-emotional dimension addresses the point that socialization is not only a critical ingredient for knowledge creation (Nonaka and Takeuchi, 1995), but also an essential process in achieving "emotional attachment"(Lembke and Wilson 1997) to overcome departmental boundaries.

The above discussion also brings out the fact that the nature of knowledge integration may have been oversimplified by the current literature (e.g. Grant, 1996), which has tended to focus on the intellectual rather than socio-emotional aspects. This discussion also surfaces the need to understand the interplay between those dimensions as a means of anticipating the processes of knowledge integration. While the analysis derived from the axial coding helps to explore in more detail the links between the issues derived from the

open coding, the final level of analysis is to use selective coding to develop a theoretical framework outlining knowledge integration processes during ERP implementation.

4.3. Selective Coding

Three knowledge integration processes generated from the analysis are termed- awareness generating, support sustaining and process reinforcing, as shown in Figure 2. While these three identified processes are analytically separated, they are highly interrelated.

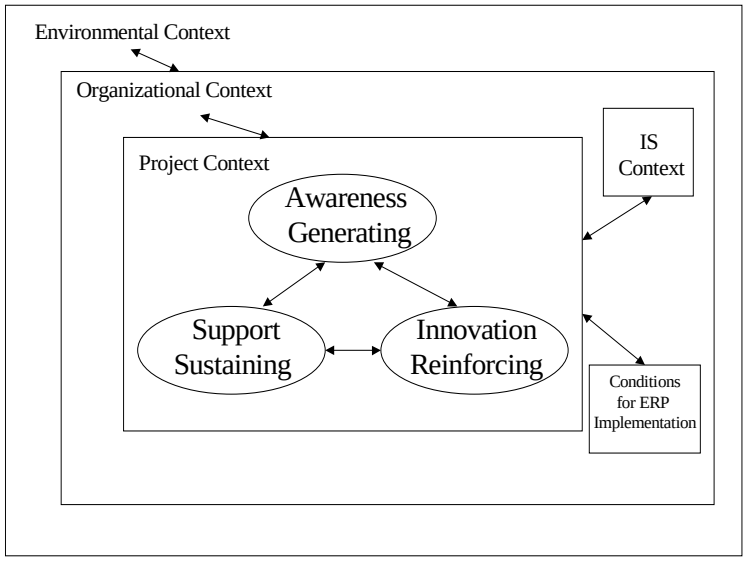

Figure 2: *Processes of knowledge integration in the context of ERP implementation*

Awareness Generating

The term 'awareness generating' refers to the process by which ERP-related knowledge is acquired and distributed. The reason for using the term is not only to describe the ongoing need for promoting the ERP philosophy across the organization, but also to sketch out how the new technology is perceived through the dissemination of knowledge. Referring to Figure 1, it is clear that the generation of ERP awareness portrays the dynamics through which information generated from the external environment is processed and interpreted (Galbraith, 1977). In addition to the influence of professional associations, as studied by Swan, Newell and Robertson (1999), ERP awareness was also generated through observing competitors and obtaining industry-specific information through various sources, such as seminars and magazines. A long-term strategic partnership between the case company and the service provider was found to be equally vital in generating such awareness.

The above observation also points out the need to address the issue of boundary spanning. In the current literature, despite the fact that the importance of boundary spanning in obtaining strategically critical knowledge is evident (Dollinger, 1984; Jemison, 1984; Lang, 1996), how boundary spanner's knowledge background affects the adoption of new technology and knowledge integration processes is often neglected. The diversity of knowledge background possessed by the organization's 'frontiers' to acquire ERP-related knowledge prior to the implementation was found to be critical. For instance, in addition to the IS Department, some members of staff in R&D, Production and Engineering were aware of the concept of ERP. Such diversity was found to influence how the project scope was defined, and how different aspects of potential usefulness related to ERP were formed. The process of awareness generating not only echoes the importance of perceived usefulness (Davis, 1989) in relation to technology adoption, but also pinpoints how the perceived usefulness can be expanded through the increase of knowledge diversity possessed by an organization's frontiers.

In addition to the importance of IS/user relationships elaborated in Figure 1, the approaches used to share and distribute ERP-related knowledge were found to largely influence the process of awareness generating. As indicated by some of the interviewees, they were informed by colleagues and friends about the ERP site on the Intranet, and they further contacted people they knew to inform them about the site and to discuss various issues they had newly discovered. This explains not only the importance of social networks in exchanging knowledge (Burt, 1992; Nahapiet and Ghoshal, 1998), but also the importance of combining formal and informal communication channels in generating awareness required for technology implementation. As shown in Figure 2, the generation of ERP awareness was found to further influence how internal and external participants could obtain support from end users and stakeholders, and how process changes required by ERP could be reinforced.

Support Sustaining

The term 'support sustaining' is used here to depict the ongoing process by which internal and external project participants obtain resources and support from other organizational members at various hierarchical levels. From the case, it is clear that support needed for ERP implementation is not limited to the management level in the form of obtaining resources. Also, there is a need to obtain support from end users across the organization through collaboration. In contrast with some project management research that regards obtaining resources as a key activity during the initial stages of a project (e.g. Case and Shane, 1998; Mamaghani, 1999), findings generated in this study suggest that it is critical to ensure support and the availability of resources throughout the project life cycle. This pinpoints the importance of support sustaining not only in energizing the continuity of ERP implementation, but also in enabling the ongoingness of knowledge integration.

While the continuous need for sustaining support from various hierarchical levels has been suggested by some studies (see for example, Markus and Keil, 1994), the dynamics of this process have been relatively under-explored. As elaborated earlier, the process of support sustaining is an intellectual activity by which the importance and value of new technology is communicated to the potential users. The intellectual dimension highlights the need to increase ERP awareness through communication, as well as the development of common knowledge (Demsetz, 1991) to create shared understanding through "perspective taking" (Boland and Tenkasi, 1995).

On the other hand, the emotional dimension of knowledge integration, as intertwined with the development of trust and distrust, is found to be equally critical for sustaining support from organizational members at various levels. Resistance and dissatisfaction observed in the case is an example which shows how organizational members' perceptions could form emotional obstacles, even though they were intellectually aware of the strategic importance of ERP. It is clear that disputes between Engineering and Production Departments were not simply an intellectual or technological issue, in terms of how ERP should be implemented. Rather, it was an emotional issue, so that "psychosocial defenses" (Allcorn, 1995) arose because of the fear of losing project and information ownership. The way in which support is sustained by the participants is also found to influence how new organizational processes and routines are created, as illustrated in the following process.

Innovation Reinforcing

The term 'innovation reinforcing' is used here to describe the process by which existing organizational routines are modified through the implementation of new technology. Organizational routines and processes, as the representation of continuous cross-functional knowledge integration and differentiation (Lawrence and Lorsch, 1967), were continuously modified and refined through various initiatives implemented within the organization. This echoes the concept of organizational learning (Huber, 1991) in which organizational memory is continuously reconfigured through incremental or radical change (Miner and Mezias, 1996). Referring to the case, the impact of ERP on the business processes was found to result in the redirection of information flows across the organization. For instance, departmental boundaries, which previously served as

"valves" in controlling the availability and accessibility of information, were gradually minimized through the implementation of ERP. Additionally, the change in knowledge flow (Starbuck, 1992) was also evident. For instance, the procurement procedure was simplified by taking away project leaders' responsibilities in dealing with suppliers. However, such modification also reduced suppliers' involvement in the development of new product. At least two Project Leaders saw this as hampering the quality and efficiency of product innovation.

Even though the reinforcement of innovation facilitates the free flow of information, it is also critical to consider how new business processes can potentially affect the dynamics of knowledge integration and creation and how "compatibility" can be ensured between the technology and the nature of task (Tornatzky and Klein, 1982). This suggests that an organization may successfully implement ERP and benefit from its ongoing capital investment, and yet improved knowledge integration through the implementation of new technology can remain a challenge.

Referring to Figure 1 and the process of awareness generating in Figure 2, it is clear that how the organization reinforces its innovation initiative through the implementation of new technology crucially depends on how awareness across the organization can be generated. Also, it is evident that the reinforcement of innovation is largely influenced by how support from various divisions and hierarchical levels is sustained, as elaborated in the second process of knowledge integration. Dynamic interrelationships between these three processes suggests that knowledge integration in the context of ERP implementation is an information processing activity since awareness is generated through the distribution of information and knowledge across divisions (Campbell, 1985; Combs, 1993; Galbraith, 1977). It also suggests that knowledge integration in the context of ERP implementation is a social construction process (Berger and Luckmann, 1967) in which social interaction between external participants, internal participants and end users shapes the implementation of new technology. The social construction of technology (McLoughlin, 1999; Pinch and Bijker, 1987) further reflects the importance of a socio-technical perspective. Examining the implementation of new technology must thus focus on understanding the interplay between structural, intellectual, socio-emotional and technological issues.

5. CONCLUSION AND IMPLICATIONS

Based on a ground theory approach, this study has explored the dynamics and processes of knowledge integration underlying the implementation of ERP. Instead of simply presenting the outcomes derived from selective coding, this paper has explored the findings generated through each stage of coding. Table 2 illustrates the findings generated from the first stage of open coding, Figure 1 illustrates the findings generated from the next stage of axial coding, while Figure 2 presents the final analysis derived from the selective coding stage. This paper thus seeks to make both a methodological contribution and a theoretical contribution. In terms of the latter, the paper considers an alternative approach to conceptualize the dynamics of ERP implementation, focusing on processes of knowledge integration. The analysis suggests that the implementation of ERP is a process that involves complex interactions between technological, socio-emotional, intellectual and structural issues.

By taking into account various contexts, such as environmental, organizational, IS, and project, this explorative account has elaborated on how decisions were made to adopt ERP, and how the implementation of ERP was influenced by the degree of awareness, support and reinforcement of innovation. More importantly, this study has generated a theory that depicts the nature and processes of knowledge integration within the context of ERP implementation. The framework developed here does not imply that successful ERP implementation necessarily leads to effective knowledge integration. Instead, the findings suggest that the implementation of ERP helps to trigger the renewal of organizational routine through process innovation, and that the successful implementation of ERP can create yet another challenge for effective knowledge integration.

In addition to the theoretical and methodological contributions, this study also has its practical implications. Lessons learnt from the case are potentially beneficial for adopting and implementing new technologies such

as ERP systems. For instance, it is critical for management to consider how awareness can be establishment and support can be obtained throughout the project life cycle. Additionally, it is vital to take into account how the ownership of an ERP project should be located, as well as how participants should be selected, both internally and externally.

REFERENCES

Allcorn, S. (1995). Understanding Organizational Culture as the Quality of Workplace Subjectivity. Human Relations, 48(1), 73-96.

Berger P. and T. Luckmann (1967). The Social Construction of Reality: A Treatise in the Sociology of Knowledge. Anchor Books, New York.

Boland, R. and R. Tenkasi (1995). Perspective Making and Perspective Taking in Communities of Knowing. Organization Science, 6(4), 350-372.

Bryman, A. and R. Burgess (1999). Introduction: Qualitative Research Methodology- A Review. In: Qualitative Research Volume I, Bryman, A. and R. Burgess (eds.), Sage, London.

Burt, R. (1992). Structural Holes: The Social Structure of Competition. Harvard University Press, Cambridge.

Campbell, N. (1985). Sources of Competitive Rivalry in Japan. The Journal of Product Innovation Management, 2(4), 224-231.

Case, R. and S. Shane (1998). Fostering Risk Taking in Research and Development: The Importance of a Project's Terminal Value. Decision Sciences, 29(4), 765-783.

Combs, K. (1993). The Role of Information Sharing in Cooperative Research and Development. International Journal of Industrial Organization, 11(4), 535-551.

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

Davis, F. (1989). Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology. MIS Quarterly, 13(3), 319-340.

Demsetz H. (1991). The Theory of the Firm Revisited. In: The Nature of the Firm, Williamson, O. and S. Winter (eds.), Oxford University Press, Oxford.

Denzin N. (1988). The Research Act. McGraw-Hill, New York.

Dollinger, M. (1984). Environmental Boundary Spanning and Information Processing Effects on Organizational Performance. Academy of Management Journal, 27(2), 351-368.

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

Fitzgerald, G. (1998). Evaluating Information System Projects: A Multidimensional Approach. Journal of Information Technology, 13(1), 15-27.

Galbraith J. (1977). Organizational Design. Addison-Wesley, Reading, MA.

Glaser B. and A. Strauss (1967). The Discovery of Grounded Theory. Aidine, Chicago.

Grant, R. (1996). Prospering in Dynamically-competitive Environment: Organizational Capability as Knowledge Integration. Organization Science, 7(4), 375-387.

Hoffman, N. and R. Klepper (2000). Assimilating New Technologies: The Role of Organizational Culture. Information System Management, 17(3), 36-42.

Huang, J. (2000). Knowledge Integration Processes and Dynamics: An Empirical Study of Two Cross-functional Programme Teams. Ph.D. Thesis, Warwick Business School, The University of Warwick, Coventry.

Huber, G. (1991). Organizational Learning: The Contributing Processes and the Literatures. Organization Science, 2(1), 88-115.

Jemison, D. (1984). The Importance of Boundary Spanning Roles in Strategic Decision-making. Journal of Management Studies, 21(2), 131-152.

Lang, J. (1996). Strategic Alliances between Large and Small High-tech Firms: The Small Firm Licensing Option. International Journal of Technology Management, 12(7), 796-807.

Latour B. (1987). Science in Action: How to Follow Scientists and Engineers through Society. Open University Press, Milton Keynes.

Lawrence P. and J. Lorsch (1967). Organisation and Environment: Managing Differentiation and Integration. Harvard University Press, Boston.

Lembke, S. and M. Wilson (1998). Putting the "Team" into Teamwork: Alternative Theoretical Contributions for Contemporary Management Practice. Human Relations, 51(7), 927-944.

Leonard-Barton, D. (1987). Implementing Structured Software Methodologies: A Case of Innovation in Process Technology. Interfaces,17(3), 6-17.

Mamaghani, F. (1999). Information Systems Project Evaluation and Selection: An Application Study. International Journal of Management, 16(1), 130-138.

Markus, L. and M. Keil (1994). If We Build it, They Will Come: Designing Information Systems That People Want to Use. Sloan Management Review, 35(2), 11-25.

McLoughlin I. (1999). Creative Technological Change: The Shaping of Technology and Organizations. Routledge, London.

Miner, A. and S. Mezias (1996). Ugly Duckling No More: Pasts and Futures of Organizational Learning Research. Organisation Science, 7(1), 88-99.

Nahapiet, J. and S. Ghoshal (1998). Social Capital, Intellectual Capital, and the Organizational Advantage. Academy of Management Review, 23(2), 242-266.

Newell, S. and J. Swan (2000). Trust and Inter-organisational Networking. Human Relations, 53(10), 1287-1328.

Nonaka I. and H. Takeuchi (1995). The Knowledge-creating Company. Oxford University Press, Oxford.

Orlikowski, W. (1993) CASE Tools as Organizational Change: Investigating Incremental and Radical Changes in Systems Development. MIS Quarterly, 17(3), 309-340.

Pisano, G. (1994) Knowledge, Integration, and the Locus of Learning: An Empirical Analysis of Process Development. Strategic Management Journal, 15(Special Issue), 85-100.

Rogers E. (1962) The Diffusion of Innovations. Free Press, New York.

Starbuck, W. (1992). Learning by Knowledge Intensive Firms. Journal of Management Studies, 29(6), 713-740.

Strauss A. and J. Corbin (1990). Basics of Qualitative Research: Grounded Theory Procedures and Techniques. Sage, London.

Swan, J., S. Newell and M. Robertson (1999). Central Agencies in the Diffusion and Design of Technology: A Comparison of the UK and Sweden. Organization Studies, 20(6), 905-931.

Wagle, D. (1998). The Case for ERP Systems. The McKinsey Quarterly, Spring Issue, 130-138.

Woolgar, S. (1991) The Turn to Technology in Social Studies of Science. Science, Technology and Human Values, 16(1), 20-50.