Managing knowledge in Enterprise Resource Planning (ERP) Implementation

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Abstract
Knowledge does not usually command significant value until it is embedded in products or processes. One approach to study how knowledge creates value to organizations is the assessment of knowledge management in value chain activities. Technology development activity is one of the supportive activities that creates value to firms by improving product quality and production techniques. The purpose of this study is to investigate how knowledge creates value to organizations through implementing IT solutions. ERP implementation is used as a sample to investigate the contributions of knowledge management to an organization’s performance. Research was carried out in two stages. The first stage is to develop a complete view of ERP management life cycle covering implementation framework. The second stage is to investigate practices of managing knowledge through the developed implementation framework.

Keywords
Knowledge management, ERP implementation, managing information and communication technologies,

INTRODUCTION
There is growing recognition that the sources of competitive advantage of firms have been shifted away from tangible assets toward intangible assets. The management of knowledge is increasingly considered as a main source of competitive advantage for corporations. Recent literature pays more attention to organizational knowledge as a core resource [7, 11, 13, 21, 26].

Knowledge does not usually command significant value until it is embedded in products or processes. Only then can its value be fully extracted [23]. One possible way to study how knowledge creates value to organizations is to assess how knowledge is managed in each value activities within the value chain model [19]. Technology development activity such as implementing Enterprise Resource Planning (ERP) is one of the supportive activities in the value chain. It creates value to the organizations by improving products or processes. The ERP system has been used as a major enabling mechanism for business process reengineering. Dozen of methodologies and frameworks for Business Process Reengineering (BPR) implementation have been developed since 1993 (see examples in [24]). There is an agreement across all the methodologies and frameworks that IT is the major enabler, and BRP rarely succeeds without IT.

To achieve successful ERP implementation, one must synthesize existing knowledge. However, most research on ERP and other IT solutions focused on using the solutions as enabling tools for knowledge management rather than studying how to manage knowledge to realize the benefits of the implemented solutions. None of the frameworks in provided the literature gives a comprehensive picture of how to manage knowledge for business process innovation through implementing IT solutions. The objective of this study is to explore how knowledge creates value to organizations by assessing knowledge management practices that enabling successful ERP implementation. Four ERP implementation projects are investigated: three successful cases and one less successful. The findings from these four case studies will reveal knowledge management practices that are critical enablers for successful ERP implementation.

LITERATURE REVIEW
Knowledge Management
Knowledge is a derivative of symbols, data, and information [20]. Knowledge management (KM) is defined hereby as the management of information and knowledge and their usage in organizational routines/processes within organizations. Its major focus is the steering of strategy, identifying and communicating various types of knowledge that resides in processes, people, products and services to support collaboration and its integration to improve productivity and efficiency.

In the KM literature, we can conclude that knowledge reside in employees, organization resources, and external partnership. Knowledge is classified in a number of categories to pursue different research interests. Nonaka [17] distinguished tacit and explicit dimensions of personal knowledge and processes required for managing such knowledge to create organizational knowledge. Pettrash’s framework [18] identified three knowledge categories, by recognizing employees’ knowledge as human capital and customer related knowledge as customer capital. Organizational knowledge referred to organizational processes, organizational structures, and organizational culture. Frameworks proposed by Teece and Sveiby [22, 23] are similar. However, they incorporate customer capital within the notion of external knowledge resources, which includes knowledge of others than customers (e.g., suppliers).

However, those conceptual studies do not separate technological and organizational knowledge. Both are grouped in a wider knowledge block that includes all
knowledge forms created, integrated, transferred, and used within the company [3, 8]. The traditional classification of organization knowledge is incomplete and does not account for the sometimes-disastrous effects on minor improvements in business process based of IT solutions.

To overcome this drawback, Fernández [9] proposed a four-type model of intangible resources that basically consists of knowledge and information. According to this classification, knowledge is distinguished into four types; i.e. human knowledge, organizational knowledge, technological knowledge, and relational knowledge. Human knowledge refers to the knowledge acquired by a person, which increase his/her productivity (professional qualifications) and the value of his/her contribution to the firm. It also includes personal contacts and relations, as well as other individual qualities such as reputation, experience, judgment, intelligence or loyalty. Organizational knowledge contributes order, stability, and quality. A firm’s organizational knowledge includes its norms and guidelines, corporate culture, organizational routines, database, as well as strategic alliances. The firm’s stock of technological knowledge includes knowledge related to the access, use and innovation of production techniques and product technology. The relational knowledge consists of the potential derived from the intangible resources related to the market place. It includes reputation, brands, customer loyalty, long-term customer relationships, shop signs and distribution channels. A recent analysis of several intellectual capital models reveals the similar classification [4]. Unlike the typology of Castro and Fernández [4, 9] considers both resource and capability in differentiation of knowledge types.

Knowledge Management researches based on resource-based perspective tried to identify distinct types of knowledge as a starting point to move toward promotion of knowledge creation. Coombs and Hull [5] argued that the approach can be clearly fruitful if the research objective is to construct plausible accounts of the development of specific knowledge and technologies within one firm or network of firms. They also propose that the relationships between knowledge management and innovation should be best studied as a set of specific practices or routines. Members of organizations can only make use of these types of knowledge through specific processes and routines of operation. The most appropriate method for such a focus is to focus upon what happens in practice, rather than distinguishing types of knowledge. Managing knowledge is impossible -only the processes leading to its development and usage can be managed. Good management of the processes that lead to the development of distinctive knowledge is becoming an imperative in many firms [2, 13].

In the KM literature, knowledge management processes are studied in accordance with distinctive knowledge types and organization objectives. It has traditionally been assumed that there are three broad types of knowledge processing – generation, transfer, and utilization. For example, Probst et al. [20] identified six knowledge processes required for managing organizational knowledge. Knowledge integration is viewed as an important process for innovation and building organizational capability [10],[23]. Coombs and Hull, [5] identified ten distinctive processes including identification, transfer, utilization, creation, acquisition, retention, codification, validation, developing, and integration of knowledge.

Enterprise Resources Planning (ERP)

ERP began life in the 1960s as Material Requirement Planning (MRP), an outgrowth of early efforts in bill of material processing [25]. It has been developed to replace MRP systems which fell short of supporting multiple plants, multiple suppliers and multiple currencies, and that did not include functions such as inventory control, plan management and order processing [12]. The ERP package aims to integrate all key business activities through improved relationships at all levels to achieve a competitive advantage [1, 6]. ERP systems can be considered as an IT infrastructure able to facilitate the flow of information between all business processes in an organization [16].

ERP Implementation Process

Wallace and Kremzar [25] proposed the Proven Path model that divides ERP implementation processes into two stages: software selection stage and software configuration and installation stage. The stage model of Kwon and Zmud [15] deliberated the process into six stages or phases: initiation, adoption, adaptation, acceptance, routinization, and infusion. The first or the initiation stage is characterized by both internal and external factors that influence the organizations to implement an integrated system such as ERP. Investment decisions and cost–benefit analysis related to implementing the ERP systems and choice of brand or vendor are carried out during this stage. In the adaptation stage, companies analyze the details of the various business processes and look for improvements or to a complete redesign. In the acceptance stage, the systems are modified in order to solve the problems reported by the end-users. The ERP system usage becomes a regular day-to-day activity in the routinization stage. At the infusion stage, the system is used to enhance the performance of the organization. The stage models reviewed by Kumar et al. [14] had a lot common with that of Kwon and Zmud [15].

However, the processes suggested by Wallace and Kremzar [25], Kumar [14], and Kwon and Zmud [15] focus only pre-implementation and implementation stages of ERP systems. Other processes related to post-implementation are not considered. Often, enterprises expect packaged applications to remain appropriate to business requirements for years after they are implemented. An ERP solution implemented today may well have a long life, but portions of the solution may have limited usefulness, or technology and product improvements may become available that render them obsolete. To increase the value of applications, enterprises should frequently improve in-
stalled applications, and identify retirement strategies when appropriate based on changing business requirements and emerging technologies.

RESEARCH METHODOLOGY

This study investigated practices of managing knowledge in successful and failed ERP implementation projects. The research was done in two stages. The first stage developed a complete model of managing ERP across the whole life cycle, since frameworks of ERP implementation from literature did not reflect later stages of the ERP management system. Information of related processes, activities, and issues in each phase along the ERP life cycle were collected and adjusted into the model. In the second stage, the emerging implementation model provided guidelines to explore knowledge management practices along the entire ERP implementation processes.

Case study approach was used in both stages. Data of the first stage was obtained from implementation proposals of three IT consulting firms submitted to an electronic subcontractor company, as well as interviews with the IT director and an expert panel constituting of implementing consultants and senior management with over ten years experience in ERP implementation projects.

In-depth interviews with the project team and external consultants for all four cases were used to obtain data for the second stage. By means of this case study approach, we were able to identify and answer to such questions as: What is the key knowledge required for ERP implementation? What are the interactions of these components? What knowledge management practices contribute to making use of key knowledge for success implementation? Why are some companies much more successful than others in implementing ERP?

The unit of analysis of this research was the project level, therefore data were collected from companies that already implemented an ERP system. Appropriate cases were carefully selected to provide insights to knowledge management practices in implementing ERP systems with different levels of success. Four companies were selected. Two companies in wholesale/trading business are named T1 and T2. They directly compete in the same market. Headquarter of T1 and T2 are in Europe. The third case in food processing industry is called F1. And the last company, manufacturing construction material, is named C1.

C1, T1 and T2 were successful in ERP implementation with re-designed business process flows of the accounting systems. F1 planned to implement the whole ERP system to integrate all business processes as well as strategic management tools, but the project failed. Only part of targeted systems was implemented and operated and still produced inaccurate information.

Key informants were directly involved in the ERP project. They were interviewed with semi-structured interview questions. The above research questions shown above provide scope for the interviewer to articulate open-ended interview questions. Required information was obtained from at least three informants with different perspectives in every case study to minimize possible information bias. The interviewees included project managers, key users, and implementation consultants. In addition to depth interviewing, documents and archival records were made available by the four firms.

RESEARCH FINDINGS

Most consulting companies have developed their own methodologies for managing ERP projects. These are worldwide standard tools used to manage various projects. Though, different consulting firms have developed their own tools, there have a lot common in the processes, activities, and outputs across these tools. All of them focused mainly on implementation activities and less on post-implementation activities. None of the methodologies covered process/activities across the entire ERP life cycle. However, they are complimentary with ERP implementation frameworks found in literature. A complete framework for managing the ERP system across all life cycle emerged when we integrated these findings with frameworks in the literature.

The emerging framework composes of six phases: plan, acquire, deploy, operate, optimize, and retire (see column 1-3 in Table 1). The first five phases have much common with six-stage model of Kwon and Zmud [15]. The additional phase called retire, in which companies have optimized people, process and technology to fully utilize the systems. After years of operating, companies need new systems to cope with business and technology changes, so the first stage will be repeated again. The model is not single sequential flow model but rather repetitive model.

Stage 1: Planning

T1 used several IT systems such as merchandize, warehouse, and back office. The first two systems were controlled by regional office. The old back office system needed to be replaced. It could not support business expansion due to database and hardware limitations. Both the regional office and local office supported this project. While the local office initiated the project, the regional office provides strategic plan for the project and allocated key resources. Three additional staff were acquired from ERP vendor to manage the project and operate the system after implementation.

T2 used to be owned by a big local company. After change of ownership in the late 90’s, the new parent company wanted to standardize the processes/systems for improving strategic management. All plans were initiated from corporate headquarter. A new experienced staff was hired to be in charge of the project and functional managers
were allocated to the project. The local office fully supports the project.

F1 started as a small family business growing up to a public company 15 years later. The computer system used was an obsolete stand-alone system. Information was fragmented and inaccurate. The company owner did not know much about IT, but he wanted to improve data accuracy and security as well as the company’s image. Thus, the owner and a senior manager were in charge of upgrading the IT system. The operational team had little involvement in this phase. In addition, none of the IT staff had experience with the new technologies, and managers had no experience in implementing integrated IT systems. F1 did not help the team by adding experienced staffs, and relied almost completely on external consultants. It was too late when F1 realized that the external consultants did not understand the food industry and was new to the ERP software as well.

C1 was forced to spin off from new parent company after the financial crisis in 1998. C1 did not have its own IT staffs, since MIS function was serviced by old parent company. C1 developed new IT system under guidance from the new parent company. Outsourcing approach was best solution for short timeframe and limited budget of C1.

Stage 2: Acquiring
At this stage, clear visions and objectives of project need to communicate effectively to related employees. C1, T1 and T2 communicated this strategic change effectively to their employees. However, F1 could not convince its employee about the benefits of the new technology. Since managements were not familiar with the technology, they asked the software vendor to help convincing their employees.

Project team should be formulated properly with highly qualified staffs. Project staffs need to work with the company for a few years to gain deep knowledge about their business processes. All four companies assigned experienced operational managers into projects.

Stage 3: Deploying
At the beginning, the project team needs proper training and skill development. In addition to formal training, simulation systems and process workshop are examples of skill development activities to gain deeper knowledge. T1 and T2 evidently used these practices.

Clear project structure and vision help to align the team members from different perspective to design together new processes. All four companies used international consulting firms to help manage the project. T1 and T2 also hired experienced project manager as full time employee, but C1 and F1 did not hire new staffs.

Stage 4: Operating
During implementation process, two parts of knowledge are captured and stored: explicit and tacit. The explicit part is mainly related to know-what and part of know-how. They were captured in several forms such as user manual, training documents, process design documents, configuration into system, etc. The tacit part is those skills and know-how to operate the system. It must be transferred from consultants to project members and then transferred to other end-users in the companies.

Levels of knowledge absorbed by project staffs depend on prior knowledge and diversity of knowledge within the project team. C1 and F1 could absorb too little knowledge from the project since none of staff had any prior knowledge of the adopted technology. But C1 outsourced system operation to external service provider.

Stage 5: Optimizing
Systems need to be adapted to cope with changing business conditions and technology trends. Capabilities to optimize and customize system depend on how much knowledge the companies can absorb from the project, develop further during normal operation, and what knowledge they can retain within the firm.

T1 was more comfortable to adjust and customize the ERP system after a period of operation than T2. T1 acquired three experts from ERP vendor, while T2 hired only one experienced manager to operate the system. In addition, T1 was also able to retain key knowledge by redundant job assignment and job rotation. T2 assigned very specialized staff for each function without any redundancies. T2 occasionally had to hire external consultants to replace employees who left the company without having trained a colleague to replace them.

Stage 6: Retiring
Implementing companies need to plan for technology retirement. Based on long experience, T1 suggested having at least two years in advance to plan for system retirement or replacement. The timeframe required for budget preparation and lead-time during implementing the replacing system.

CONCLUSIONS
This pilot research has empirically explored how to manage knowledge to improve business process enabling by IT solutions. As found in the literature, four knowledge domains reside in the firms: i.e., human, technology, management, and relational knowledge. Empirical evidence from these four cases showed that these knowledge domains were essential for business process improvement and ERP implementation. To study KM in business process improvement by implementing ERP system, specific knowledge management practices in each process of ERP implementation were investigated. There are six phases of ERP adoption across its life cycle: i.e., plan, acquire, deploy, operate, optimize, and retire.

Plan and acquire stage were related to strategic knowledge management. During these phase deficiencies in four knowledge domains need to be identified. Technology and management knowledge was stored in people, so they may be acquired and transferred to companies by employing additional staff. Relationship knowledge is an alternative
source of the missing knowledge, so ERP adopting companies could hire external consultants to help implement and operate system. Technology knowledge must come along with human knowledge. When companies acquired new technology, they needed to consider what human knowledge necessary for deploying, operating, and optimizing the new IT system. Successful companies designed clear knowledge strategy for implementation of technology strategy. However, explicit element of knowledge, i.e., know-what, was transferable. Tacit knowledge, related to know-how, know-why, and care-why cannot be completely transferred. This knowledge must develop internally or can be acquired through human resource from external sources.

In the deploying stage, operating, and optimizing concern with the operational level of knowledge management. Creation of new business processes needed diversity of key knowledge. Management knowledge was essential to integrate process knowledge, technology knowledge, industry knowledge, and relational knowledge to create or improve existing business processes. This new process knowledge could be captured, shared, and transferred within and across projects by proper project management resources such as communication protocols and tools, standard formats and templates of documentation, and project infrastructures – like central repository, intranet, videoconference, etc. While these project resources determined the ability to capture/ share/ transfer project knowledge, the level of team’s prior knowledge determines ability to absorb new knowledge. Knowledge management practices across ERP life cycle are summarized in Table 1.

Table 1. Summary of knowledge management practices in ERP implementation processes

<table>
<thead>
<tr>
<th>Stage</th>
<th>Step</th>
<th>Activities</th>
<th>Knowledge management practice</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Analyze motives for ERP implementation</td>
<td>• Key knowledge: human, technology, management, relational knowledge</td>
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<tr>
<td>Acquire</td>
<td>Software selection</td>
<td>First-cut education, Vision statement, Cost-benefits analysis, Go/No Go Decision, Project organization, Performance goals, Software selection</td>
<td>• Design knowledge strategy to support implementing new technology</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Identify missing knowledge and acquire from internal and external sources</td>
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<tr>
<td>Deploy</td>
<td>Implementation plan</td>
<td>Adjust project organization, Define implement strategy: objectives, approach, working routines, and standard language for communication, Clarify scope</td>
<td>• Relational knowledge is alternative source for the missing knowledge</td>
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<td></td>
<td>Process analysis</td>
<td>Analyze current process, Assess current process constraints, Design To-Be process, Map/Gap analysis with software, Define customization strategy</td>
<td>• Diversity and depth of team’s knowledge are critical for re-design of business processes</td>
</tr>
<tr>
<td></td>
<td>Systems design</td>
<td>Design new process, Define customization specification, Define data conversion specification</td>
<td>• Team’s knowledge need development to gain deeper knowledge</td>
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<td></td>
<td>Configure &amp; adaptation</td>
<td>Refine business process, Configure systems, Develop customized program, Prepare data for new systems, Prepare training material and user procedure</td>
<td>• New business process can be created by integrating human knowledge, technology knowledge and relational knowledge</td>
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<tr>
<td></td>
<td>Testing &amp; acceptance</td>
<td>Train the trainers, User acceptance test, End-user training</td>
<td>• Management knowledge is essential to integrate process knowledge technology knowledge, industry knowledge to create or improve business processes</td>
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<tr>
<td>Operate</td>
<td>Routinize</td>
<td>Transition to new system (parallel run), Cut-over old system, Day-to-day usage of new systems, Assessment II: Assess performance goals, Disband project organization</td>
<td>• New process knowledge could be captured, shared, and transferred by proper project management resources such as communication protocol, standard format and templates of documentations, project infrastructures like central repository, intranet, etc.</td>
</tr>
<tr>
<td>Optimization</td>
<td>Improvement</td>
<td>Identify the pain, Identify alternatives, Prioritize, Plan, Execute</td>
<td>• Explicit part of knowledge (mainly know-what) could be captured in several forms such as user manual, training documents, process design documents, etc.</td>
</tr>
<tr>
<td>Retirement</td>
<td>Retirement</td>
<td>Identify retirement strategy, Repeat initiation stage again for new technology</td>
<td>• Tacit part of knowledge must be transferred from consultants to project team, then to users.</td>
</tr>
</tbody>
</table>

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REFERENCES


