AN EXPLORATORY STUDY OF KNOWLEDGE TYPES RELEVANCE ALONG ENTERPRISE SYSTEMS IMPLEMENTATION PHASES

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Abstract

Enterprise Systems (ES) are now established business operating systems in many organizations worldwide. Knowledge management research in ES has been significantly focused on the creation, sharing and storage of knowledge. However, it is often not clear what type of 'knowledge' has to exactly managed. Therefore, there is a need to address the epistemological domain of knowledge along the implementation phases of the market leading Enterprise Systems SAP R/3. This exploratory study attempts to identify and analyze the different types of knowledge along the implementation phases of a SAP system. Through an analysis of knowledge types and critical success factors along the phases of SAP's implementation methodology, it is possible to gain insights into the relevance of knowledge types required for implementing an ES.

1 INTRODUCTION

The demand for Enterprise Systems (ES)-related knowledge and support resources is high and the lack of expertise has resulted in the turnover and poaching of staff experienced in ES (Gable et al., 1997). The loss of employees with ES-specific knowledge often hurts an organization in poorly equipped post-implementation phases. Another major drawback is that managers are often unable to successfully tide their system over for the future maintenance and upgrade phases of an ES as they lack an overall understanding of *what* ES knowledge is available and *how* it can be managed. Klaus and Gable (2000) suggested that Knowledge Management (KM) in an ES environment is important because:

(1) ES are the prevailing form of business computing for many large corporations and many government organizations.

(2) ES themselves, due to their scale and breadth, require significant structures for information management and considerable expertise for their implementation, operation and maintenance.

(3) ES software is constantly evolving, striving to integrate further business processes and even inter-enterprise areas such as Customer Relationship Management, which will increase the requirements regarding an elaborated Knowledge Management approach.

Due to the aforementioned predicament in the ES environment, selecting, implementing, using and continuously changing ES requires a great amount of knowledge and experience (Rosemann and Chan 2000, p. 623). ES implementation involves the organization's participation and requires a combination of different knowledge types during its entire life span. Fundamentally, the interrelation between Knowledge Management and Enterprise Systems has two facets:

- On the one side, implemented Enterprise Systems can serve as a main source of knowledge for a companies' Knowledge Management. As Enterprise Systems often support various areas of a company like procurement, manufacturing, warehousing, sales, distribution, accounting, human resources management, etc., an analysis of the runtime data (transactions, involved organizational units) can provide the knowledge manager cost-effectively with useful data about the current process performance. This perspective characterizes Enterprise Systems as a knowledge repository and can be described as 'Enterprise Systems for Knowledge Management'.

- On the other side, the management and especially the implementation of an ES solution requires a substantial amount of specific knowledge and expertise. Thus, a separated ES-related Knowledge Management can be identified that covers the entire management of knowledge in an ES project. This perspective can be characterized as 'Knowledge Management for ES'.

To expand on the two facets, the first perspective with using Enterprise Systems as a platform for managing knowledge is seen to occur at a technologically-inclined level. This perspective uses ES as a repository for KM and is largely advocated by Davenport (2000) "Knowledge management is the most sophisticated domain in which ES can operate. Here the interaction between systems and humans becomes more collaborative; while the system itself can have some decision making capability programmed into it, the system also acts as an extension of the human ability to store and process knowledge. From the standpoint of the systems' intelligence, it can begin to transform data into knowledge through complex statistical analyses."

Approaches in this direction are SAP's Knowledge Warehouse and Reverse Business Engineer as well as IDS' Process Performance Manager. SAP's Knowledge Warehouse provides access to explicit knowledge related to the SAP product itself as well as to related industry and company specific knowledge. Access to this knowledge can be individualized based on the role, language, industry or product version. The Reverse Business Engineer allows organizations to identify characteristics of the current system use by extracting data from the productive system. The RBE reports on executed transactions as well as on the system configuration.

(Davenport 2000) also indicates that "another application of knowledge management to internal processes involves the capture, storing and use of process best practices, workarounds, and shortcuts for use by the human users of a system." Davenport (2000) cites further examples of how the capturing of reasons behind the decisions made or identifying the rationale for the execution of the process be considered as process knowledge management.

The perspective of knowledge management for ES is evident in literature. As examples of KM and ES studies, Haines and Goodhue (2000, p. 1) studied the role of implementation partners and the knowledge transfer between these partners, the software vendor and the system user. Along this perspective, Lee and Lee (2000, p. 281) examined ES implementation from a knowledge transfer perspective. Newell et al. (2001, p. 1122) reported the findings of the knowledge creation process in an ES project team. Huang, Newell et al. (2001, p. 1136) examined the complementary implementation of ES and KM systems in an organization setting. This is the perspective adopted for the research.

Knowledge management research has been significantly focused on the creation, sharing and storage of knowledge through the adoption of ES. However, it is often not clear what types of 'knowledge' have to be managed. Therefore, there is a need to address the fundamental issues in constraining the domains of knowledge. This exploratory study attempts to identify and analyze the different types of knowledge along the implementation phases of a SAP system. In order to define the relevance of knowledge types along the different phases, this paper established the relationship between the types of knowledge and the Critical Success Factors (CSFs) required for the successful implementation of an ES project. Thus, this analysis of the relevance of knowledge types along SAP implementation phases seeks to:

- Assist managers to plot and prioritize knowledge types that need the most attention and therefore,
- Facilitate the allocation of organizational resources;

- Provide guidance in the selection of ES project team members; and
- Provide support to the development of new ES implementation methodologies.

The paper is organized as follows. First, the theoretical background on KM and ES is set in context. Following, the two key concepts used in this research are discussed: critical success factors (CSFs) and knowledge types. This leads to the definition of relationships between CSFs and knowledge types. Next, the implementation methodology ASAP offered by SAP is described. The analysis of ASAP is employed to analyze the relevance of knowledge types along ASAP implementation phases. The paper concludes with a summary and considerations for future work.

2 RESEARCH METHODOLOGY

In order to answer our research question, we adopt a process approach. "In the process approach, ES implementation may be conceived as a sequence of stages, in which related activities occur" (Robey et al. 2000). Figure 2 shows the research approach used in this study.

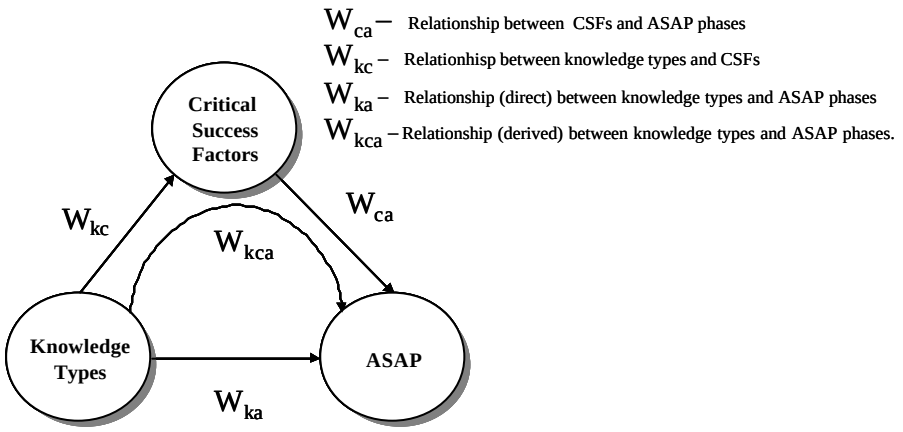

Figure 2 – Analysis of the Relevance of CK types along ASAP phases.

The research approach consists of four main steps:

- Definition of knowledge types and CSFs in ES implementation projects
- Establishment of relationships between CSFs and knowledge types (W_{kc}).
- Establishment of relationships between CSFs and ASAP implementation phases (W_{ca}).
- Analysis of the relevance of knowledge types along ASAP phases (W_{kca}).

3 UNDERSTANDING ES KNOWLEDGE MANAGEMENT THROUGH KNOWLEDGE TYPES

Kay and Cecez-Kecmanovic (2002, p. 103) state that "unless the field of KM first addresses the fundamentals of that which it claims to manage, it runs the risk of being discarded as just another failed management fad that promised much but delivered little." Fahey and Prusak (1998, p. 265) caution that "a common mistake made by practitioners is to not have a working definition of knowledge as the basis for their initiatives." As the construct for 'knowledge' is not well-established in knowledge management literature, a review of knowledge from its epistemological roots is required. In order to fulfill this, we find that a marginalization to perspectives offered by Tsoukas and Cummings (1997, p. 655) useful and posit our understanding of knowledge for ES along techne or skills. Techne is "trained ability of rationally producing". i.e. the ability to produce something reliably under a variety of conditions, on the basis of reasoning. This involves having knowledge, or having what seems to be knowledge (awareness) of whatever principles and patterns one relies on.

The definition of techne for this study is restricted to the study of what skills are required and not exclusively how the skills can be acquired or how they can be applied. The objective of the study is then to identify what types of skills are required in the context of ES and how they are distributed and relevant in the different phases of an ES implementation. In general, while there is motivation to manage knowledge resources, it is not clear what the espoused 'knowledge' is. To support this notion, Benson and Standing (2001, p. 233) state that "effective knowledge management requires a classification system that has distinctive classes, not so many as to be cognitively unwieldy nor so few as to be too coarse grained". Therefore, the knowledge types defined below seek to meet these criteria. We have adopted a framework offered by Chan and Rosemann (2001, p. 47) that represents a structure of different types of knowledge required to manage ES projects. The different types defined are the following:

- *Business knowledge* covers the business issues in the management of ES. This includes functional knowledge in areas such as general ledger accounting, purchasing, sales, human resource management, or strategic planning, organizational knowledge like business process management, communication policies, or document management, and knowledge about the industry-specific business processes.
- *Technical knowledge* represents knowledge that is necessary in conjunction with the selection and use of database management software, network management, add-on programming, client-server architectures, performance measurement, etc.
- *Product knowledge* reflects the need for knowledge, which is specific for a unique ES solution. ES solutions are comprehensive packages with a high degree of complexity. This area of knowledge includes among others the understanding of the architecture of the product, knowledge about its functionality and existing constraints, the implementation methodology, or knowledge about the ES-specific programming language (ABAP for SAP).
- *Company-specific knowledge* covers knowledge, which is specific for one organization with specific characteristics and an individual organizational population, organizational culture, social norms and practices, rules and policies.

- *Project management knowledge* covers the management of human resources, time and cost to accomplish the objectives of a project. The implementation of an ES often requires project management for a time between 6 to 24 months. Project management involves planning, organizing and controlling a project with various time and cost constraints, and gathering senior management support. It also seeks to achieve outputs such as milestone definition and objectives.

It is obvious, that even if the five types of knowledge (business, technical, product, company, project) are available in an ES project, the missing capability to efficiently interact between the involved knowledge owners results in the inability to conduct the project successfully. Consequently, communication, coordination and cooperation knowledge is required in order to integrate the five types of knowledge. Other variables such as beliefs, power, politics, and culture are manifested but are intentionally except for the context of the study.

4 ES IMPLEMENTATION CRITICAL SUCCESS FACTORS

Rockart (1979) was the first author that applied the CSF approach in the information systems area. According to his account, CSFs are “the limited number of areas in which results, if they are satisfactory, will ensure successful competitive performance for the organization". CSFs have been applied to many aspects and tasks of information systems, and more recently to ES implementations (Esteves and Pastor 2000). Based in a set of studies published by authors focusing on CSFs in ES implementations, Esteves and Pastor (2000) coalesced the publications to consolidate them into a CSF unified model (see figure 1). The CSFs are categorized in different perspectives and thus, each CSF is identified and defined.

	Strategic	Tactical
Organizational	• Sustained management support • Effective organizational change management • Adequate project team composition • Good project scope management • Comprehensive business redesign • Adequate project champion role • Trust between partners • User involvement and participation	• Dedicated staff and consultants • Appropriate usage of consultants • Empowered decision makers • Adequate training program • Strong communication inwards and outwards • Formalized project plan/schedule • Preventive trouble shooting
Technological	• Avoid customization • Adequate ERP implementation strategy • Adequate ERP version	• Adequate infrastructure and interfaces • Adequate legacy systems knowledge

Figure 1 - Unified critical success factors model.

5 RELATIONSHIP BETWEEN ES-CSFS AND KNOWLEDGE TYPES

In this section, the relationship between the CSFs and the different knowledge types is analyzed. If it is very important to consider CSF, one has to be aware of the required knowledge for these CSFs. These relationships can be studied by the matrix shown in Table 1. The matrix was tabulated in the following way: the first dimension was obtained by focusing on each CSF and completing the question: 'which types of knowledge required in order to achieve this CSF?' Secondly, the knowledge types were examined to derive the knowledge types required for each CSF. The relationships were established by using a coding procedure. The coding procedure consisted in coding line-by-line all the CSF definitions using a predefined list of codes, in this case the list of knowledge types. In this case, knowledge types were elected as the categories and the concepts were drawn from the definition of the CSFs.

		Critical Success Factors	Knowledge Types				
			1. Business	2. Technical	3. Product	4. Company	5. Project
Organizational	Strategic	A. Sustained management support	●			●	●
		B. Effective organizational change management	●			●	●
		C. Good project scope management	●		●		●
		D. Adequate project team composition	●	●	●	●	
		E. Comprehensive business process redesign	●		●	●	
		F. User involvement and participation	●			●	
		G. Project champion role	●			●	●
		H. Trust between partners	●			●	
	Tactical	I. Dedicated staff and consultants					●
		J. Strong communication inwards and outwards				●	●
		K. Formalized project Plan/schedule					●
		L. Adequate training program	●			●	●
		M. Preventive trouble shooting					●
		N. Appropriate usage of consultants	●			●	●
		O. Empowered decision makers	●			●	●
Technological	Strategic	P. Adequate ERP implementation strategy	●		●		●
		Q. Avoid customization	●		●		
		R. Adequate ERP version	●	●	●		
	Tactical	S. Adequate infrastructure and interfaces		●	●		
		T. Adequate legacy systems knowledge			●		

Table 1 - Relationship between CSFs and knowledge types in ERP implementations.

6 RELATIONSHIP BETWEEN ES-CSFS AND SAP PHASES

In 1996, SAP introduced the Accelerated SAP (ASAP) implementation methodology with the goal of speeding up SAP implementation projects. ASAP was advocated to enable new customers to use the experience and expertise gleaned from thousands of implementations

worldwide. In Dolmetsch et. al (1998), four case studies conducted in small to medium companies came to the eventual result that the ASAP implementation methodology for SAP supported the criteria for a successful SAP R3 implementation by providing a transparent implementation process which allows organization to make the most efficient use of consulting time. Abeerden (1998) found that ASAP provided assistance in facilitating the completeness and early delivery required in project training which allowed a greater degree in knowledge transfer from the project. The ASAP implementation methodology is a structured implementation approach that can help managers achieve a faster implementation with quicker user acceptance, well-defined roadmaps, and efficient documentation at various phases. This is specifically targeted for small and medium enterprises adopting SAP. The phases of the ASAP methodology, also known as the ASAP roadmap are:

- **Project preparation** – the purpose of this phase is to provide initial planning and preparation of the SAP project. The steps of this phase help identify and plan the primary focus areas to be considered such as: objectives, scope, plan and definition of project team. The outcome is the project charter.

- **Business blueprint** - the purpose of this phase is to create the business blueprint, which is a detailed documentation of the organizational structure and business processes gathered during requirements workshops/meetings. It will allow the implementation project team to clearly define their scope, and only focus on the SAP processes needed to run the organization business.

- **Realization** - the purpose of this phase is to actually configure SAP R/3 based on the specifications of the business blueprint as well as taking further input into account (Questions & Answer database). The objective is the final configuration os the system, an overall test, and the release of the system for production (live) operation.

- **Final preparation** – the purpose of this phase is to complete the final preparation, including testing, end user training, system management and cut over activities. The final preparation phase also serves to resolve all open issues.

- **Go live & Support** - the purpose of this phase is to move from a pre-production environment to live production operation. A support organization must be set up for end users to provide long-term support. This phase is also used to monitor system transactions and to improve overall system performance. Finally the completed project is closed.

The structure of each phase is the following: each phase is composed of a group of work packages. These work packages are structured in activities, and each activity is composed of a group of tasks. For each task, a definition, a set of procedures, results and roles are provided in the ASAP roadmap documentation. According to a survey of Input company (Input 1999) organizations are more satisfied with SAP tools and methodologies than with those of their implementation partners. Implementations where ASAP or Powered by SAP methodologies were used averaged only 8 months, compared to 15 months for standard implementations. Esteves and Pastor (2001) developed a model of CSFs along the ASAP

implementation phases (see table 2). This model is the basis upon which the relevance of critical knowledge types along the SAP implementation phases is defined.

			Phase1	Phase2	Phase3	Phase4	Phase5
Organizational	Strategic	Sustained Management Support	8	5	5	5	8
		Effective Organizational Change	6	8	5	5	6
		Good Proj. Scope Management	5	4	4	4	5
		Adequate Proj. Team Composition	4	4	4	4	4
		Comprehensive Business Process Redesign	4	7	4	4	5
Perspective		User Involvement and Participation	5	8	10	8	6
		Proj. Champion Role	10	10	9	10	10
		Trust Between Partners	6	4	4	4	5
	Tactical	Dedicated Staff and Consultants	4	4	4	4	5
		Strong Communication Inwards and Outwards	7	7	6	8	8
		Formalized Proj. Plan/Schedule	8	7	7	7	5
		Adequate Training Program	5	5	5	7	5
		Preventive Trouble Shooting	4	4	8	8	7
		Usage of Appropriate Consultants	6	8	9	6	5
		Empowered Decision Makers	4	4	4	5	4
Technological	Strategic	Adequate ERP Implementation Strategy	5	4	4	4	4
		Avoid Customization	4	4	5	4	4
Perspective	Tactical	Adequate ERP Version	4	4	4	4	4
		Adequate Infrastructure and Interfaces	6	6	7	7	4
		Adequate Legacy Systems Knowledge	4	4	4	4	4

Table 2- CSFs relevance along the ASAP implementation phases.

7 RELEVANCE ANALYSIS OF ES KNOWLEDGE TYPES ALONG SAP PHASES

This section describes how the relevance of knowledge types along the SAP implementation phases has been derived. The relevance was established on the following manner: the matrix of CSFs versus knowledge types was amalgated with the CSFs along SAP phases (see table 3) by assigning for each relationship between a knowledge type and a CSF, the respective CSF relevance value in each SAP implementation phase. For example, the relationship of ‘sustained management support’ and ‘business knowledge’ is computed as a value of 8 (the respective value of ‘sustained management support’ relevance in phase 1, see table 2). In phase 2 that value is 6 and so on. Consequently, the values for each knowledge type were consolidated and finally, the scores were converted into a scale of ten. In this scale, results from 1-3 were considered not relevant, from 4-7 of normal relevance, and 8-10 of high relevance. Conceptually, this value represents the knowledge type relevance in that phase. Table 3 details the whole exercise of how we worked out the values for phase 1 – project preparation phase. The results for the other SAP implementation phases were worked out in the same way. Table 4 presents the exploratory findings for all ASAP implementation phases.

		Critical Success Factors (CSFs)	Knowledge types					
			CSFs relevance	Business	Technical	Product	Company	Project
Organizational	Strategic	Sustained management support	8	8			8	8
		Effective organizational change management	6	6			6	6
		Good project scope management	5	5		5		5
		Adequate project team composition	4	4	4	4	4	
		Comprehensive business process redesign	4	4		4	4	
		User involvement and participation	5	5			5	
		Project champion role	10	10			10	10
		Trust between partners	6	6			6	
	Tactical	Dedicated staff and consultants	4					4
		Strong communication inwards and outwards	7				7	7
		Formalised project Plan/schedule	8					8
		Adequate training program	5	5			5	5
		Preventive trouble shooting	4					4
		Appropriate usage of consultants	6	6		6	6	6
		Empowered decision makers	4	4			4	4
Technological	Strategic	Adequate ERP implementation strategy	5	5		5		5
		Avoid customization	4	4		4		
		Adequate ERP version	4	4	4	4		
	Tactical	Adequate infrastructure and interfaces	6		6	6		
		Adequate legacy systems knowledge	4		4	4		
		Total:		76	18	42	65	72
		Normative value		7	2	4	6	7

Table 3 – Relevance of knowledge types for SAP project preparation phase (phase 1).

	Phase 1	**Phase 2**	**Phase 3**	**Phase 4**	**Phase 5**
Business	7	7	7	7	7
Technical	2	2	2	3	3
Product	4	5	5	4	4
Company	6	7	6	6	6
Project	7	7	7	7	7

Table 4 – Relevance of knowledge types along SAP implementation phases.

From the findings, it can be observed that:

- **Business knowledge** – This knowledge has the same relevance in all phases of SAP implementation, since the ASAP methodology is focused on how to implement the business processes of an organization in the SAP system. As (Scheer 1998, p. 1) points out, "Screens [in the example of SAP R/3], provide the typical user interface to a business information systems. These screens display a variety of systems aspects such as technical commands (user commands), functions, data and organizational concepts. Users are able to understand the screen's contents only if their familiarity with the business background allows them to interpret the information contained in the screens." In practice, therefore, users are trained in the subject background.

- **Technical knowledge** – This knowledge type has the lowest relevance value of all knowledge types. This reinforces the assumption that an ES project is more an organizational and business project rather than a technological one. In phases 4 and 5, its relevance increases as these stages consist of the actual technical environment where the system is defined, tested and operationalized.

- **Product knowledge** – This knowledge is specially required in phases 2 and 3. In phase 2, it is necessary to understand the complexity and the functionality of the ES in order to achieve the best benefits possible during business process improvement. In phase 3, the system is parameterized. Thus, it is suggested that these phases require product-specific knowledge such as the ES-specific programming language (ABAP).

- **Company knowledge** – This knowledge is specially required on phase 2 in which business processes are modeled and improved according to the company specific needs and the functionality offered by the new system. During this phase, the employees in the organization are required to actively give input on their respective business processes.

- **Project Knowledge** – This knowledge is relevant in all the phases since the complexity of this kind of projects requires a tight control of resources, time and budget and the accomplishment of objectives. Project knowledge is seen as crucial to an organization during the implementation phase as it is usually 'new' and unavailable to employees of the organization. Organizations also realize that they rely heavily on external knowledge (consultants).

Based on these findings, a three relevance-level model of knowledge types along SAP implementation phases is proposed. The first level (L1) is represented by the knowledge types with scores of 7 (high relevance), second level (L2) scores between 4-6 (normal relevance) and finally third level (L3) scores between 1-3 (low relevance).

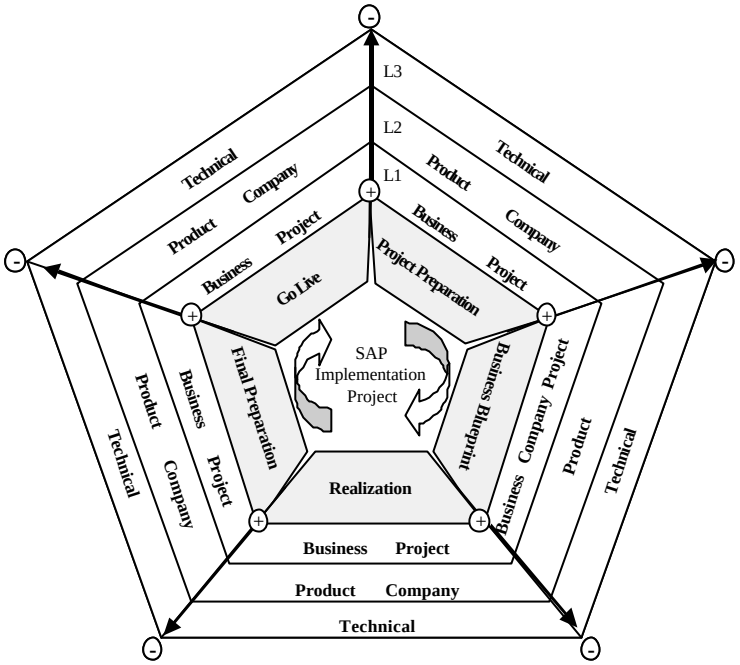

Figure 3 – A three relevance-level model of knowledge types along SAP implementation phases.

8 IMPLICATIONS FOR PRACTITIONERS

This study can help managers improve their project teams and their ES project success. "Organizations have astonishing varying degrees of success with implementation" Bancroft et al. (1998). According to Bancroft et al. (1998), the difference is in their abilities to address each of the CSFs for ES implementation projects (see section 4). For the organization's ability to manage an ES implementation project, the selection of the adequate people plays an important role. CSFs such as adequate project team composition and adequate training program may be improved and efficiently managed if knowledge types relevance is take into account.

Another aspect where this model may be useful is the efficient use of consulting resources. Consultants are typically expensive, so the decision about whom and when to use them is an important one. The objective should be to identify a partner whose technical skills, business knowledge, management skills, and commitment to its client success will help the company attain its project objectives. With the proposed model, managers can analyze which knowledge they have internally and which knowledge must be developed by contracting external resources.

9 IMPLICATIONS FOR RESEARCHERS

This paper could only provide a brief overview about the consolidation of two research streams, i.e. the identification of relevant knowledge types and the extraction of Critical Success Factors along SAP implementation phases. An interesting topic that deserves

further attention is the analysis of how organizational and national culture may affect the relevance knowledge types and CSFs. Further research is also required in order to understand how the different types of knowledge evolve over time. Based on a single case study, Baskerville et al. (2001) have shown that ES knowledge in the organization is both converging and diverging. “As a result of ES, IT development experts need to learn more about the business processes, and business process experts need to learn more about their IT systems. From the individual perspective, however, knowledge is becoming more divergent. An expert in customer billing now must learn in more diverse areas than before” (Baskerville et al. 2001, p. 402).

10 CONCLUSIONS AND FURTHER WORK

This study attempts to identify the knowledge types necessary for a successful ES implementation project and analyzes their relevance along the different phases of an ES implementation project. The results of this study highlight the importance of business, company and project knowledge in these projects. It is emphasized that all knowledge types are needed in a SAP implementation but selected knowledge types would be more relevant in some stages than others. Thus, this analysis of the relevance of knowledge types along SAP implementation phases seeks to:

- Assist managers to plot and prioritize knowledge types that need the most attention and therefore, to acquire required skills according to the organization needs;
- Facilitate the allocation of organization resources;
- Provide guidance in the selection of ES project team members; and
- Provide support to the development of new ES implementation methodologies.

Future research will focus on the validation of the conceptual findings developed in this study. An invested effort will be committed to understand how organizations develop, manage and share all different knowledge types. A further working area would be to examine how these knowledge types can be represented in an ES implementation project.

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