ABSTRACT

Current IS research regarding ERP implementation stops short at system ‘start-up’ and does not address post-implementation issues. In fact, ERP implementation is a continuous improvement effort and continued work after system start-up will largely influence the ultimate success of an ERP system. This paper contributes a four-phase ERP continuous improvement model that incorporates knowledge management into each major implementation phase, this provides practitioners with a guideline for integrating two major IS operations in an organization and improve success rates of ERP implementation in the long run.

Keywords: Knowledge Management, ERP, Implementation, Continuous Improvement

INTRODUCTION

A great deal of time, effort, and costs are directed toward the implementation of ERP systems. Projections for 2002 estimated a total of $72.63 billion would be spent by organizations on implementation and support of ERP systems (1). ERP projects are a large commitment by an organization and the inherent size and scope of these projects lead to complexities not encountered in implementing legacy systems. Research in ERP implementation methodologies has been focused on the initial start-up complexities of projects. There has been little effort spent in the area of post-implementation support (5). Many organizations mistakenly see the go-live of an ERP system as the final goal instead of a milestone within an overall ERP scheme (6)

It is our experience that ERP projects rarely have a discrete and evident endpoint; continued efforts are required to lengthen the life and maximize the benefits of these expensive systems. We argue that the whole ERP implementation is a continuous improvement process. A key methodology supporting ERP continuous improvement would be knowledge management. To succeed in ERP implementations, knowledge management must be incorporated into ERP projects in order to ensure that knowledge is captured once it is created. The creation of knowledge is not a by-product of an ERP project but an important component of the system itself. A framework is needed for the incorporation of knowledge management into ERP projects. This framework must focus on the practitioners’ needs and understandings of each implementation phase. It must reconcile the creation of implementation deliverables and the supportability of those deliverables, which will be used by both the ERP project team and the central ERP support unit. To accomplish this, organizations will need to embrace knowledge management to ensure that the vast amount of knowledge created during implementation is captured and distributed.

This paper identifies the steps needed to incorporate knowledge management into ERP continuous improvement. First, relevant components of implementation methodologies will be
reviewed. Second, we will review knowledge management and its implications with a focus on the unique challenges of ERP projects. Third, we will discuss how to incorporate knowledge management into ERP implementation projects. Fourth, the advantages of incorporating knowledge management into ERP implementation will be reviewed. The last section will provide a summary and concluding remarks.

**ERP IMPLEMENTATION METHODOLOGIES**

Current ERP implementation methodologies represent the culmination of years of evolutionary learning. It is our experience that a complete ERP implementation spans four different phases: analysis, design, construction, and deployment. Each phase has its own set of implementation deliverables and project checks & balances. Traditionally, these phases were seen as a liner process and the main goal of implementation was to get the project completed. However; in our opinion, a linear implementation methodology is not an efficient use of organizational resources. For complex IS projects like ERP implementations, linear models cannot guarantee the ultimate success. In ERP continuous improvement “older” applications are no longer superseded by newer ones; instead, modules are reworked and retooled to satisfy updated business processes and technical infrastructures. Organizations need to adopt the continuous improvement methodology seen in figure 1.

![Figure 1. Typical phases of ERP implementation & continuous improvement](image)

As the figure shows, the support group is the center of the four phases. As project teams are created and eventually disbanded, the central support group should be in place to coordinates all necessary deliverables for the perpetual support of the ERP systems. This assumes that the support group has access to all the knowledge and deliverables from the different project phases. One typical ERP implementation issue is that third party resources are typically involved. These resources include subject matter experts (SME) from the software vendor(s) and external consultants. To maintain self-sufficiency the organization must capture intellectual capital created in the implementation process and responsibly manage it.

**KNOWLEDGE MANAGEMENT**

Sarvary (4) provides the most relevant definition of both knowledge and knowledge management: “Knowledge is information plus the causal links that help to make sense of this information. [Knowledge management] might be seen as a process that establishes and clearly articulates such links.” How knowledge is created depends on what type the knowledge is. Two types of knowledge exist: tacit and explicit (3). Explicit knowledge “can be expressed in words and numbers and shared in the form of data, scientific formulae, specifications, manuals and the like. This kind of knowledge can be readily transmitted between individuals formally and systematically.” Tacit knowledge “is highly personal and hard to formalize, making it difficult
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to communicate or share with others. Subjective insights, intuition, and hunches fall into this category of knowledge.”

Knowledge creation at an organization level is not simply a linear process. It is the interaction between the two types of knowledge that result in an evolutionary process. There are four possible conversion paths between these two types of knowledge inside an organization: socialization, externalization, combination, and internalization. The SECI model can be used to represent these four conversions and the inherent relationships between them.

Figure 2. SECI knowledge spiral (adapted from Nonaka and Konno, 1998 p.43)

In an organization, knowledge can be retained at three levels: individual, group, and organization. Knowledge is tacit if only an individual can capture it. It becomes explicit when it is assimilated into groups and organizations. Each quadrant in the SECI model describes how knowledge reconciles in its two different forms. The process begins in the socialization quadrant where only tacit knowledge exists. This is the exchange of thoughts and ideas between individuals leading to an improved understanding about the system, which provides the initial trigger for knowledge creation. Once tacit knowledge has been created, it is formalized and standardized in order to be communicated in groups, which leads to the creation of explicit knowledge (Externalization). Once explicit knowledge is created, it can be reconciled with other pieces of explicit knowledge created by other implementation groups and the knowledge is expressed in a format that it can be retained at organizational level (Combination). The practical application of explicit knowledge is described by the final quadrant where each group and individual assimilates and applies the knowledge (Internalization).

KNOWLEDGE CHALLENGES IN ERP IMPLEMENTATION

Our experiences have shown that knowledge management in ERP implementation methodologies can face a number of challenges. First, knowledge has been captured and processed by transient resources that will vanish soon after the ERP implementation is complete. Therefore, knowledge-carrying bodies are not perpetual in an organization. Second, traditional methodologies do not explicitly have a check-and-balance process to ensure that the knowledge being captured has been assimilated, verified and stored for future use. Third, the body breadth and volume of knowledge being created prevents it from being condensed into a single deliverable at the end of implementation.

In order to address these issues, knowledge that has been captured must be transferred to the central support group that will maintain the system after implementation. It has to be ensured that
knowledge transfers between individuals, groups and organizations and the knowledge will be incorporated into the post-deployment process. Knowledge management as a business process is composed of three sub-processes: organizational learning, knowledge production and knowledge distribution (4). The first two sub-processes dealing with the creation of knowledge have already been addressed by Nonaka et al. (2 & 3), however; knowledge distribution has not been addressed by ERP implementation studies. Thus, it is imperative to revise traditional ERP implementation methodology by incorporating knowledge management.

**REVISED ERP IMPLEMENTATION METHODOLOGY**

By explicitly identifying the steps required to enable knowledge management in ERP implementation, we can improve our ability to distribute the knowledge created. Four fundamental knowledge requirements need to be identified for each implementation phase:

1. Each phase requires a distinct beginning point, the rules of engagement are explicitly described, deliverables identified and the techniques to be used within that phase are examined and implemented.
2. An examination of the alignment of the business knowledge captured during each phase with the eventual deliverables to be produced.
3. Sub-groups within the project team must reconcile this knowledge amongst themselves to ensure that all requirements are addressed for that phase.
4. The functional requirements must then be reconciled with the methodology tools as well as the ERP functionality (relevant with that phase) to address any necessary compromises. Additionally, the techniques used to capture the knowledge must be documented and updated. Practical experiences with the use of the methodology must be incorporated to improve future use.

The deliverables for each phase will vary as well as the duration and resources required; however, these four general steps will exist in each phase. The progression inside each implementation phase is linear, i.e., from steps 1 to step 4. At the end of step 4, the initiation of the next phase of the project begins (starting again at step 1). Figure 3 is an adaptation of Nonaka et al. model, with migration through the quadrants using the four steps described above. One iteration of the spiral through all four quadrants represents a single implementation phase of the project. However, a significant departure from the Nonaka et al.’s model is the explicit identification of the activities that occur during the progression between quadrants. Nonaka et al.’s model only explained the relationship of knowledge as it is changed from one form to the next. This modified spiral model (figure 3) identifies what activities have to occur within the project phase to support knowledge progression between quadrants.

Step 1 occurs in the socialization quadrant. Tacit knowledge from the organizations employees, project consultants, and a high-level understanding of the phase deliverables are brought together. Veteran employees leverage previous project experiences while novice employees leverage freshly learned tools and techniques. This mutual exchange of tacit knowledge is informal and continues throughout the phase. Step 2 occurs in the externalization quadrant. Possessing the understanding of what the project phase represents and the deliverables to be produced, team members begin to formalize the tacit knowledge by interacting with the rest of
the organization. These formalization activities are the first steps in generating explicit knowledge.

![Image of revised knowledge management spiral](image)

**Figure 3. Revised knowledge management spiral.**

Step 3 occurs in the combination quadrant. Usually, the large size of ERP projects forces project teams to specialize in functional areas. The combination phase reconciles the explicit knowledge gathered by project sub-teams to provide a single view of the implementation for the organization. Compromises and clarification are made so that the entire group understands the captured explicit knowledge. Step 4 occurs in the internalization quadrant. The deliverables and improved understanding of the business requirements and processes gathered during the externalization and combination phases must be interpreted. Individuals on the project team perform a holistic review of the explicit knowledge and the techniques used to gather it. This review provides two main benefits; first, it reconciles newly learned knowledge with existing explicit knowledge already possessed by the team. Second, it can identify improvement opportunities for the methodology and deliverables. These improvements may manifest themselves as new deliverables, improved documentation, improved training, process refinements, etc. The continuous improvement aspect of this step is critical to the complete incorporation of knowledge into ERP implementation. These improvements are then reintroduced to the team and organization at the start of the next cycle.

Merging the traditional implementation methodology shown in figure 1 with the modified spiral approach to phase knowledge in figure 3, we are able to generate a self-sufficient model (figure 4). This model propagates refined knowledge from one project phase to the next and positions project deliverables for efficient use by the support group.

![Image of improved ERP implementation methodology](image)

**Figure 4. Improved ERP implementation methodology incorporating knowledge management**
BENEFITS OF KNOWLEDGE MANAGEMENT

Each of the four steps described earlier (identified in figure 5 by Nonaka et. al’s quadrant names) provides a relative advantage to the project and organization. The magnitude of its value depends on the organization’s commitment to knowledge management as a whole. Each step does not return a uniform benefit curve. Figure 5 provides a sample representation of how this curve could appear to an organization for a given project phase.

![Figure 5. Representation of knowledge gained and benefits received](image)

The initial quarter of the curve (socialization) is the steepest in ERP continuous improvement. Individuals may be experiencing the project methodology for the first time. Informal orientation, along with structured overviews of the project and the particular phase, provides an environment where a great deal of information is exchanged, which leads to the initial development of tacit knowledge. The next two sections of the curve are still positive but return the smallest relative benefits. The gathering of tacit knowledge and its evolution into explicit knowledge provides value, but from the perspective of individual team members it may appear to be just documentation-of-the-obvious. The steeping curve toward the end of combination is due to the new inferences made between knowledge that had previously been thought to be unrelated. The final section of the curve continues the trend from externalization and combination, but also steepens toward the end due to the improvement efforts being applied to the implementation process. New deliverables increase the teams and organizations’ knowledge.

Using such a curve for each phase and linking the phases together provides a comprehensive view of the knowledge management benefits for a given project (figure 6). Each ERP implementation phase encompasses the entire curve (as seen in figure 5) with the dashed lines denoting the step boundaries within each phase. The post-deployment section denotes a transition point; as figure 4 indicates, this would typically be the next analysis phase.

![Figure 6. Knowledge management curve for an implementation project](image)
The extent of the return depends on an organizations’ commitment to incorporate knowledge management into ERP continuous improvement. Particular attention should be given to the ‘unrealistic curve’ (represented by the dotted line). Many organizations try to save time during the initial phases of ERP project and wait until the end of the deployment phase to document the whole implementation. This approach may document the end-state of the knowledge but it is unrealistic to document the whole implementation process and knowledge created. For the support group, understanding why a particular decision was made is just as important as seeing how it is implemented. These causal links make up a great deal of the ERP implementation knowledge. The documentation at the end of a project only shows what the system looked like, it will not be able to answer why it looks like that. The central support group needs to understand the whole process in order to correctly maintain the system. New requirements and processes must be reconciled to ensure that the original intent is not being corrupted.

**SUMMARY**

Existing IS research about ERP implementation is limited to the implementation as new a system. Most organizations do not explicitly manage the knowledge created during ERP implementation process. Revising the traditional linear development methodology into one that is circular with a focus on the central support group provides the managerial structure of incorporating knowledge management into ERP implementation. Explicit identification of the steps with Nonaka, et al’s knowledge spiral provides practical guidelines for ERP practitioners. This ensures that ERP implementation allows knowledge to be captured, assimilated, refined, documented and leveraged for the next project phase. This cumulative process builds a knowledge base that can be used to support the ERP system after the initial implementation is complete.

**REFERENCES**