Managing knowledge in IT projects: a framework for enterprise system implementation

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Abstract

Purpose – *The purpose of this study is to explore the knowledge management (KM) perspective of information technology (IT) projects based on enterprise system (ES) implementations. The study determined what knowledge is needed in each of the project phases (what for, from what sources), how this knowledge is transformed during the project (what knowledge activities are performed concerning this knowledge) and what knowledge-related artifacts are created. A KM framework for ES projects is formulated based upon the results.*

Design/methodology/approach – *The research has a qualitative exploratory design based on multiple data sources: documentation, semi-structured interviews and participant observation. A coding procedure was applied with the use of a pre-defined list of codes, as derived from KM literature regarding knowledge types, actors, project phases and activities. Open coding was used to determine the role of each type of knowledge in the implementation process.*

Findings – *The study examined the significance of the particular types of knowledge of each project actor across the project phases, and identified the specific knowledge activities that need to be performed for a successful outcome. In contrast to existing literature, this study also demonstrates that project management knowledge consists of two components: generic and product-related. Meta-knowledge, i.e. knowledge about other people's knowledge was also identified as critical in the initial phases of the project. Solution knowledge was identified as the primary knowledge product. It is the result of the integration of company and product knowledge and is embedded into the system.*

Research limitations/implications – *The limitation of this study is that it concentrated on a specific type of the IT project, namely ES implementation. The results cannot be directly extrapolated to other IT projects.*

Practical implications – *The results of the study may aid in effective staffing for ES implementations and in identifying the necessary knowledge sources. They may also enable the development of relevant KM procedures for a project.*

Originality/value – *No comprehensive project KM framework for ES has been found in the existing KM literature, and this study fills this gap in the research.*

Keywords *Enterprise systems, ERP, IT projects, Knowledge activities, Knowledge requirements, Project knowledge management*

Paper type *Research paper*

1. Introduction

Projects in general, and information technology (IT) projects in particular, have been studied in depth for several decades. However, the traditional research on projects has concentrated on the perspective of action, in which a project is considered "as an arena in which action is paramount and in which tasks, budgets, people and schedules must be managed and controlled to achieve expected results" (Reich *et al.*, 2008). This approach and the resulting project management (PM) practices can (and has been) be applied effectively, but another research perspective can also be applied to examine the project phenomenon, i.e. the knowledge management (KM) perspective (Gemino *et al.*, 2007; Lee and Lee, 2000; Reich *et al.*, 2008). Projects in general, and IT projects in particular, are knowledge-intensive activities (Tiwana, 2003; Wang *et al.*, 2007); thus, the presentation of

Received 8 January 2014
Revised 25 March 2014
Accepted 26 March 2014

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all the possible aspects of knowledge and KM in projects is a valuable research direction (Chan and Rosemann, 2001; Reich, 2007).

Research on KM is most widely encountered in the context of the organization (Reich, 2007); however, research on KM in projects is also available (Snider and Nissen, 2003). According to Reich *et al.* (2008):

> Knowledge management in the context of a project is the application of principles and processes designed to make relevant knowledge available to the project team. Effective knowledge management facilitates the creation and integration of knowledge, minimizes knowledge losses, and fills knowledge gaps throughout the duration of the project.

Although the number of research publications on project knowledge management (PKM) is significant, according to Hanisch *et al.* (2009), the literature has identified specific problems and challenges, but the general solution on how to manage knowledge in projects and project-based firms is not yet available. In addition, projects involve inter-organizational knowledge management and transfer, and these generate numerous additional barriers (Fang *et al.*, 2013). The need for general solutions on how to manage knowledge in projects and project-based firms should encourage further research on PKM because managing knowledge appears to be one of the most important tasks of a project manager (Hanisch *et al.*, 2009; Reich, 2007). As IT projects are among the most knowledge-intensive ones (Tiwana, 2003; Jackson and Klobas, 2008), PKM for IT projects is a promising research direction.

A significant subgroup of IT projects involves implementation of standard, off-the-shelf software packages rather than the development of new systems (Daneva, 2004, Soffer *et al.*, 2003). As Reich *et al.* (2008) state: "In this environment, the project manager's primary task is to combine multiple sources of knowledge about technologies and business processes to create organizational value". The most common representation of standard, off-the-shelf software packages are enterprise systems (ES) application suites that are built around enterprise resource planning (ERP) systems, and in addition to ERP, these also contain customer relationship management (CRM), business intelligence, workflow and possibly many other applications, which require merging knowledge from different sources and from people with different professional backgrounds (Chan and Rosemann, 2001; Wang *et al.*, 2007).

Other authors have also contributed to this field of study, including Esteves *et al.* (2003) who postulate the formulation of the KM for ES. McGinnis and Huang (2007) agree that "systematic incorporation of KM into ERP PM is strategic and critical". On the other hand, Sedera and Gable (2010) state that "studies rarely address the diversity of needs, types, and sources of knowledge in support of the ES" Therefore, this research, which creates a KM framework for ES projects, makes a valuable contribution.

Existing KM frameworks include the work of Chan and Rosemann (2001), which analysed the importance of knowledge types in the ERP life cycle. Similarly, in the study by Esteves *et al.* (2003), the knowledge types are allocated in the life cycle of a system. However, these frameworks do not present the knowledge dynamics in the project, i.e. the knowledge flows and activities. Research available in the literature also includes specific aspects of knowledge in projects, such as the role of knowledge in the success of projects (Sedera and Gable, 2010). It also includes the project manager's role in integrating and managing knowledge (Kasvi *et al.*, 2003), knowledge risks and best practices to avoid them (Leseure and Brookes, 2004; Reich, 2007), the impact of knowledge skills on project success/

performance (Sedera and Gable, 2010), PKM success factors (Hanisch *et al.*, 2009) and knowledge transfer in and/or between projects (Ghobadi and D'Ambra, 2012; Santhanam *et al.*, 2007; Wang *et al.*, 2007). However, research that points toward a holistic view of KM in ES projects, including both knowledge statics and dynamics, is scarce, and this study endeavors to fill that gap.

This paper explores the KM perspective of ES implementation projects by determining what knowledge is needed in each of the project phases (what for, from what sources), how this knowledge is transformed during the project (what knowledge activities are performed with regard to this knowledge) and what knowledge-related artifacts are created. The paper first presents the theoretical background for the study, followed by a presentation of the research methodology used in the study and the study results. The results are summarized and used to create a KM framework for ES projects.

2. Theoretical background

2.1 Knowledge taxonomy

Knowledge taxonomy is the first aspect of KM for ES projects that has to be determined. The prevalent classification criterion in the literature, which is also used in this study, is the knowledge content (Chan and Rosemann, 2001; Reich *et al.*, 2008, Rus and Lindvall, 2002). The most detailed classification, performed according to the knowledge content criterion, is presented by Chan and Rosemann (2001). It includes the following knowledge types:

- business;
- technical;
- product;
- company-specific;
- project; and
- communication/coordination/cooperation.

Similar knowledge types are used by Reich *et al.* (2008), but this study also identifies institutional knowledge, and this type is added to the list of knowledge types used in this study. In addition, the definition of PM knowledge, presented by Chan and Rosemann (2001), appears to not be sufficiently precise. This is because it may refer to both the generic knowledge on PM that a team should possess and be able to use it to perform the required tasks (e.g. knowledge on scheduling techniques or risk management procedures) and to use the specific knowledge regarding a given project (e.g. its schedule, scope, budget, resources, risks and current work status). To distinguish between these two knowledge types in this study, the first has been designated PM knowledge, and the second is referred to as project knowledge.

Therefore, the knowledge taxonomy, according to the content criterion used in this study, is as follows:

- Business knowledge – includes functional knowledge in areas such as general ledger accounting, purchasing, sales, human resources or strategic planning.
- 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 and performance measurement.
- Product knowledge – knowledge specific for a unique ES solution.
- Company-specific knowledge – knowledge about the specificity of a company in which the system is implemented, including its business processes, internal procedures and other individual factors.

- PM knowledge – represents knowledge a project manager should possess to be able to perform his/her job in a professional manner – constitutes PM body of knowledge.
- Project knowledge – the knowledge about resources, time and cost to accomplish the objectives of a specific project, schedules, milestones, etc.
- Institutional knowledge – includes an organization's power structure, values and history.
- Communication, coordination, and cooperation knowledge – skills required to integrate the above knowledge types and to enable cooperation between individuals from differing disciplines and cultures. This is designated communication/cooperation knowledge in the remainder of this paper.

2.2 Knowledge activities

The second aspect of KM is the knowledge life cycle or KM phases/activities. A summary of different definitions of KM phases is presented by Sedera (2009), who concludes that, although different authors propose different number of phases:

> [...] four common phases spanning the knowledge management life cycle can be loosely superimposed: acquisition/creation/generation, retention/storage/capture, share/transfer/disseminate and application/utilization/use.

Differences in the observation time frame results in the inclusion of initial phases, such as knowledge needs (requirements), identification (Gasik, 2011) and knowledge identification, as well as terminal ones, such as unlearning (Chan and Rosemann, 2001). Chan and Rosemann (2001) indicate that the knowledge life cycle phases do not appear in a sequence and that the co-relations between each task are complicated. Taking this into account, the following knowledge life-cycle phases (activities) are considered in the study:

- identification;
- acquisition/creation;
- transfer/dissemination;
- storage/capture; and
- use/application.

Unlearning is excluded, as this study concentrates on KM for a single project, and unlearning occurs after the project is finished.

The knowledge life cycle presented above may concern both organizations and projects. However, some papers have indicated additional KM activities that are project-related. Pan *et al.* (2007) and Reich (2007) highlight additional KM activity and knowledge integration, which is understood as:

> [...] the process of bringing different specialist forms of knowledge (i.e. cross-functional) together to address an identified issue and to create knowledge that is greater than the sum of its parts: a new idea, a shared understanding, or an integrative model (Reich, 2007).

Another understanding of knowledge integration in relation to software projects is presented by Tiwana (2003), in which knowledge integration is "a process of embodying business application domain knowledge with technical knowledge in the design of the software." To distinguish the two different definitions of knowledge integration, the second phenomenon can be designated as "knowledge embodiment".

2.3 Project life cycle

The literature on the ES project life cycle is very extensive and may be accessed through literature reviews, such as the one by Esteves and Bohorquez (2007). As all the projects being analyzed in this study were SAP implementations, and interviewees were also mostly

engaged in SAP projects, the ASAP project phases were used as a framework to reflect the implementation process. These phases are:

- Project Preparation.
- Business Blueprint.
- Realization.
- Final Preparation.
- Go-Live and Support.

The activities and products of each phase were investigated during the study and are presented in the section on research results.

2.4 Project actors

Somers and Nelson (2004) identify the following project stakeholders:

- top management;
- project champion;
- steering committee;
- implementation consultants; and
- project team.

Amoako-Gyampah (2004) gives a different list of project participants:

- top management;
- project managers;
- team leaders;
- trainers;
- end users;
- consultants; and
- vendors.

Themistocleous *et al.* (2011) mention provider project manager, provider consultants, developers, project sponsors/champions, steering committee members, auditors, key-users, implementation team members and company IT staff. As the literature provides an ambiguous list of project participants, and some of the categories appear to overlap, the project stakeholders were identified for the current study.

The following actors were identified during the analysis of the documentation and confirmed during the interviews:

- Involved in all phases of the project (main actors):
  - Project manager consultant – lead of the consulting team, responsible for the project delivery from the side of the consulting enterprise.
  - Project manager client – lead of the client team, responsible for the project delivery from the side of the client organization.
  - Consultants – functional consultants, performing the project from the side of the consulting company;
  - Key-users – performing the project from the side of the client organization.

The consultants and key-users form the implementation team that jointly perform project activities.

The following actors are involved in some phases of the project or play supportive roles:

- Steering Committee members/top management – support the project at the highest level, supervise the project execution and solve the problems that cannot be solved by the project team.
- Programmers – perform the developments that exceed normal system configuration (if needed).
- Data migration consultants – are responsible for the preparation of the data migration from legacy systems to the new system.
- Users – client company members actually using the system after it is deployed, not involved in the current project activities (contrary to key-users).
- Local IT – the IT staff of the client company. In the client–consultant implementation model presented in this paper, the role of local IT is limited to data extraction from the legacy systems and supervision of the infrastructure.

The detailed analysis of KM in this study was performed for the main actors only.

3. Research methodology

The literature review and discussion from the preceding sections indicate that there is a significant lack of fieldwork on PKM for ES s. According to Creswell (2009, p. 18), "if a concept or phenomenon needs to be understood because little research has been performed on it, then it merits a qualitative approach". For this reason, an exploratory, qualitative research strategy was chosen for this study. "In qualitative study, inquirers state research questions, not objectives or hypotheses" (Creswell, 2009, p. 129). Therefore, the following research questions (RQ) were posed:

RQ1. What knowledge is needed to accomplish the project phase (and from what sources)?

RQ2. What knowledge-related activities are performed in each project phase, and what actors perform these activities?

RQ3. What is the knowledge output/result of each phase?

The knowledge types, knowledge activities, project phases and actors were derived from the literature presented in the "theoretical background" section. During the course of the study, these lists were verified for completeness.

Qualitative research calls for multiple data sources and data triangulation to increase the reliability of the study (Yin, 2003, p. 116). To meet this requirement, the following data sources were used:

- Contractual documentation from five projects, including contract appendices and project charters – determining the division of the project roles, activities and products.
- Full documentation, produced during three projects, including project charters, meeting minutes, status reports, business blueprints, configuration documentation and user manuals.
- Participant observation from three projects – as the author was actively involved in these projects as a consultant and/or project manager, the impact of his own beliefs may bias the results. Therefore, this data source was used only as a triangulation source for interviews with project managers, for the purpose of double checking the data saturation in the interviews.
- Semi-structured interviews with four project managers, three of whom have also had a consulting background, with experience ranging from 5 to 15 years, and with accumulated knowledge from 42 full-time implementation projects.

The informants were asked the following three questions:

1. What knowledge is needed from the project participants in each of the project phases?
2. What knowledge activities take place in each of the project phases? Who participates in these activities?
3. What is the product of each project phase?

The interviews lasted from 40 minutes to 1 hour.

The following research procedure was applied to the above data sources.

- Analysis of the contractual documentation from five projects was used as the primary source for the determination of the activities performed by the project actors and the products of each project phase. The supportive source of evidence used to triangulate the data was interviews with project managers. The data were coded with the use of MAXQDA qualitative analysis software to unify the naming of activities and products. The resulting list of activities and products formed a framework that allowed further systemizing of research regarding KM in the project.
- Semi-structured interviews with four project managers were used as a primary data source for the determination of knowledge needs (*RQ1*) and knowledge-related activities (*RQ2*). The responses were coded with the use of MAXQDA software. A pre-defined list of codes, derived from the KM literature, as described by Miles and Hubberman (1994, p. 58), was used concerning knowledge types, actors, project phases and activities. Open coding was used for the determination of the role of each knowledge type in the implementation process. The data from the interviews were triangulated with the use of participant observation in three projects to assess the validity and completeness of the responses given by the interviewees. The sampling for the interviews was finished, once the data saturation was reached, and the knowledge types and activities mentioned during the interviews matched the findings from participant observation.
- Full project documentation produced during three projects was used to identify the knowledge outputs (*RQ3*). Interviews were used as the triangulation source.

The results of the study are presented in the remaining sections of this paper.

The research results are broken down by the project phase. A description of each project phase is provided, followed by:

- a presentation of the knowledge requirements from each of the project actors;
- the knowledge activities performed in a given project phase; and
- the resulting outputs.

Only the actors and activities identified for each phase are described, so the absence of an actor or activity under given phase means that this actor/activity was not present in the phase being described.

4. Project preparation phase

4.1 Phase description

Project preparation is a phase that results in the definition of the Project Charter document containing all the project knowledge available at the end of this stage including:

- final confirmation of project scope, budget and schedule. Scope, budget and schedule are defined during the pre-implementation phase and are included in the contract documents, which form the input for the detailed planning performed during the project preparation;

- project divided into phases, together with the definition of products and milestones;
- approval procedure for products and milestones;
- project roles and responsibilities, with the assignment of participants to each of the roles;
- project procedures:
  - *communication procedures:* means of communication, form of status reporting and frequency and form of status meetings;
  - risk management procedures and reporting;
  - change management procedures and reporting (organizational change and project scope change);
  - problem solving and escalation procedures; and
  - quality assurance.
- document templates, document storage procedure, document approval procedure and roles; and
- project infrastructure – IT infrastructure, rooms and communication media.

The main workload during the preparation phase is imposed on the project manager consultant and the project manager client. They work closely together to produce the project charter. The project manager consultant is responsible for delivering the project charter template, together with suggestions regarding project procedures. The project manager client is responsible for adjusting the templates to the needs of the specific client company. Both project managers form their respective teams and communicate the contents of the project charter to them.

Steering committee members (including project sponsors) also play an important role. They set up project goals, promote the project in the organization and help assign the right people to each of the project roles. Other team members are taken on board during that phase and play marginal roles, although they may serve as knowledge sources for the project managers.

4.2 Knowledge requirements

4.2.1 Project manager consultant. Before the project preparation phase, the project manager consultant needs to have the following types of knowledge to accomplish his tasks:

- PM knowledge (four interviewees) – Because he/she is responsible for the preparation of the project charter, he/she has to possess general knowledge on PM. Three of the interviewees highlighted that the PM knowledge of the consultant project manager should be "product-specific" – i.e. it is not sufficient that he/she is familiar with the general PM methodologies. According to the interviewees, PM knowledge must be based on the context of the product to be implemented and must be related to the product knowledge and experience from similar previous projects. Therefore, the project manager consultant requires two subtypes of PM knowledge: generic PM knowledge and product-related PM knowledge.
- Communication/cooperation skills (three interviewees) – These skills are necessary, as the project preparation phase requires tight cooperation with the project manager client, and with other project members at a later stage.
- Product knowledge (two interviewees) – General product knowledge helps the project manager to determine the products of the subsequent phases, as well as to assess the feasibility of the scope of the project, within the given budget, schedule and resources. This knowledge type is closely connected to the product-related PM knowledge.

- Meta-knowledge (two interviewees) – Two interviewees indirectly pointed to a new knowledge type, not present in the literature on PKM: meta-knowledge. The project manager consultant has to set up a consulting team for the project, and therefore, he/she needs to do the following:
  - know the project roles and knowledge requirements for these roles;
  - know the knowledge and skills of people available for the project; and
  - be able to match the people (with required knowledge and skills) to the roles.

Knowledge about other people's knowledge and skills may be called meta-knowledge.

4.2.2 Project manager client. The project manager client needs the following knowledge types to accomplish the goals of the project preparation phase:

- Institutional knowledge (four respondents) – This was highlighted as the most important knowledge type for the project manager client during the project preparation phase. Understanding of the power structure of the organization allows for selection of the right people for the project (people with decision-making capabilities and people with the necessary knowledge), gaining proper sponsorship and assuring that the project has a high priority in the organization. Institutional knowledge is also necessary for establishing valid communication, as well as for risk management and escalation procedures.
- Communication/cooperation skills (four interviewees) – All respondents pointed to communication/cooperation skills of the project manager as very important. At this stage, the PM client has to cooperate closely with the PM consultant to produce the project knowledge. He/she also needs these skills to communicate with the steering committee and the project team.
- Company knowledge (four respondents) – A general knowledge of the company specificity is necessary to understand and assess the feasibility of the scope of the project, within the given budget, schedule and resources.
- Meta-knowledge (two interviewees) – While describing the role and interrelations between institutional and company knowledge, two of the respondents pointed to meta-knowledge as an important knowledge type for the project manager client. One of his/her main tasks during the preparation of the project charter is the assignment of people to project roles. This requires the project manager client to possess knowledge about other people's knowledge – meta-knowledge.
- PM knowledge (three respondents) – Two out of three respondents mentioned the PM knowledge of the project manager client as "nice to have", and one said it was important. The following can be explained by the division of responsibilities, which the respondents outlined. The project manager consultant is responsible for delivering the PM knowledge, and the project manager client is responsible for delivering institutional and company knowledge. Therefore, it is not necessary for the project manager client to be an experienced project manager. It is more important for him/her to have a good understanding of the client company (institutional and company knowledge) and the communication/cooperation skills necessary to manage the team.
- Business knowledge (two respondents) – The respondents did not specify what this knowledge type is needed for.

The other project members are appointed at this stage. They must be selected according to the knowledge and skills' requirements for subsequent project phases and these requirements are presented with the description of these phases.

4.3 Knowledge activities

4.3.1 Knowledge identification. Knowledge identification is the main knowledge activity that is performed during the project preparation phase. Project managers must determine what

knowledge and skills are necessary to accomplish all the project activities, identify the appropriate knowledge sources and secure access to these sources for the duration of the project (or for the given project phase/activity for which the knowledge source is needed).

The first step is the determination of the knowledge and skills required to carry out the project. The main role in this process is assigned to the project manager consultant, as he/she knows the project methodology, products and project roles. Based on these, he/she determines the knowledge that is needed for each activity and role. According to both interviews and the participant observation, identification of the knowledge needs does not take a formal form. It is determined indirectly through the description of project activities and roles included in the project charter. The knowledge identification is also performed during the conversations between the project managers. It is the responsibility of the consulting project manager to inform the client project manager what knowledge should be supplied to the project.

Based on the knowledge needs, both the project manager consultant and project manager client must identify the knowledge sources. The main knowledge source, according to all respondents, is people. Therefore, the crucial responsibility of project managers is to identify and appoint the right people to each of the project roles. Additional knowledge sources, identified during the research, are formal documentation, including organizational charts, process models, procedures and legacy systems. This requires meta-knowledge from both project managers, which allows them to localize the knowledge resources they need.

The next step is securing access to the identified knowledge sources. Formal documentation and legacy systems may require non-disclosure agreements and formal security procedures. Assuring the participation of people with the necessary knowledge requires the project managers to have enough power in their respective organizations. This is especially important for the client organization, where the employees must divide their time between daily activities and the project, and therefore may tend to favor their "normal work".

4.3.2 Knowledge transfer. The following knowledge transfers are required in the project preparation phase:

- From project manager client to project manager consultant – company and institutional knowledge during the joint preparation of the project charter: This is an initial transfer on a general level and will be continued in the subsequent phases. It does not have a formalized structure but takes a form of conversations between the project managers. An additional source of this knowledge is the contract and sales people in the consultant organization who took part in the contract negotiations.
- From project manager consultant to project manager client – general product knowledge, and product-related PM knowledge: This is an initial transfer, on a very general level, and will be continued in the subsequent phases. It is executed through the conversations between the project managers.
- From project managers to the project team – project knowledge: Project knowledge is created in this phase and is then disseminated among the project team members. The dissemination has the following main forms:
  - kick-off meeting and presentation – this is the first meeting of all the team members, during which the main outline of the project knowledge is given to the team in a form of a presentation; and
  - project charter – all the project knowledge, integrated and created during this phase, is gathered in the project charter document. This document is disseminated among the team members.

A very early transfer of product knowledge from consultants to the key-users in the form of training may also take place in the project preparation phase. This training is performed using a standard system (i.e. not reflecting the specificity of the implementing company),

and the aim of the training is not to train the key-users but rather to accustom them to the general system logic and nomenclature.

4.3.3 Knowledge creation. During the project preparation phase, the project knowledge is created. Multiple sources of information and knowledge are integrated and codified. Project knowledge available before that phase is detailed and expanded with PM knowledge, institutional knowledge, company knowledge, product knowledge and meta-knowledge.

4.4 Knowledge output

The knowledge output is the project charter, including all project knowledge known to the team at this stage. In addition, a project repository is created as a central knowledge source. This is updated in subsequent project phases.

5. Business blueprint phase

5.1 Phase description

During the business blueprint phase, a detailed analysis of business processes and requirements is performed by the consultants, who later determine the way these requirements will be reflected in the system. This analysis consists of analytical workshops, during which consultants interview the business process owners and the key-users regarding business processes in the company and the detailed requirements. During these workshops, consultants also explain how the processes and requirements will be reflected in the system. The workshops usually take place within functional teams that are responsible for a certain business area. To coordinate work between these groups, integration workshops are held, during which inter-area issues are agreed.

Based on the results of these workshops, the consultants prepare a business blueprint document containing the specification of the system configuration, master data, extensions, reports, forms and interfaces. The main workload during that phase is imposed on the consultants and key-users. They have to cooperate closely to produce a viable and comprehensive design of a new solution. The role of project managers is to coordinate the work of the project teams that consist of consultants and key-users. They also facilitate communication and knowledge flow, manage change and control the project status.

5.2 Knowledge requirements

5.2.1 Project manager consultant. According to the interviewees, the main role of the project manager consultant in this phase is the coordination of project work and status control, and therefore, he/she needs the following knowledge types:

- Communication/cooperation skills (three respondents) – The key role of the project manager in this phase is the coordination and facilitation of work inside and between the project's functional teams, which requires strong communication, cooperation and coordination skills.
- Project management and project knowledge (three respondents) – As the project manager has to control the scope, budget and schedule, he/she needs current project knowledge, combined with the PM knowledge.
- Institutional knowledge (two respondents) – This is important if escalations are needed regarding the scope or if there are conflicting solutions in the system.

5.2.2 Project manager client. The knowledge needed by the project manager client in this phase is the same as for the project manager consultant. Therefore, he/she needs communication/cooperation skills, project knowledge and institutional knowledge. PM knowledge was mentioned as being nice to have.

5.2.3 Consultants. Consultants need the following knowledge types:

- Product knowledge (four respondents) – Product knowledge is the main asset of a consulting company in an ES implementation project. The consultants are hired because they have product knowledge that is not available in the client company. During the business blueprint phase, this knowledge is needed to design the way business processes and other requirements of the client company will be reflected in the system via its configuration and customization.
- Communication/cooperation skills (four respondents) – The business blueprint phase requires considerable cooperation between the consultants and key-users, as well as between the various consultants. As consultants are required to lead the analytical and design workshops, they need strong communication/cooperation skills.
- Business knowledge (four respondents) – Business knowledge is required from the consultant to cover the culture gap. They should be experts in the business domain that they implement in the system, so that they speak the same language as the key-users. This enables them to understand their requirements correctly and to suggest the best solutions in the system and possible improvements to the business processes.
- Technical knowledge (three respondents) – The necessity of having technical knowledge depends on the type of consultant and his/her function in the project. Functional consultants do not need this type of knowledge, but it is crucial for programmers and master data migration team members.
- Project knowledge (two respondents) – Consultants should also have project knowledge, which they acquired during the project preparation phase. This includes project scope, budget, schedule, milestones, products and procedures.
- PM knowledge (one respondent) – One respondent highlighted that the consultants should have, at least, elementary PM knowledge so that they understand the "non-product-related" tasks that they are asked to perform during the project.

5.2.4 Key-users. Key-users play a very important role during the business blueprint phase because they are responsible for articulating all of the requirements and accepting the solutions presented by the consultants. To effectively perform their tasks, they need the following types of knowledge:

- Company knowledge (four interviewees) – Company knowledge is the main reason for the key-users' participation in the project. They have to make sure the company knowledge is properly embedded into the new IT solution so that the organization's way of working is reflected in the new system.
- Communication/cooperation skills (four interviewees) – These skills are considered to be extremely important by all the respondents. The key-users must be able to cooperate with the consultants, communicate inside the organization and work out the best solutions, which are quite often the product of a compromise.
- Business knowledge (four respondents) – Key-users should also be experts in their respective business domains so that they are open to the solutions currently not applied in their organization and can judge new proposals made by consultants.
- Project knowledge – (three respondents) – The key-users should have project knowledge, acquired during the project preparation phase, so that they know what they may expect from the project, regarding its scope. They should also know the schedule and their tasks in every phase, as well as all the project procedures.
- Institutional knowledge (two respondents) – This knowledge is necessary to provide smooth decision-making in the project. The situation is optimal when the key-users have the decision-making power themselves, but if this is not the case, they need to know who can make a certain decision and what the shortest path to obtaining

it is. Institutional knowledge is also helpful for coping with the functional structure and the project structure at the same time.

- Product knowledge (one respondent) – One interviewee noted that it helps when the key-users have product knowledge. It is then easier to discuss the solutions that are going to be included in the business blueprint document and later implemented in the system.

5.3 Knowledge activities

5.3.1 Knowledge transfer. The following knowledge transfers are identified in this phase:

- From key-users to consultants – company knowledge – during the analytical workshops: The key-users are asked to describe business processes and formulate requirements regarding reflection of these processes in the future system. They are also asked about their information requirements, which have to take the form of reports, interfaces and printouts.
- From consultants to key-users – product knowledge: After consultants acquire enough company knowledge, they start designing the system and present the possible solutions to the key-users. The knowledge transfer takes the form of discussions during the workshops or presentations in the standard system.
- From consultants and key users to project managers and vice versa – project knowledge: The teams report on progress, suggested changes to the project scope and risks. Project managers communicate to the team about how the suggested changes are going to be managed, how the risks are going to be mitigated, as well as the status of the project in general.
- From consultants to all the team members – solution knowledge: Solution knowledge, included in the business blueprint, which is the product of this phase, has to be disseminated among all the project participants.

5.3.2 Knowledge identification. The main sources of knowledge for the duration of the whole project were identified during the project preparation phase. However, during the business blueprint workshops, it may occur that the key-users do not possess all the knowledge necessary to describe the business processes and other requirements in sufficient detail. Therefore, it is necessary that they, or the project manager client, identify the additional sources of company knowledge and secure access to these knowledge sources.

On the other hand, consultants may also face the problem that they are unable to solve with the use of their current product knowledge. According to the respondents, they can look for additional product knowledge on the Internet forums and among peers, or they can try to find a solution in the system by prototyping.

5.3.3 Knowledge creation. During the interviews, the respondents noted that a new knowledge type is created during the business blueprint phase: this is the solution knowledge that is a result of the integration of company and product knowledge and determines how the specific requirements of a client company will be reflected in the new ES.

5.4 Knowledge output

The main knowledge product of this phase is the business blueprint document. It contains the solution knowledge, which includes company structure in the system, master data specifications, system configuration specifications, user authorization concepts and the specifications of all programming works: reports, interfaces, conversions, enhancements and forms/document printouts (RICEF). This knowledge has to be disseminated to all project members.

6. Realization phase

6.1 Phase description

During the realization phase, the system is actually configured according to the design from the business blueprint. Master data are prepared for migration from legacy systems, and all programming work is performed. The main workload in this phase is imposed on functional consultants, data migration consultants and programmers. Functional consultants configure the system according to the design from the business blueprint. They also have to prepare detailed specifications of the programming jobs (as the blueprint contains only general descriptions) and supervise the programmers during the development. They also prepare detailed specifications of the master data in the system, which lets the data migration team prepare the data input forms, conversions and automatic migration programs. Local IT is responsible for the extraction of the data from the legacy systems and their mapping to the format required. The phase ends with the unit and integration tests, which are performed jointly by the consultants and the key-users or by the key-users alone. The project manager consultant has to integrate the actions of all the consultants, resolve integration issues between them and manage change. The key-users supply additional information if the design in the business blueprint proves to be inaccurate or ambiguous. They supervise the consultants' work and may perform some repetitive configuration tasks by themselves, depending on their involvement in the project. The project manager client supervises the progress of the work.

6.2 Knowledge requirements

6.2.1 Project manager consultant. The project manager consultant needs the PM and the up-to-date project knowledge (three respondents) to be able to correctly react to the deviations from the project plan, and to identify and mitigate risks/issues. Communication/cooperation skills (three respondents) are needed to integrate the consultants' activities and to facilitate the communication between them. He/she also needs solution knowledge (one respondent) on a general level to be able to understand the possible issues raised by the implementation teams.

6.2.2 Project manager client. The project manager Client also needs the PM and up-to-date project knowledge (three respondents). Communication/cooperation skills (three respondents) are necessary to cooperate with the project manager consultant during possible problem-solving. He/she also needs solution knowledge (one respondent) on a general level to be able to understand the possible issues raised by the implementation teams.

6.2.3 Consultants. Consultants are the ones who perform the majority of activities in the realization phase and require the following substantial range of knowledge:

- Product knowledge (four respondents) – Product knowledge needs to be able to configure the system according to the assumptions made during the blueprint phase.
- Company knowledge (four respondents) – Company knowledge is acquired during the blueprint phase to reflect the client's requirements in the system.
- Technical knowledge (three respondents) – Technical knowledge is "nice to have", as it helps with communicating efficiently with the programmers and the migration team, as well as enabling better supervision of their work.
- Solution knowledge (two respondents) – Solution knowledge is the product of the integration of company and product knowledge and is codified in the business blueprint document. The consultants are the authors of this document and therefore possess this knowledge. Their main task in this phase is to embed the solution knowledge into the new system.
- Project knowledge (two respondents) – Project knowledge is acquired in the previous phases and updated constantly. It is needed to perform the work according to the

procedures and within the budget and schedule constraints. Consultants also need to know the formal procedures regarding the system documentation, preparation of the test scenarios, test execution and documenting.

- Communication/cooperation skills – These skills are needed to communicate with the other consultants and programmers during system configuration and customization (two respondents) and to cooperate with key-users during tests (three respondents).
- Business knowledge (one respondent) – Business knowledge is useful in discussions with the key-users to ensure that the solutions in the system are compliant with the law and business best practices.

6.2.4 Key-users. Key-users play a limited role in the realization phase, except for the activities related to system testing and need a limited number of knowledge types in this phase:

- Company knowledge (three respondents) – This is needed to clarify potential open issues, not included, or not detailed enough in the business blueprint document, as well as for the preparation of test scenarios and for verification if the system reflects the company's requirements in a correct way.
- Product/solution knowledge (three respondents) – This knowledge is necessary during system testing. The possible ways of acquiring it is described in the knowledge transfer section below.
- Communication/cooperation skills (two respondents) – These are necessary to cooperate with consultants, mostly during the system tests.

6.3 Knowledge activities

6.3.1 Knowledge transfer. The intensity of knowledge transfers in the realization phase depends on the quality of the blueprint phase and knowledge transfer approach chosen by the client company. With high-quality blueprints, the transfer of company knowledge from the key-users to the consultants should be very limited, as all the knowledge is included in the blueprint document. However, if not enough effort was expended during the blueprint preparation, there may be a need for clarifications of emerging issues during the realization. Company knowledge is always transferred as follows:

- from client IT to the migration team – regarding detailed mapping of master data fields to be migrated; and
- from consultants to the programmers – in the form of RICEF specifications.

Product/solution knowledge transfer from consultants to key-users depends on the knowledge transfer approach chosen by the client company and key-user involvement. All the respondents emphasize that including the key-users in the configuration process, let them gradually gain the understanding of the new system complexity and incorporate necessary product/solution knowledge, which is difficult to achieve during the formal training sessions in the subsequent phases. However, in most projects in which the respondents took part, the involvement of the key-users in the realization phase was very limited.

Product/solution knowledge is always transferred to the key-users during testing, as the tests are performed by or with the participation of the key-users.

6.3.2 Knowledge embodiment. The respondents noted another knowledge-related activity, which is knowledge embodiment. The solution knowledge, created in the blueprint phase, is now embodied in the system in the form of configuration and customization.

6.4 Knowledge output

The main product of the realization phase is that the system is configured, customized and tested. The solution knowledge, created in the preceding phases by combining the company and product knowledge, is therefore embedded into the system, which now

reflects the business processes and information needs of the client organization. Additional knowledge products of this phase include documentation of the system configuration, customization of the system (including the solution knowledge from the technical perspective) and user manuals (including the solution knowledge from a business/operational perspective).

7. Go-live preparation phase

7.1 Phase description

During the go-live preparation phase, the system is fine-tuned, key-users are trained and the go-live plan is prepared and executed. This includes freezing the legacy systems, exporting master data, open items and closing balances, importing of these data to the new system and setting the system to production mode. The product of this phase is a system that is ready to go live.

7.2 Knowledge requirements

7.2.1 Project manager consultant. The project manager consultant needs the product-related PM knowledge (one respondent) to prepare the go-live plan, including the sequence of steps needed to prepare the technical and business environments for the transition from legacy to the new system. He/she also needs continuously updated project knowledge (two respondents). Communication/coordination skills (two respondents) are necessary to integrate the activities of all the staff engaged in preparation of the system to go live.

7.2.2 Project manager client. The project manager client needs institutional and meta-knowledge (one respondent) to identify all the staff required for the go-live, and to assign the tasks to each of them. He/she needs company knowledge (one respondent) to supply the company-specific part of the go-live plan. Communication/coordination skills and up-to-date project knowledge (two respondents) are needed to manage the activities during go-live.

7.2.3 Consultants. Consultants need product and solution knowledge (four respondents) to prepare the system for the go-live phase, to provide input for the go-live plan to the project manager and to train the key-users. They need project knowledge (three respondents) to perform all the steps necessary for preparations to go-live on time, and to perform training in a form that is compliant with the methodological assumptions of the project. They need communication/cooperation skills (one respondent) to perform this training.

7.2.4 Key-users. Key-users need product/solution knowledge (one respondent) to train the users, and communication/cooperation skills (two respondents) to perform the training.

7.3 Knowledge activities

7.3.1 Knowledge identification. All major sources of knowledge should have been identified in the previous phases. However, there may be miscellaneous needs for additional technical, product, company or institutional knowledge to prepare and execute the go-live plan.

7.3.2 Knowledge transfer. Project knowledge in the form of the production start plan is disseminated to all project members. Product/solution knowledge is transferred from consultants to the key-users and users and from key-users to users during training.

7.3.3 Knowledge creation. No new knowledge, except from project knowledge included in the productive start plan, is created in this phase.

7.4 Knowledge output

The only knowledge output of this phase that was identified during the study was the go-live plan, which includes the sequence of steps necessary to stop the legacy system and migrate all the operations to the new system.

8. Go-live and support phase

8.1 Phase description

In the last phase of the implementation project, the system is launched. All the users start working with the system. Consultants support the daily activities of the users and solve the problems reported by them.

8.2 Knowledge requirements

8.2.1 Project manager consultant. The project manager consultant needs the PM knowledge to prepare problem reporting and solving procedures (one respondent).

8.2.2 Consultants. Consultants need product knowledge (four respondents), company knowledge (four respondents) and solution knowledge (two respondents) to support the key-users and users and to solve the possible issues. They need project knowledge (one respondent), i.e. problem-reporting and -solving procedures to use during problem-solving.

8.2.3 Key-users. Key-users need product knowledge (four respondents), company knowledge (four respondents) and solution knowledge (two respondents) to operate the system and to help the users. They need project knowledge (one respondent), i.e. problem-reporting and -solving procedures to use during problem-solving.

8.3 Knowledge activities

8.3.1 Knowledge transfer. Knowledge transfer includes solution knowledge transfer from the consultants to the key-users and the users, and also from the key-users to the users.

8.3.2 Knowledge creation. Project knowledge concerning problem-reporting and -solving procedure is created. In addition, lessons learned should be codified in the form of post-implementation reports both in the client and consultant companies.

8.4 Knowledge output

The knowledge output of this phase is the problem-reporting and -solving procedures and reports on the lessons learned.

9. Framework summary

The framework summary is presented in Table I.

The knowledge types and activities, not typically mentioned in the literature on IT projects, are highlighted using "underscoring and bolding". The knowledge types acquired by a given actor during the project are highlighted in *italics.* Continuous updating and dissemination of the project knowledge were excluded from the table for clarity.

The most important knowledge types, required from the project manager consultant include PM knowledge (both generic and product-related), communication/cooperation skills and meta-knowledge regarding knowledge types that the consulting team needs to possess for a project of a given scope. The project manager client needs institutional, company, communication/cooperation and meta-knowledge concerning the knowledge resources of the company. With the help of their communication/cooperation skills, they exchange PM, institutional, company and meta-knowledge with each other to create the project knowledge and disseminate it among the other team members. Later in the project, they constantly update and disseminate project knowledge, help to integrate other knowledge resources and control the performance of the project.

Consultants need to be equipped with product knowledge, communication/coordination skills and business knowledge to be able to communicate with and understand the key-users. They may also benefit from technical knowledge to

Table I Knowledge management for ES framework summary

		Project manager consultant	*Project manager client*	*Consultants*	*Key-users*
Project preparation	Knowledge requirements	Project management (generic and product-related) Communication/cooperation Product Meta-knowledge	Institutional Communication/cooperation Company Meta-knowledge PM (nice to have)	Appointed at this phase–knowledge requirements listed in the business blueprint phase	Appointed at this phase–knowledge requirements listed in the business blueprint phase
	Knowledge activities and products	Identify knowledge sources Create project knowledge – more than in the project charter Transfer (initial) PM, product, company and institutional knowledge between the project managers Transfer project knowledge to the team members		Absorb project knowledge from project managers Transfer (initial) the product knowledge in the form of training with the use of the standard system from consultants to key users	
Business blueprint	Knowledge requirements	Communication/cooperation PM *Project* Institutional	Communication/coordination PM *Project* Institutional	Product Communication/cooperation Business Technical *Project* PM	Company Communication/cooperation Business *Project* Institutional Product
	Knowledge activities and products	Absorb solution knowledge from business blueprint	Identify additional company knowledge sources Absorb solution knowledge from business blueprint	Transfer of product and company knowledge Integrate product and company knowledge into solution knowledge – more than in the business blueprint Absorb solution knowledge from Business Blueprint	
Realization	Knowledge requirements	PM *Project* Communication/cooperation *Solution knowledge*	PM *Project* Communication/cooperation *Solution knowledge*	Product Company *Solution* Technical *Project* Communication/cooperation Business	Company Product *Solution* Communication/cooperation
	Knowledge activities and products	–	–	Embed solution knowledge (mixed product and company) – more than into the system Store solution knowledge – more than in the documentation Transfer and use of product, solution and company knowledge during testing	

(*Continued*)

Table I

		Project manager consultant	*Project manager client*	*Consultants*	*Key-users*
Go-live preparation	Knowledge requirements	Product-related PM *Project* Communication/cooperation	Institutional Meta-knowledge Company Communication/cooperation *Project*	Product *Solution* *Project* Communication/cooperation	Product *Solution* Communication/cooperation
	Knowledge activities and products	Create project knowledge (using product-related, institutional, meta-knowledge and company knowledge) – more than in the productive start plan		Transfer product and solution knowledge to end-users	
Go-live and support	Knowledge requirements	PM	–	Product Company *Solution* *Project*	Product Company *Solution* *Project*
	Knowledge activities and products	Use PM knowledge to create project knowledge – more than in the form of problem-solving procedure Create lessons learned on the basis of project knowledge	Create lessons learned on the basis of project knowledge	Use all above knowledge types for problem-solving	Use all above knowledge types for system operation

communicate with the programmers and PM knowledge to better understand their tasks in each of the phases of the project.

Key-users must have company knowledge and communication/coordination skills. Business and institutional knowledge is also useful to have. Consultants and key-users exchange product and company knowledge with each other to create the solution knowledge and let consultants embed it into the system.

During the initial stages of the project, the knowledge flow regarding company knowledge is more intense from the key-users to the consultants. Later in the project, product knowledge is transferred more intensively from the consultants to the key-users. Both consultants and key-users exchange project knowledge with the project managers continuously throughout the project. The main knowledge product is the solution knowledge, which is stored in the form of the business blueprint, configuration documentation, user manuals and, most importantly, embedded into the system.

10. Conclusions

This study resulted in the formulation of the KM framework for the implementation of ES, including the knowledge types that are necessary to accomplish each of the phases of the project, the knowledge activities that have to be performed during the project and the resulting outputs. The study confirmed that ES projects are extremely knowledge-intensive undertakings and require the merging of various knowledge types from different sources. Critical knowledge, required from the main project participants, was identified, including PM knowledge (generic and product-related), communication/cooperation skills and meta-knowledge needed by the project manager consultant, and the institutional, company, communication/cooperation knowledge and the meta-knowledge needed by the project manager client. Consultants need product knowledge, communication/coordination skills and business knowledge, while the key-users require company knowledge and communication/coordination skills.

Knowledge activities were identified in all project phases. In the Project preparation phase, identification of knowledge and knowledge sources, creation and dissemination of the project knowledge were identified, while in the blueprint phase, the transfer of company and product knowledge and their integration into the solution knowledge were the important activities. In the realization phase, activities include the embodiment of the solution knowledge into the system and product/solution knowledge transfer. In the closing stages of the project, the major activities are solution knowledge storage and transfer to the users.

New findings have been presented that are not found in the existing literature. The study demonstrated that PM knowledge consists of two components: generic PM knowledge, which is available in PM body of knowledge guides, and product-related PM knowledge, which includes best practices for performing the projects involving the implementation of a specific system. Meta-knowledge, the knowledge of other knowledge types, was also identified as critical in the initial phases of a project. Solution

"ES projects are extremely knowledge-intensive undertakings and require the merging of various knowledge types from different sources."

"The observation of knowledge flows also revealed how the asymmetry of knowledge slowly decreases over the course of a project."

knowledge, resulting from the integration of company and product knowledge, and later embedded into the system, was identified as a main knowledge product. The study confirmed the importance of knowledge integration (Reich, 2007), as well as knowledge embodiment (Tiwana, 2003).

The observation of knowledge flows also revealed how the asymmetry of knowledge slowly decreases over the course of a project. Each participant starts the project with his/her own knowledge base. As the project proceeds, knowledge is exchanged between the participants. The client learns about the PM procedures and product, and the consultant gains knowledge of the company and its business domain.

The limitation of this study is that it concentrated on a specific type of the IT project, namely, ES implementation. The results may not be directly extrapolated to other IT projects, although they may be of help in formulating KM frameworks for other IT project types.

The results of this study will be of use to project managers and consultants carrying out ES projects as well as companies planning to implement these complex systems. Careful KM through the course of a project proves to be a *sine qua non* for the success of a project. The KM framework presented in this paper adds the knowledge component to traditional PM methodologies, which have concentrated on the action perspective rather than on knowledge. The results may also be of assistance to researchers, studying various aspects of KM in IT projects. It provides a knowledge map that is useful in detailed studies of knowledge identification, requirements, transfer and usage.

This study also revealed that knowledge identification, mapping and sourcing does not take place in a structured manner. Designing and testing structured approaches for these activities appears to be a promising research direction. In addition, research on knowledge asymmetry, its nature and implications for the success of a project, as well as means and cost of its reduction should be further investigated.

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