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Integrating Knowledge into Process Models – A Case Study

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Abstract

Enterprise Systems (ES) are now established business operating systems in many organisations worldwide. Although the familiarity with these comprehensive systems has increased rapidly, they appear to be one of the most complex applications that organisations have ever implemented. Organisations realize the need to better leverage their knowledge resources as they lack in-house ES knowledge and the costs of engaging experienced consultants are paramount.

The case study presented uses an existing framework to manage knowledge in ES and puts this into context by applying it in real-life practice. This is done through the proliferation of extended reference process models. By integrating proposed types of knowledge into process models, it will be demonstrated what types of knowledge can be captured and how this knowledge can be managed in organisations. Employees in the organisation have not only been interviewed but also encouraged to participate in capturing knowledge for their business processes. This co-operation fostered the completion of a reference model, which supports employees in managing their knowledge.

Keywords

Process Engineering, Conceptual Modeling, Reference Modeling, Knowledge Management

THE NEED TO MANAGE KNOWLEDGE RESOURCES

Implementing comprehensive IT applications like Enterprise Systems (ES) is a knowledge-intensive task. As such, it requires a great amount of experience from a wide range of people such as representatives from business departments, technical specialists from the IT department and project managers within the organisation to external business and implementation consultants. The total cost of engaging these people and the lack of in-house knowledge have proven to be enormous when implementing an ES. Organisations implementing Enterprise Systems recognize this and realize that they need to manage knowledge as it is both strategically advantageous and seeks to deal with the problem of leveraging knowledge.

While most existing ES literature has focused on the types of knowledge, methodologies and critical success factors required for the implementation of ES software (Clemons 1999, Kirchmer 1999, Scott 1999, Slooten, Yap 1999, Sumner 1999), a further step needs to be taken. The evolved question is “How can this knowledge be managed?” This question addresses where the knowledge resources are available, when it is needed and what managers and consultants can do to more effectively select, implement, use and upgrade an ES.

In related research, Haines and Goodhue (2000) confirm this need to manage knowledge as they found that while organisations want to reduce the engagement of costly consultants, they are faced with predicament of not having the necessary internal knowledge and skills to implement an ES system successfully without external help. Haines and Goodhue (2000) suggest that transferring and retaining knowledge within the organisation becomes essential thereafter to the overall success of an ES implementation. It is not difficult for organisations to recognize this fact and become conscious that managing knowledge deals with the most significant costs of an ES project. Thus, there is strong motivation for the better leveraging of ES knowledge and making this knowledge available to those involved in the ongoing management of an ES. This paper is structured in the following way. The next section will identify the types of knowledge required for managing ES. The third section describes the ES lifecycle and how knowledge can be integrated with extended reference process models. The fourth section presents the case study and discusses results both from the managerial and user perspective. The paper summates with an outlook for further research.

Types of Knowledge Required for the Management of Enterprise Systems

Before the research can be conducted, it is essential to find out what needs to be known when implementing an ES. An intensive literature review discussing the critical success factors for ES implementation (Chan and

Rosemann 2001) was conducted. From the literature reviewed, six different types of knowledge were identified for the successful management of ES software. These types of knowledge are:

Business knowledge covers the business issues in the management of Enterprise Systems. Most of the attributes of this dimension should be addressed before the actual implementation of ES in an organisation. Business knowledge includes (1) functional-knowledge in areas like general ledger accounting, purchasing, sales, human resource management, or strategic planning, (2) organisational-knowledge like business process management, communication policies, or document management, (3) educational-knowledge and knowledge about organisational culture, social norms and practices.

Technical knowledge represents knowledge that is necessary in conjunction with the selection and use of database management software, network management, middleware solutions, add-on programming, client-server-architectures, performance measurement, etc.

Product knowledge reflects the need for knowledge specific for a unique ES solution. Most ES solutions are comprehensive packages with a high degree of complexity. This area of knowledge includes an understanding of the architecture of the product, knowledge about its functionality and constraints of applications, the implementation methodology, the release strategy or knowledge about the ES-specific programming language (like SAP's ABAP).

Company-specific knowledge is the most individualistic type of knowledge. ES software is selected, implemented, used and changed in a specific company with specific characteristics and an individual organisational population. ES cannot be managed successfully without having a precise understanding of these company-individual characteristics. This is the reason why the participation of the end users is often cited as a critical success factor for ES implementation projects.

Project management knowledge covers the management of human resources, time and cost to accomplish the objectives of a project. The implementation of an Enterprise System in an organisation often requires project management for a time between 6 to 24 months. Project management involves planning, organising and controlling a project with various time and cost constraints, as well as harnessing senior management support.

Further areas of knowledge cover the fact that a capability to combine the five types of knowledge discussed above must exist for successful Enterprise Systems management. Usually different project participants contribute to different types of required ES knowledge. Consequently, *communication, coordination and cooperation knowledge* is indispensable in order to integrate the five types of knowledge. The missing capability to efficiently interact between the involved knowledge owners is a key reason for a project failure. This absence of this knowledge is often due to the fact that it takes a significant amount of time to develop the required communication, coordination and cooperation knowledge and to get the knowledge from different project members. Henceforth, this research seeks to bridge this gap and increase the transparency of the organisation's business by enhancing the communication, coordination and cooperation between employees through the use of process models.

The Enterprise System Lifecycle

ES have life-spans that spread over a number of phases. Varying types of knowledge and skills are required over these different phases. It is crucial to pay attention to what is required to be known, who knows what and when it is required to know. This section addresses the 'when?' question and examines the phases of an ES. The *selection* stage includes the definition of the companies' requirements, a pre-selection of ES solutions, a request for proposals, detailed system evaluation, economic evaluation and final ES selection. The *implementation* consists of the configuration of the ES software and the introduction of corresponding organisational and technical changes like the definition of new responsibilities or the design of new interfaces (Kirchmer 2000, Keller and Teufel 1998). In relation to the entire life span of Enterprise Systems software, the implementation phase is rather short. An ES can be in *use* for up to 15 years without major changes. In order to execute the ES processes the staff member needs a precise understanding of the software and related business knowledge. In contrast to the implementation, explicit knowledge is more widely available during the use of an ES. Eventually, an Enterprise System has to be continuously *changed* as it usually reflects a major part of the organisations' businesses.

Integrating Knowledge within Reference Process Models

Using an existing framework (Rosemann and Chan 2000), this research focuses on the two of the three dimensions (i.e. ES Lifecycle and types of knowledge). These two dimensions are extended by a perspective that depicts the role-specific and the process-specific viewpoint of an ES. Thus, this approach will allow one to identify who possesses what type of knowledge with relevance to what processes in which phase of the ES

lifecycle. In order to do this, existing reference process models are used. The following section explains the characteristics of reference process models and how they can be applied to integrate knowledge.

Many ES providers have designed comprehensive reference process models in order to document how their solutions support various business processes (e.g. Curran and Keller 1998). With this approach, they have simultaneously captured knowledge about their product. Figure 1 shows as an example of an extract from a simple ES-specific reference process model. The example below shows a part of the dunning process in SAP R/3. The modeling grammar used is known as the *Event-driven Process Chain* (Scheer 1998). It consists of events (hexagons) and function (rectangles) as well as control flow constructs (AND, inclusive and exclusive OR), which describe joins and splits in a process model. The model below shows an AND-split.

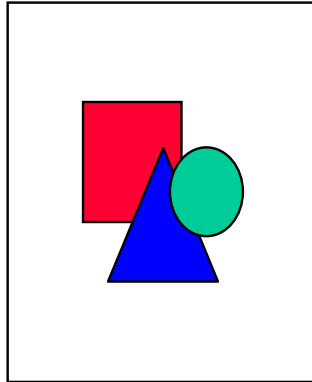


Figure 1: Exemplary ES-specific reference process model (extract)

While reference models represent the entire functionality from the viewpoint that the complete system is used, it is not obvious what configuration alternatives exist. The weakness is that reference models focus on the elements that are of importance for the specific ES but enterprise-individual aspects of the organisation, business-objectives or manual tasks cannot be seen in these models. The models do not include any references to the involved or required knowledge.

In order to overcome the missing link between ES-specific reference models and managing knowledge, this research proposes to integrate 'knowledge' into process models. The use of *extended* reference process models (eEPCs) is suggested. With eEPCs, it is possible to identify what type of knowledge is required in which processes. This proposition is to add further *knowledge objects*, which are related to Knowledge Management (Scheer 2000). These knowledge objects represent knowledge in the form of explicit or tacit knowledge and are connected with the functions of a process.

A knowledge object is a symbol in a conceptual model that represents relevant knowledge. As such, it can be compared to an entity type in a data model or to a function type in a process model. A knowledge object has attributes that characterise this 'knowledge' further into knowledge types such as business, product or technical knowledge, explicit or tacit knowledge, or declarative or procedural knowledge. Knowledge objects can have interrelations with each other (e.g. 'is part of', 'is a'). Furthermore, knowledge objects not only have static attributes, but also behavioral attributes (Rosemann 2001). In addition to the ES lifecycle phase and through the differentiation between explicit and tacit knowledge, every knowledge object can be classified by the knowledge type.

Methodology

While the extension of the reference process models contributes to theory building, the usefulness and applicability of the model can only be justified by ES users in the real-world. A case study method is used for this purpose. The aim of the case study method is to investigate a contemporary phenomenon within its real-life context when the boundaries between the phenomenon and the context are not clear (Yin 1994). This approach contributes to building existing theory as well as theory testing through the application of reference process models. The data-collection process included gathering material from existing documentation, interviews, direct observations and participant observations.

The interviews were highly structured and designed around the types of knowledge elicited from the literature review, it also provided scope for the interviewees to propose their own factors. The method used to validate the types of knowledge inferred from the literature was a structured questionnaire delivered in an interview format. Employees who had direct interaction with a selected business process (dunning process) and involved in the ES implementation were interviewed in order to understand the ES *use* in practice. The aim was to elicit experienced practitioners' perception about the types of knowledge required for the selected business processes.

THE CASE STUDY

Organisation A (ASC) is a government agency in Australia that was established in July 1996 to meet the corporate services needs of other government agencies. ASC comprises three service areas in Business Advisory, Support Services and Corporate Information Systems and these areas are supported by a Development and Strategy Unit. The organisation delivers a range of corporate services under a Service Level Agreement (SLA). It is responsible for operational and processing functions for corporate services with the strategy and policy functions remaining with client departments.

Currently, ASC has a staff of 260 employees and a financial budget of A\$20M. It's shared services provider - whose number of employees total to approximately 8000 - utilises ASC's products and services. This delivery of corporate services covers areas in the aspects of Finance, Human Resources, Administrative and Corporate Information Systems capabilities. ASC is currently running a 'live' SAP R/3 (Version 3.1h) system. Its R/3 Finance system has been up since November 1998 with 'HR since late April 1999.

ASC had been selected as previous collaborative projects conducted have shown that ASC has a good understanding of their business processes as well as an appreciation for the use of reference process models. Through the use of these reference process models, process-improvement projects have been proven to be successfully carried out in ASC.

The case study has the following objectives, (1) to seek the establishment's assistance in validating the feasibility and the appropriateness of the framework, (2) identify how the framework can be applied to an organisation for managing its knowledge, (3) test how well the application of the framework is accepted by the organisation. The research raises the following important questions: a) Are the types of knowledge recommended reflective of what knowledge can be captured in the business processes? If not, what other types of knowledge are of relevance? b) To what extent can the types of knowledge be integrated into reference process models? c) How useful/acceptable are the proposed process models to manage knowledge?

The case study was conducted in two parts. The first part was carried out by interviewing the Financial Manager of the Accounting Department in ASC. The second part was conducted with two accountants in ASC and required active-participation from them. The interviews were conducted in person, and a structured interview method was used. Prior to the interview, data was collected on the organisation. Each interview lasted about 45 minutes. At the commencement of the interview, data about the participant's background was collected. This was followed by a description of the types of knowledge were and how they can be applied in the reference process models. The interviewees were then asked to evaluate the framework and the applicability of the extended process models. Especially in the second part of the case study, the employees had to evaluate the existing reference models and to add knowledge objects that they felt were relevant to their daily activities and henceforth to evaluate the use and acceptance of the extended reference process models.

Case Study Part 1 –Evaluating the Framework

The Financial Manager (John Reid) was a Certified Professional Accountant who has had an experience of 20 years in the industry. John was involved as a Project Manager for the implementation of SAP and the FI (Financial) module and was therefore familiar with the SAP R/3 system and the business processes in Financial Accounting.

In the interview, John was asked to express his opinions and critique on the applicability of the extended process models. John was also asked to evaluate if the recommended types of knowledge were relevant to manage ASC's business processes and if there were any additional knowledge required. Following this, John was also asked if he felt that the process models would be of value to employees in the ASC.

Observations

When asked about the applicability of the extended process models, John felt that the recommended process models were useful and that the extended process models will fill the knowledge gap in ASC. The following quotes support this notion.

“That I believe would be quite useful...but if I want to find out how my accounts receivable department is going, I will contact my accounts receivable supervisor and tell him the information that I want, this is what I need”.

John appeared to be concerned when he pointed out that extended process models were 'useful' for managing knowledge for employees in ASC. It is noted at this point that although the organisation does not explicitly concentrate on knowledge managing activities, knowledge sharing and an unwritten structure of knowledge process owners exist within the organisation.

“The change is so much we have to delegate people to put the changes through. Sometimes it’s better to communicate [directly] to each other and tell that something has changed and has to be done.”

John shares the above view that refers to the need for communication between knowledge owners, which is reflected in the framework as communication/cooperation/collaboration knowledge. John was aware of who has the necessary knowledge in the organisation and how to retrieve it. This facet is reflected in the aforementioned quotes. The following statements relate to the issues and concerns highlighted by John.

“My question would be, once [the knowledge is] on the system, how often would they access that?”

“... So that again will change from time to time. From my experience, when I learn a new requirement from Treasury and Treasury requires something in 4 weeks, I have to [do it]. So if I put something in now, ...it will be obsolete. For next year, I t [the end of Financial Year reports] will may be May/June next year [rather than in July] and it may be obsolete. So this Knowledge Management system has to be fairly static, or if it is dynamic, it is just too much effort.”

John felt that from his experience, knowledge was extremely time-dependent and that the dynamic nature of the organisation, policy changes and unexpected regulatory events attributed to the impediments of managing knowledge in organisations. John was skeptical about managing knowledge when he expressed concerns about the issue of the “half-life of knowledge”. John was apprehensive during the interview that if and when employees do have the access to the knowledge, how often would they access it? And when the employees do use it, would it be still valid then? The term ‘half-life’ is borrowed from the world of physics and is described by Shapiro (1985) as “the time after completion of training when, because of new developments, practicing professionals have become roughly half as competent as they were upon graduation to meet the demands of their profession.”

This impression is supported by the fact that knowledge has a temporal dimension. This is highlighted in Chan (1999), “Temporal factors - knowledge is a process of reuse, review and renewal. The renewal of knowledge occurs relative to time: knowledge captured may be valid during the time of implementation but may not be as useful post-implementation.” It is important to note that while knowledge may be dynamic, but it is essential to capture the ‘critical’ knowledge. This critical knowledge is described as knowledge that is both important and essential to the executing of the organisations’ daily and strategic activities.

“We need to be aware that we are working in the government environment and not the commercial environment, it would be hard for us to block customers.”

John further expressed that their business processes were different and unique in comparison with private organisations. Being a governmental organisation, John brought to light issues in which certain processes required sensitivity to governmental procedures. As an example, John illustrated that even if after sending multiple reminder letters to customers for payments or for customers who have not paid for some time, customers will not be brought to legislative action due to government policies. Although these processes are not documented in the business processes, it is observed that this part of knowledge (which is tacit) could be a potential area in which could be critical to the organisation carrying out its operational and strategic tasks. The lesson that can be learnt from this interview is that further research is required to understand how tacit knowledge (especially dynamic knowledge) can be explicitly represented in process models in a timely format. Problems faced by John such as context-specific (governmental) and industry-specific elements are not new but they have to be taken into consideration as they are sensitive issues in the construct of extended process models.

Case Study Part 2 - Applying the framework

This part of the case study seeks to evaluate the framework through the application of the extended process models. A meeting was conducted with two accountants in ASC, who had been working directly with the dunning process. The dunning process is essentially a process, which checks the items that are overdue by the customers, after which dunning notices are sent to inform customers of late payments. Dunning can occur at different levels and different dunning notices are sent based on the relevant dunning levels.

As the accountants were empowered with decision-making capabilities and not mere ‘drones’ in the organisation, they are therefore referred in this study as the *process owners*. Process owners have specialized knowledge of the company’s business processes in their assigned business area and have ultimate ownership of the business process, or groups of processes. The process owners were shown the EPCs from reference models recommended in SAP (without any prior knowledge objects added). They were then asked to evaluate the EPCs and to add knowledge objects, which they felt were relevant to executing and performing their daily tasks and activities. Following this, a follow-up meeting was conducted with the process owners to review the amended process models and confirm the statements made in regards to the types of knowledge. This review serves to

enhance the validity and reliability of the interview results as well as ensuring that the changes to the process models were exactly what the process owners expressed.

The table below summarizes the key observations and the quotes supporting the statements.

Key Observations	Extracted quotes
<ul style="list-style-type: none"> The process owners felt that knowledge used during implementation was not important to them during the execution of their daily tasks. Understanding the SAP terminology and learning to configure the dunning process was only critical for them during the implementation phase of the ES. They felt that project management knowledge was only required during implementation and henceforth “expired” and not of high value to them in their daily tasks. 	<ul style="list-style-type: none"> “In determining dunning levels, this has been done at the project level so we don’t really do this.”
<ul style="list-style-type: none"> Although the EPCs display the overall processes that occur during dunning, the process owners only come into contact with the operational side of the business processes. The process owners only see it from the system interface point of view and the transactions that take place. The process owners seem to be more interested in a functional view of the process. 	<ul style="list-style-type: none"> “If an employee needs to enter the dunning data, on a data entry, they don’t really need a lot of business knowledge. It is just 3 clicks and they are done”
<ul style="list-style-type: none"> Business knowledge is not regarded as highly important in executing a process. However, a good understanding of business is desirable to more efficiently carry out a task. 	<ul style="list-style-type: none"> “...the employee would probably need some understanding of debt management but to execute the process is just a number of clicking the screens and following through.”
<ul style="list-style-type: none"> Much of the knowledge that is required to carry out the process is tacit. The employees emphasized a number of times on the concept of “familiarity”. This familiarity draws from the employees experience in dealing with the customers and knowing intuitively how to treat each customer different. There is no documentation of how each customer should be treated. 	<ul style="list-style-type: none"> “But again, it really boils down to familiarity, being familiar with who the customers are.” “...when you have negotiated with the customer, you will know instinctively [what to do]”

Analysis

Project management knowledge is seen as crucial to an organisation during the implementation phase as it is usually 'new' and unavailable to employees of the organisation. Organisations also realize that they rely heavily on external knowledge (consultants). The process owners place this type of knowledge outside the realm of conducting their daily businesses. There has been no important mention in retaining this type of knowledge within their organisation for future use and change of the ES. This is possible as the migration of a new upgrade may not depend heavily on “old” existing project management knowledge and may require a new set of different skills and expertise. The explanation for this behavior could be that users of the ES feel that project management knowledge is not critical to their performance of the daily tasks. As indicated previously, there are different perspectives following the ES lifecycle, these results were reported from the *use* perspective.

Product knowledge is used only during the implementation. The process owners were very certain that understanding SAP specific terms like "dunning", how to operate the system, what the functions and what menu bars meant were required before the system went 'live'. Once this knowledge is acquired, it resides in the 'head' of the process owners and does not need to be changed.

Business knowledge is required for understanding the generic concepts but not highly essential for the operational aspects of executing the process. To operate the ES from a transaction point of view, it requires only menial data entries to system. However, an understanding of the business rules (like debt management) helps to understand and appreciate how the processes are carried out.

Technical knowledge is also not often strongly associated in the *use* of the ES. The reason for this is that the process owners are aware that when all the configurations for the printing process have already been set up, they did not feel the need to rely heavily on this type of knowledge. The process owners were aware that technical knowledge is required in the configuration (e.g., for the printing of the dunning notices) of the ES. Although the process owners are not directly responsible for the configuration of this task, they were able to identify who the responsible process owners were (i.e. IT department). While technical knowledge is 'outsourced' internally, it is important for the organisation to recognize the ownership of the knowledge.

Company-specific knowledge is the most important knowledge perceived by the process owners. The process owners repeatedly expressed that this knowledge comes with experience. This 'experience' is learnt often by

dealing directly with the customers and knowing who they are and why not to 'block' the customers' transactions. The process owners also stated that there is no easy way to achieve this 'familiarity' and a good grasp of 'common sense' of intuitive knowing is required. This knowledge is not documented but essential to operate the dunning process. This 'familiarity' with the customers is not something that can be taught or written down. It requires the actual contact, communication and learning. In dealing with customers, it is often learning from mistakes and having gone through the actual experience that one would know how to handle a certain type of customer.

In this sense, the process owners were aware that tacit knowledge resides with them. When asked if there was any additional knowledge that should be taken into mind besides the types prescribed, the process owners agreed that there was not any and they stated repeatedly that "familiarity" was required in dealing with the customers and that it was essential in enabling them carry out their tasks. There was no documentation of such knowledge about customers in the organisation. The process owners took some time to try to describe this knowledge, "Um...it is hard to describe...um...what it really is...you know...kind of...like...um". It is this difficulty to describe the types of knowledge that Nonaka (1995) explains as "tacit knowledge [that] is difficult to articulate and encode, and consequently difficult to transfer." This tacit knowledge of knowing how to deal with different customers differently "intuitively" comes from the process owners' experience. This is an important aspect and perhaps the most important knowledge for managing the dunning process. In so forth, context sensitive company-specific knowledge is felt to be ranked highly among the process owners.

From the analysis of the case study, the evidence provided indicates that the types of knowledge used to categorize the knowledge objects for the extended process models were complete and adequate for capturing knowledge related to ES processes. The process owners could easily identify relevant types of knowledge and communicate them through the models. The process owners were also keen on how this application can be used in other business processes. An outcome of the case study demonstrated that knowledge had a time-dependent component. For example, project management knowledge and product-specific knowledge is required in the early stages of an ES implementation but more emphasis is put on company-specific knowledge during the use of an ES. It has been pointed out that this 'tacit' knowledge is important and essential for the organisation's growth. Important knowledge management issues referring explicably to the dynamism of managing knowledge and the transparency of the processes were highlighted. While these issues are not new, the need to resolve these issues were stressed again. Therefore, there is motivation for further research to look into this aspect.

SUMMARY AND OUTLOOK

This paper applied a proposed framework (Rosemann and Chan 2000) for the management of knowledge in Enterprise Systems. It looked into what knowledge can be managed in organisations and how knowledge can be managed through the use of extended reference process models. Participants in the case study who had evaluated the proposed models generally accepted the use of these models. The research also developed a complete extended reference model of the SAP's dunning process using the suggested framework. The proposed dunning process could serve as a reference point for organisations intending to evaluate a way for managing their enterprise knowledge.

The case study has demonstrated that while reference models supplied by ES providers are beneficial for the configuration and implementation needs, they do not focus on enterprise-individual aspects, business objectives or manual tasks. The application of the framework in terms of extended process models allows managers and process owners more transparency.

One interesting outcome of the case study is that there were two different levels of perception of the application of process models. The first level is abstracted from the Financial Manager who views the business process from a strategic point of view. Although he found them useful in general, he hesitated to perceive an enormous value in maintaining these models. The second level takes the perspective from the operational point of view from the process owners. The process owners who dealt directly with the business processes appreciated the extended reference process models from a different view in which the proposed models can be employed in the running their daily businesses. This indicates that there is a different perception of the usefulness of business process models from different roles in the organisation.

Following the further analysis of the extended models in the previous section, further meetings with the process owners will be held to evaluate how well the models have been accepted and used by them longitudinally. A second case study is currently conducted with a large Australian postal organisation. In formal interviews with business analysts, it will be studied how they evaluate the feasibility, acceptance and correctness of the extended models.

Note:

Organisation names and names of employees have been changed to maintain confidentiality.

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