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Special Theme of Research in Information Systems Analysis and Design - I. Unraveling Knowledge Requirements Through Business Process Analysis

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SPECIAL THEME OF RESEARCH IN INFORMATION SYSTEMS ANALYSIS AND DESIGN - I UNRAVELING KNOWLEDGE REQUIREMENTS THROUGH BUSINESS PROCESS ANALYSIS

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ABSTRACT

Organizations analyze their business processes in order to improve them. Business processes are also considered retainers, users and creators of organizational knowledge. Thus, they can be analyzed to identify the knowledge used, created and embedded in them. A process analysis approach that focuses on redesign does not necessarily capture the knowledge used and created in a process. Choosing a knowledge-focused approach should lead to understanding knowledge needs but might not lead to improved business processes. This paper describes an approach for Knowledge Requirements Analysis (KRA) that combines process analysis with identifying knowledge used and created during the process. KRA is the process of identifying and analyzing existing organizational knowledge and prescribing improvements to it. The KRA methodology presented in this paper combines two methods: a knowledge engineering method (CommonKADS) and a process modeling method (EDPDT). The EDPDT constructs are used to operationalize the organization and task models of CommonKADS and thus create the KRA methodology. The methodology was applied successfully to the process of ethical reviews of grant applications in a university. The main advantage of the proposed methodology is that it enables organizations to keep track of their knowledge resources embedded in various business processes. Knowledge that is not shared or used can be detected and new knowledge can be identified to support and improve existing processes better. This approach can lead to improved knowledge management in organizations

KEYWORDS: knowledge requirements analysis, knowledge engineering, business process modeling, business process analysis.

I. INTRODUCTION

Knowledge is widely recognized as a key asset of organizations that contributes to competitiveness and provides the basis for long-term growth, development, and continued existence [Kalpic et al., 2002; KPMG, 2003]. Therefore it is important for organizations to identify and analyze organizational knowledge and understand how it is used. Recognizing the importance of managing their knowledge, organizations are moving to deploy information systems to support knowledge management [KPMG, 2003; Hicks, 2003; Lau et al., 2003].

In organizations, knowledge is often embedded not only in documents or formal repositories but also in organizational routines, processes, practices, and norms [Amaravadi and Lee, 2005; Davenport et al., 1998; Walsh and Ungson, 1991].

Knowledge can be related to business processes in two main ways:

1. Activities in the processes usually refer to actions which use or generate knowledge. Thus, when a process is designed, the decisions about activities to be performed implicitly deal with knowledge.

2. The structure of the process (which includes sequencing of activities, various process branching and joining conditions, and the way activities exchange information) represents knowledge about organizational procedures.

Remus and Schub [2003] describe advantages of integrating knowledge management with business processes. These are:

- As a result of the integration, knowledge value chain and general value chain are more strongly connected,

- Knowledge can be offered to an employee in a more targeted way, and

- Information overload can be avoided because only information relevant to value-creating activities is made available to employees.

The links between business processes and knowledge also introduce a problem that many organizations face, namely, how to combine business process management and knowledge management in a way that will enable effective management of both knowledge and processes. This problem is noted in studies examining different links between knowledge management and process reengineering [Papavassiliou et al., 2002**;** Papavassiliou and Mentzas 2003**;** Maier and Remus, 2003; Smith and McKeen, 2004]. For example, Smith and McKeen [2004] discuss the need to study knowledge management within the context of business process reengineering, and provide guidelines to organizations on how to integrate knowledge management in the design of business processes. As an example for a knowledge management problem that can arise when a process is redesigned, consider the case when an activity is eliminated or changed to improve the process, but results in the loss of knowledge. For instance, in a purchasing process, the purchasing agent considering a quote from a supplier, might be instructed to look at alternative suppliers. If this activity is eliminated, the process will be expedited, but market knowledge will not be obtained as in the past.

This paper focuses on assisting organizations in a specific aspect of the knowledge-process relationship: identifying knowledge used and generated by process activities. To distinguish this analysis from that related to knowledge embedded in the process structure we use the term process-related knowledge requirements analysis. In the context of information systems, requirements analysis is about identifying the scope of a system, typically in terms of its expected inputs, outputs and functionality. Narrowing the focus to knowledge management, KPMG defines knowledge requirements analysis (KRA) as a process that brings to light what knowledge is needed and how it can be obtained and maintained [KPMG, 2003].

Traditional process engineering methods such as business process reengineering often do not enable the designer to conduct a knowledge requirements analysis. While some knowledge will be transferred into a newly redesigned process, and some deemed unnecessary following the redesign, the organization may still be at risk of losing important knowledge, which was generated by the old process.

The objective of this paper is to examine the need to combine knowledge and process engineering. Using a case example we describe a KRA methodology, which combines two related analysis techniques:

- A knowledge engineering method, namely – *CommonKADS,* and
- A process modeling technique named "*event driven process diagramming technique*" (EDPDT).

The paper proceeds as follows. Section II describes each of the techniques used in the KRA approach and how the KRA approach and EDPT can be integrated. We then apply the proposed approach in a case setting (Section III) followed by conclusions and recommendations for future studies in section IV.

II. METHODS

KNOWLEDGE ENGINEERING

Knowledge Engineering (KE) is closely related to software engineering. KE evolved as a separate discipline involving the development of knowledge-based systems or expert systems [Liebowitz, 2001]. CommonKADS [Schreiber et al., 1999], MIKE [Angele et al., 1998], and PROTÉGÉ II [Gennari et al., 2002] are examples of popular KE methods and techniques developed in recent years. To develop our KRA approach we chose CommonKADS as the knowledge engineering method because of the importance it places on the requirements analysis stage and the level of detail in which this stage is described in the method. In Protégé II it is assumed that the developer already analyzed the requirements of the application [Tu et al., 1995]. Similarly, in MIKE the development process does not include the requirements analysis stage [Angele et al., 1998]

CommonKADS supports the development of knowledge systems from selected business processes and is applied by developing a set of six models [Schreiber et al. 1999]. These models are:

An organization model	An agent model	A knowledge model
A task model	A communications model	A design model

Each of these models captures specific aspects of the knowledge system to be developed and its environment.

The organization, task, and agent models of CommonKADS describe the organizational environment and the corresponding critical success factors for developing the knowledge system. The communication and knowledge models are developed based on information from the organization, tasks, and agent models. The knowledge and communication models describe the structure of knowledge used in performing a task and how this knowledge should be communicated among agents respectively.

These models provide further inputs to the development of the design model that describes the implementation details of the knowledge system. A brief description of CommonKADS models is

provided in Appendix I. To develop our KRA approach, we mainly focus on the organization and task models of CommonKADS because they cover the requirements analysis stage.

Organizational Model

The organization model consists of five components.

1. The first one focuses on problems and opportunities as seen in the wider organizational context. It contains the broader categories such as organization's mission, goals, and strategy.

2. The specific aspects of the organization such as business processes, people, resources and knowledge.

3. The business process is divided into smaller tasks. An indication is given on how knowledge-intensive these tasks are and what knowledge is used by them.

4. The knowledge used in each task.

5. The business and functional feasibility of implementation of suggested solutions.

The Task Model

The task model provides an analysis of each knowledge intensive task (as identified in the organization model) and a detailed analysis of these tasks. It describes task bottlenecks and possible improvements of the knowledge associated with these tasks.

In applying CommonKADS to perform knowledge requirements analysis, that is to capture knowledge needed for the business processes, three problems arise that are related to the operationalization of the organization and task models.

1. Only a limited number of techniques are provided for CommonKADS users on how to identify elements ("constituents") such as knowledge, process, context or people and their relationships. Users need to employ their own techniques (e.g., a technique to represent actors and resources or to represent knowledge).

2. More guidance is needed for gathering information, especially for exploring mutual impacts and relationships among concepts such as people, resources and processes [Hoog et al., 1996].

3. Specific methods are needed to model how tasks are performed.

To overcome these problems we propose to incorporate a specific process analysis method in the requirements stage of CommonKADS that enables description of tasks and the resources related to them.

PROCESS ANALYSIS AND MODELING

Embedding knowledge management in business processes should begin with process analysis and design to ensure that knowledge management activities are included in the process [Nissen et al., 2000]. In the information systems context, process analysis and modeling typically provide graphic representations of processes that capture, manipulate, store, and distribute data between a system and its environment, and between different components within a system [Hoffer et al., 2002]. We use a specific process modeling technique – Event Driven Process Diagram Technique (EDPDT) – to support the operationalization of the organization and task models of CommonKADS. Specifically, we believe that this process modeling technique can help identify knowledge and its users in organizational processes and to analyze the knowledge requirements for possible improvements.

Event Driven Process Diagram Technique (EDPDT)[1]

In EDPDT processes are decomposed into a set of *activities* that begin and end on events. A process is modeled as a sequence of *events* linked by *logical connectors* and activities. Processes can be represented graphically in *process maps*. For example a process of order delivery can be decomposed into five activities – (1) process order, (2) assemble products, (3) prepare and send invoice, (4) process payment, and (5) ship product (shown in Figure 1). The specific notations used in EDPDT are summarized in Table 1.

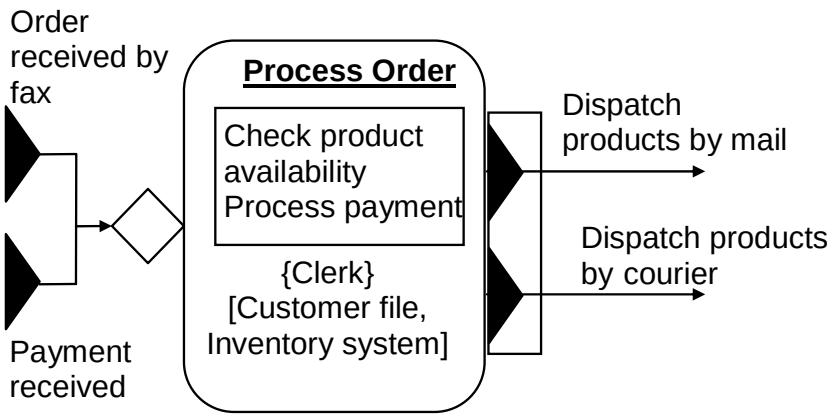

Figure 1. Example of 'Process Order' Activity

Looking at Table 1 we note the similarities between *activities* in EDPDT and the concept of task (a subpart of a business process [Schreiber et al., 1999, p. 18]) in CommonKADS. Both constructs represent components of processes. Both include similar associated constructs such as inputs, outputs, resources, and agents. Thus we can establish a link between EDPDT and CommonKADS on the basis of the task/activity constructs. This link facilitates the development of our KRA approach that examines both knowledge and process requirements. In the following section we describe this approach using CommonKADS as the base method but substituting the *EDPDT activity* construct for tasks in the CommonKADS models.

THE INTEGRATED KRA METHODOLOGY

By operationalizing the organization and task models of CommonKADS with EDPDT we form the integrated KRA methodology. In particular, we focus on the aspects of the organization and task models that directly relate to analyzing knowledge in business processes[2].

The KRA methodology consists the following sequence of six steps which use both CommonKADS methods (steps 2, 4, and 5) and EDPDT model elements (steps 1, 3). Step 6 was added to the methodology to address the possible impact of conducting KRA in organizations.

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[1] EDPDT employs notation from Martin and Odell, [1992] and was further developed by Adjunct Professor Jacob Steif at the Sauder School pf Business, University of British Columbia.

[2] Note, we do not address some components of the organization model such as the organizational environment (e.g. goals and purpose) and feasibility of implementing knowledge because these components are not directly related to KRA.

Table 1. EDPDT Notations

Name	Notation	Description
Activity		An activity represents change of state, which signals the need of a response. The plus sign shown in the activity box means that the activity is decomposed to a number of activities (n).
Event		Events trigger, or are triggered by, an activity. The triangle 'points' to the moment when a state change occurs. The direction of the arrow denotes the sequencing and flow of consecutive activities and events.
Operations		Operations are processing units that make a change of state. Activities can be decomposed into operations. For an example an activity- '*review* a research grant application' may be decomposed into two operations, *read* the application and *write* comments about the application.
Resources	**[Resource]**	Resources are used in activities and are necessary to conduct the activities successfully. Resources can be consumables, or decision support tools such as an information system, database, or documents. EDPDT also includes *Knowledge resources* such as experience or expertise.
Rules	**(Rule)**	Rules describe controls (if any) that are necessary for processing an activity
Actors	**{Actors}**	Actors are responsible to accomplish the activities.
Input / Output	**<Input>** **<Output>**	Inputs are physical resources to be processed by an activity. Outputs are physical resources that result from the activity. For example, 'applications and supporting documents' are input to the activity 'review a research grant applications' and output of this activity is 'written decision taken applications'. The difference between input and output signifies that the activity has been processed.
Logical connectors linking events		
AND		All events associated with an activity *must* occur together when triggering, *or triggered by*, an activity.
OR		One or more events may or may not occur.
XOR		(Exclusive OR) *One and only one* of the events will occur, wither when triggering, or when triggered by, an activity.

Step1: Identify and map organizational processes and related activities

Step 2: Generate activity sheets for each activity identified in the processes

Step3: Identify knowledge-intensive activities and knowledge items

Step 4: Rank and select activities for KRA

Step 5: Analyze knowledge deficiencies and suggest improvements

Step 6: Redesign activities and processes

Recall that knowledge is embedded in business processes, through process structure and by activities definition. In the 6-step procedure, steps 1 and 6 deal with process structure. Thus, if the process modeling method used conveys sufficient information about the process structure, it effectively captures this knowledge. The process structure knowledge is therefore conveyed through the semantics of the process modeling technique. The knowledge used and generated in activities is dealt with in steps 2-5. These steps are specifically related to KRA and are usually not

included in process modeling. To illustrate our approach fully, especially the KRA-specific steps, we describe an application in the next section.

III. A CASE: PROCESSING ETHICAL REVIEW APPLICATIONS IN A UNIVERSITY

Ethical review of research applications is an essential part of conducting research in universities, especially when human subjects, animals, or bio-hazardous materials are involved. The case described here was conducted on the Ethical Review (ER) process within the social sciences at the University of British Columbia, a large public university, and focused on studies involving human subjects. The goals of the analysis were to improve the efficiency of the ER process and to introduce elements of knowledge management into the process by capturing and storing knowledge to support actors in the process.

The ER process begins when a researcher submits a paper-based application to the ER committee for review. The committee discusses applications in bi-weekly meetings and, if an application addresses the necessary ethical concerns, issues a certificate of approval for a period of one year. If an application does not address all ethical concerns (as identified by the committee), a note is sent to the researcher listing the deficiencies found in the application. The researcher addresses these issues and the application is reviewed again. This cycle continues until all ethical concerns are addressed. The actors involved in the ER processes are researchers, the ER manager, a secretary, Committee members, and the Committee Chair.

The case was initiated by identifying problems in the existing process. Initial discussions with stakeholders suggested that the main problems were the long turnaround time for processing applications and the inconsistencies in the committee's decisions over time[3]. Inconsistencies were said to be due to limited access to past ER decisions. The goals of the project were hence:

1. to improve the process and reduce processing time, and
2. to improve knowledge sharing and accessibility of past knowledge to committee members.

Because these two goals required the joint execution of both process analysis and knoweldge engineering techniques, we implemented the proposed KRA methodology.

A KNOWLEDGE REQUIREMENTS ANALYSIS

The KRA methodology involves six consecutives steps (Section II). We now describe each of these steps in the context of the case.

Step1: Identify and map organizational processes and related activities

To understand the process, ER meetings were attended over several months and representatives of all stakeholders were interviewed. Three main processes were identified:

1. Processing new applications for ethics approval,
2. Processing approved applications for renewals/amendments, and
3. Handling queries.

A total of forty-six individual activities were associated with these processes. For each of the three processes, an EDPDT process map was created to describe all activities together with the relevant events and their connectors. Process maps were then shown to involved actors and modified to reflect comments and to increase the maps' accuracy and correctness. A partial

[3] Committee members serve for a fixed period of time after which they are replaced.

example of such map for the process 'processing new applications for ethics approval' is shown at the top of Figure 2, mapping two specific activities and the connections between them.

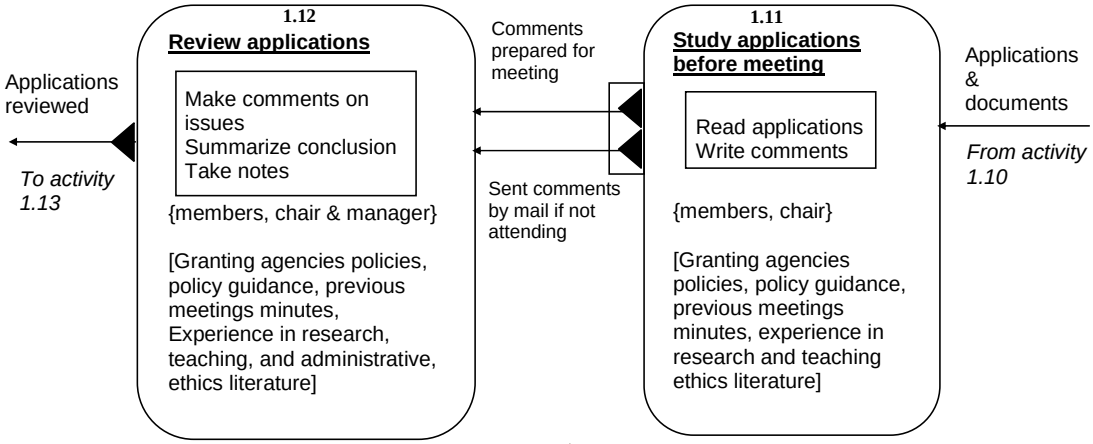


Figure 2. Partial Example for an Initial Process Map for 'Processing New Applications for Ethics Approval'

Step 2: Generate activity sheets for each activity identified in the processes

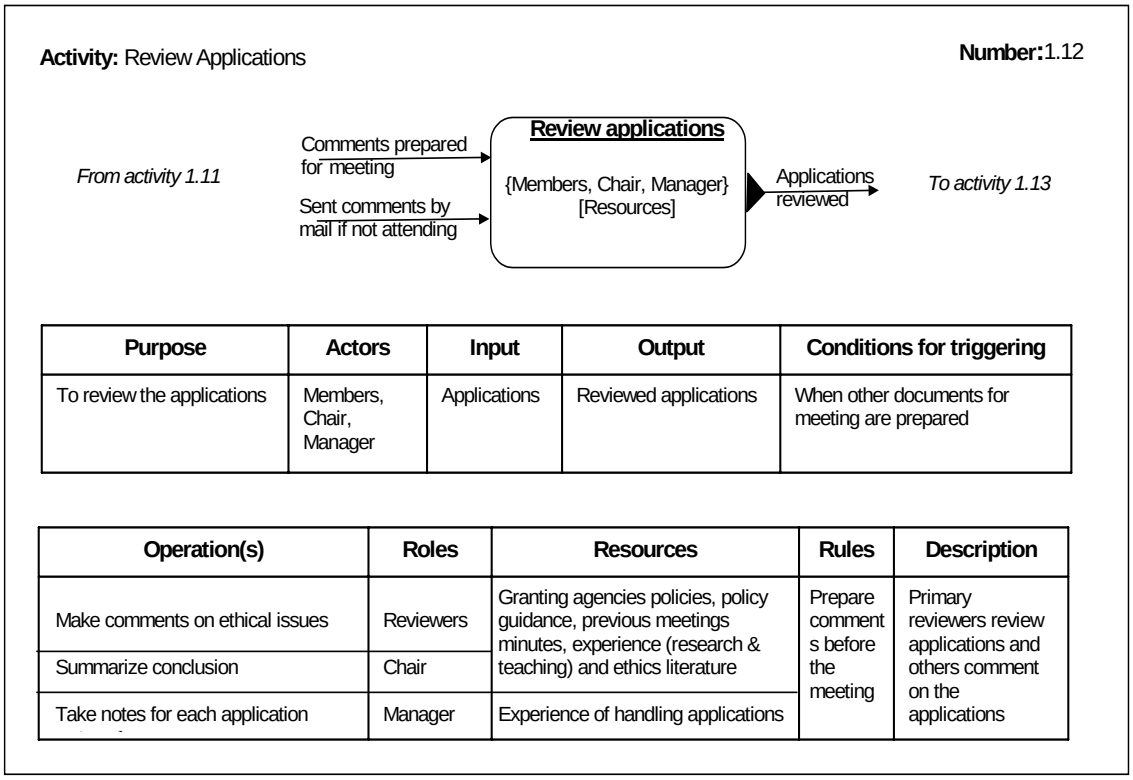
One of the main purposes of a knowledge system (and thus of KRA) is to capture information about knowledge users and knowledge generators. We introduce the following terms:

1. *Activity sheets* are used to capture this information about the activities analyzed.
2. *Purpose* of an activity;
3. *Conditions for triggering* an activity;
4. *Description* that helps understand the activity better; and
5. *Roles* that actors play in the activity, and, if the activity involves operations, roles that actors play in each operation.

The last four terms are activity related constructs added to EDPT.

An example for an activity sheet is presented in Figure 3 for the 'review application' activity. The top portion of the sheet shows the activity (selected from the process map) and the lower portion describes all the constructs related to the activity drawn in Figure 2. The sample activity sheet shows the different roles the actors play in three operations and the resources actors use in these operations.

In this activity the reviewers and chair use the same resources but the manager uses different resources. Forty-six activity sheets, similar to Figure 3 were generated for the three processes analyzed in this case.



Purpose	Actors	Input	Output	Conditions for triggering
To review the applications	Members, Chair, Manager	Applications	Reviewed applications	When other documents for meeting are prepared

Operation(s)	Roles	Resources	Rules	Description
Make comments on ethical issues	Reviewers	Granting agencies policies, policy guidance, previous meetings minutes, experience (research & teaching) and ethics literature	Prepare comments before the meeting	Primary reviewers review applications and others comment on the applications
Summarize conclusion	Chair			
Take notes for each application	Manager	Experience of handling applications		

Figure 3. Activity Sheet for 'Review Applications' Activity

Step3: Identify knowledge-intensive activities and knowledge items

We define knowledge-intensive activities as those that use or generate some knowledge resources. Based on this definition, we identified seven knowledge-intensive activities from the total of forty-six activities in the three ER processes. The knowledge resources of these activities were termed knowledge items (corresponding to the knowledge-item term used in CommonKADS [Schreiber et al., 1999]). Furthermore, we analyzed each of the knowledge resources and defined explicit and tacit knowledge items [Nonaka et al., 1995, Polanyi, 1967]: Explicit included items such as literature, granting agencies policy manuals, or guidance notes for ER, and tacit included items such as research and teaching experience. Table 2 lists the knowledge items in the knowledge-intensive activities based on the tacit/explicit classification.

Step 4: Rank and select activities for KRA

For efficiency considerations CommonKADS [Schreiber et al., 1999] suggests that activities be ranked as to their importance. The specific ranking criteria might vary from case to case. For the case described here we adapted the original CommonKADS ranking procedure [Schreiber et al., 1999] based on four criteria,

- the costs involved (e.g. the cost of the experts involved in conducting the activity),
- the frequency of the activity,
- the resources used, and the
- criticality of the activity.

Table 2. Knowledge Items Identified

No.	Activity	Knowledge items	
		Explicit	**Tacit**
1.2	Check correctness of applications	Guidelines to fill the applications	
1.11	Study Applications before the meeting	Tri-council policy, policy guidance, previous meetings minutes, ethics literature	Experience (research & teaching)
1.12	Review applications	Tri-council policy, policy guidance, previous meetings minutes, ethics literature	Experience (research & teaching), experience of handling applications
1.13	Summarize and enter information	Ethics guidelines	Experience of handling applications
1.15a	Verify complete application	Ethics guidelines	Experience in handling ethics applications
2.2	Review Amendments	Ethics guidelines	Experience in handling ethics applications, Ethics related research experience
3.4	Refer guideline/ policy	Ethics guidelines and policy	

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- the costs involved (e.g. the cost of the experts involved in conducting the activity),
- the frequency of the activity,
- the resources used, and the
- criticality of the activity.

We excluded frequency as a criterion since in the case discussed here each activity is conducted exactly once. To rank activities according to the three other criteria we applied a five points scale for each criterion, where 1 indicated the lowest level and 5 the highest. These scores where assigned by the first author based on interviews with stakeholders. The three criteria were then averaged[4] to attain the overall ranking of the activity. The ranking of the knowledge related activities is presented in Table 3.

To demonstrate the next steps in our proposed KRA approach we focus on the two highest-ranking activities. These activities are 'study applications before the meeting' and 'review applications'.

Step 5: Analyze knowledge deficiencies and suggest improvements

To identify gaps between the required and available knowledge for these two activities actors were again contacted for interviews and asked to indicate efficiencies and suggest improvements for each activity. The findings for the review applications activity are presented in Table 4.

[4] In general, the specific weighting of scores depends on the case at hand. In the case described here we chose simple averaging of the values estimated by the people involved in each activity.

Table 3. Ranking of Knowledge Related Activities

No.	Activity	Actors	Cost	Resources	Criticality	Final score
1.2	Check correctness of applications	ER Assistant	2	4	4	3.3
1.11	Study Applications before meeting	Chair, Committee members	4	4	5	4.3
1.12	Review applications	Chair, Committee members, Manager	4	5	5	4.6
1.13	Summarize and enter information	Manager	2	4	4	3.3
1.15a	Check application	Manager	2	4	4	3.3
2.2	Review Amendments	Chair, Manager	3	2	4	3
3.4	Refer guideline/policy	ER Assistant, Manager	3	2	2	2.3

Table 4: Analysis of Knowledge Items in the Review Application Activity

Knowledge item	Deficiency	Suggested improvements
Manuals of granting agencies policies	Formal & detailed document, not available in electronic form and not updated	Summarized and highlighted issues to be available to the committee members in electronic form
Policy guidance	Not updated and not available in electronic form	Guidance should list main ethical issues (such as processing of longitudinal data), an example of each issue and suggested decisions
Previous meetings minutes	Available only in paper form, committee members unable to link this with earlier minutes. Decisions of earlier meetings not shared electronically	A repository for capturing earlier decisions.
Experience (research & teaching)	Knowledge is tacit type and not easily shared with other members	A repository for capturing earlier decisions that will facilitate knowledge extraction
Experience (handling applications)	Knowledge is tacit and not easily shared with other members	A repository for capturing earlier decisions that will facilitate knowledge extraction.
Ethics literature	Sources of documents not known or reliable, mainly available in paper form and sometimes too general	Regular updates on changes in review processes, recommended readings for ethics reviewing (such as underlying principles, challenges, current policies, and privacies).

The analysis of the knowledge items (such as guidelines and manuals) in the 'review application' activity found two deficiencies:

1. lack of updated and easily sharable information, and
2. some required information was not available.

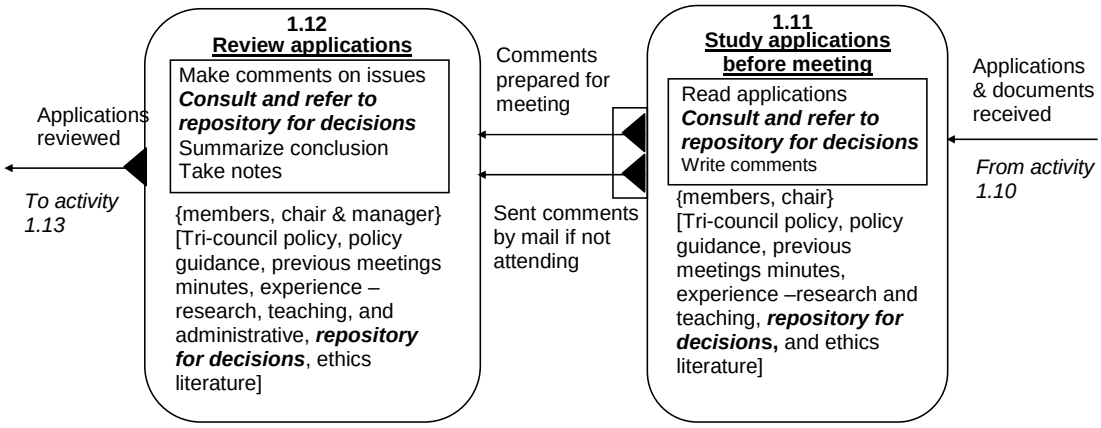
For example, the knowledge item previous meetings minutes was not easily accessible. Some documents, such as current ER policies and underlying principles for ER decision-making, were not available.

The main problem motivating the knowledge analysis part of this case study was the inconsistency of decision-making, which was attributed to the lack of proper access to previous decisions made by the ER committee. Therefore, after applying the KRA methodology, we proposed that the ER office introduces a new knowledge item, which we called a repository for ER decisions that would provide electronic access for a richer set of decision information from previous years. The proposed repository (when implemented as a database) can also eliminate deficiencies in other existing knowledge items. For example, it can be used to extract a set of principles for each important ethical issue, identify a list of protocols (such as rules, guidelines or methods to handle the issue) and summarize decisions taken on those ethical issues. Thus, the system can help reduce inconsistencies in decision-making and improve both the overall efficiency and effectiveness of the process.

In summary, by identifying the main knowledge deficiencies in the previous stages we were able to suggest an answer to the ER process knowledge needs.

Step 6: Redesign activities and processes

The last step in the KRA is the presentation of the new process, which includes the new knowledge items. Figure 4 shows the new process map and shows the new items and operations added to each activity in italics and bold. For example, with the introduction of the item Repository for ER Decisions, a new operation is defined Consult and Refer to Repository for ER Decisions in the activities Study Applications and Review Applications. By executing this operation, the ER decisions are expected to be more consistent than before.



Note: New items and operations added to each activity are shown in italics and bold.

Figure 4: A Partial Example for the Revised Process Map for 'Processing New Applications for Ethics Approval'

RELATION OF PROCESS DESIGN AND KNOWLEDGE ANALYSIS

We complete the description of the example by showing how the process (re)design itself is related to knowledge analysis. The knowledge embedded in a business process relates to how the process is conducted. This knowledge includes both process structure and the way activities are conducted. Process structure is determined by the rules governing execution of activities (shown explicitly in the activity diagrams), the sequencing of activities (such as an activity A must be followed by an activity B) and the linking of activities (such as two activities A and B must be

connected by AND symbol before the third activity C occurs). This knowledge is conveyed by the semantics of the diagramming technique (in our case EDPDT). This knowledge can be useful to participants in the business process (in our example the Ethical Review process) or to designers of similar processes (e.g. the selection process for conference papers). In our example, the usefulness of making the embedded knowledge in the business processes explicit is evident when a new committee member is introduced to the ethical review (ER) process. Studying the diagram is effectively transfer of embedded process knowledge to the new committee member.

IV. CONCLUSION

We described an approach to knowledge requirements analysis that builds on process analysis and knowledge engineering methods to focus on knowledge requirements when designing or redesigning business processes.

CommonKADS prescribes a set of models to guide users in identifying knowledge required to manage a process effectively. It further provides guidance on the development of a knowledge system. The models are generic and the operationalization of the models is left to the users. We suggest that the use of a comprehensive process modeling method such as EDPDT can serve the following purposes:

1. Provide information that might otherwise require the use of several methods or techniques (one to identify activities, another to map resources, and yet another to represent knowledge).

2. Serve to identify several knowledge-related concepts (people, processes, activity, resources, knowledge) needed for the organization and task models of CommonKADS. The constructs of EDPDT (defined in Table 1) are all those needed to identify the knowledge-related concepts to be used in the KRA methodology. This justifies why we chose EDPDT (other than the fact that the way CommonKADS defines activity is the same as task is defined in EDPDT).

3. Using EDPDT to operationalize the organization and task models provides a consistent and structured approach to identify the knowledge-related concepts. Specifically the activity sheets developed from EDPDT provide a template for collecting relevant information used as input to CommonKADS organizational and task models.

Using a case we demonstrated how the proposed methodology can be applied in organizations. The case experience demonstrated how the proposed methodology helps identify knowledge-intensive activities and analyzed the knowledge items in these activities in details.

In summary, CommonKADS provides the steps required to identify knowledge in a process. We modify these steps by adding a few more (Section II) and suggest how to operationalize the identification of knowledge in a process within the CommonKADS framework.

The proposed methodology makes it possible for organizations to identify knowledge resources that are not shared or used and identify new knowledge needed to support existing processes better. Such identification can lead to improved knowledge management in the organization.

The proposed KRA methodology also makes it possible to analyze and improve organizational processes. By introducing new knowledge items as resources and adding new operations related to knowledge resources (Figure 4). Improved and new knowledge items and knowledge-intensive operations should help increase the quality of decision-making and enable process improvements.

A KPMG survey on knowledge management indicates that failure to integrate knowledge management with business processes results in missing out on key business opportunities [KPMG, 2003]. The KRA methodology proposed in this paper can help organizations analyze

their business processes so that they can benefit from knowledge used and created in these processes.

LIMITATIONS

Two limitations of the proposed KRA methodology are:

First, the number of knowledge intensive processes could be significantly large in some organizations. This situation would entail analyzing and keeping track of a large number of knowledge items in these processes, and thus may result in difficulty in employing the proposed KRA methodology.

Second, some subjective judgment may be required to use the KRA methodology. For example, the terms “knowledge-intensive activities” could be interpreted differently by different users. This ambiguity could pose problems in ranking the activities. Users may need to employ a different strategy (than demonstrated in this paper) to rank the activities based on their interpretation of “knowledge-intensive activities”.

FUTURE RESEARCH

An important area of research in knowledge management is to assess the knowledge of organizational members to facilitate knowledge transfer and sharing. [Wakefield, 2004]. Maier and Remus [2002] argue that making knowledge assets visible and identifying and supporting knowledge seekers and knowledge providers are key reasons for organizations to implement knowledge management. Inasmuch as KRA helps to identify the knowledge that is available to people in the organization to execute tasks; an extension of this research is to develop methods to trace their knowledge transfer and sharing. Such methods should help developing knowledge repositories that could be used effectively and provide better support for knowledge flows within organizations.

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APPENDIX I. COMMONKADS: A BRIEF DESCRIPTION

Developed over 18 years in the context of the European ESPRIT IT Programme, CommonKADS provides methodologies for conducting knowledge analysis and developing knowledge systems in organizations. It enables spotting the opportunities and bottlenecks in how organizations develop, distribute and apply their knowledge resources, and thereby provides tools for corporate knowledge management. CommonKADS supports the development of knowledge systems from selected business process by providing methods to perform a detailed analysis of knowledge-intensive tasks and processes. Based on Schreiber et al. [1999], we describe the CommonKADS models in Table A1.

Table A1. CommonKADS Models Description

CommonKADS Models	Description
Organization	The organization model provides a structured approach to model the major parts of the organization such as structure, processes, and resources. The model supports the analysis of the major features of an organization, in order to discover problems and opportunities for knowledge systems, establish their feasibility and assess the impacts on the organization of intended knowledge actions.
Task	The task model analyzes the global task layout of the organization, its inputs and outputs, preconditions and performance criteria, as well as needed resources and competencies. The model concentrates on bottlenecks and improvements relating to specific areas of knowledge.
Agent	The purpose of the agent model is to understand the roles and competences that the various participants bring to perform a shared task. The agent model describes the characteristics of agents, in particular their competencies, authority to act, and constraints. It also provides input information for other CommonKADS models, especially the communication model.
Knowledge	The knowledge model explicate in detail the types and structures of the knowledge used in performing a task, independent of how the knowledge will be implemented in an IS. As a result, the knowledge model an important vehicle for communication with experts and users about the problem-solving aspects of a knowledge system during system development.
Communication	The communication model specifies the procedures to realize the knowledge transfer between agents. The communication model does so in a conceptual and implementation-independent way.
Design	CommonKADS models can be seen as constituting the requirements specification for the knowledge system. Based on these requirements, the design model gives the technical system specification in terms of architecture, implementation platform, software modules, and computational mechanisms needed to implement the functions laid down in the knowledge and communication models.

LIST OF ACRONYMS

commonKADS	A knowledge engineering method
EDPDT	A process modeling method
ER	Ethical review
KE	Knowledge engineering
KRA	Knowledge requirements analysis

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