MANAGING KNOWLEDGE IN WEAKLY-STRUCTURED ADMINISTRATIVE PROCESSES

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Abstract

IT support for knowledge workers in their daily work can take many different guises: groupware systems and information access and retrieval tools support knowledge processes, while workflow management covers the support for rigidly structured processes. However, what is missing so far is an environment that integrates the business process and knowledge management aspects of weakly-structured knowledge work and actively supports the worker in using and adding to knowledge resources. This paper aims to present a new approach to support weakly-structured knowledge-intensive business processes. As an example we sketch a case study from the Greek public sector.

1. Introduction

On the front of Knowledge Management efforts, an emphasis is given to the strategic applications of knowledge-related initiatives and a focus on creating the right culture and organisational structure that facilitates knowledge sharing and enables knowledge leveraging; see e.g. Davenport and Prusak (1998).

One of the most commonly mentioned barriers for Knowledge Management in organisations is the lack of time. “I have no time” or “My team has no time” have become common expressions in many organisations dealing with knowledge management. Therefore, Knowledge Management activities have to be integrated into daily work. However, the approaches that focus on knowledge management within the business process level are limited; see e.g. Wiig (1995) who claims that “knowledge-related perspectives need to be part of BPR”.

On the other hand, most BPM efforts have not focused much on knowledge. This is indeed critical, considering that knowledge is treated more and more as a principal success factor – or the major driving force behind business success. Moreover, although business process modelling tools and/or workflow management systems support in an adequate manner the modelling and enactment of business processes, they lack any support for knowledge-related activities.

From the above, it becomes clear that an approach that explicitly integrates knowledge management activities into the business process environment is missing.

In the present paper we attempt to fill that gap by developing and testing integrated methods and tools for proactive, context-sensitive delivery of knowledge in such processes. Our work builds on the artificial intelligence approach to organizational memories [Abecker et al. (2000), Reimer et al. (2000)] and extends the work of other researchers in the field of integrating organizational memories with workflow management [Staab et al. (2000), Van Kaathoven et al. (1999)]. The main extension is the explicit treatment of the knowledge-intensive, weakly-structured character of some decision-oriented processes in public organisations [Abecker and Mentzas (2001)].

Our approach to weak-workflow support combines a project management tool's flexibility with the complex handling aspects of traditional workflow systems . It provides open points allowing for later process refinement at runtime and flexible change possibilities facilitating process adaptation on the fly; see Klein et al. (2000).

We believe that our IT solution must be introduced in a company with appropriate methodological guidance and modelling tools. For this reason, we develop a Business Knowledge Method that integrates modelling and management of processes and knowledge. The method consists of the following steps: Business Process Identification, Business Process Analysis, Task Analysis, Business Process Design, Ontology Creation and Ontology Refinement.

Our modelling tool extends the formalisms used in most existing business process modelling tools [Yu and Wright (1997)] supporting in an integrated manner the modelling of weakly-structured processes and domain knowledge structures

Finally, we present the application of our approach and the implementation of the modelling tool to a knowledge-intensive business process of the largest Greek Social Security organisation. We have selected the process of granting full old age pension to insured people, which is, to some extend, a straightforward and well-defined business process. Nevertheless it contains critical knowledge and document intensive steps for finding a decision; see Wenger (1998) for similar forms-based knowledge intensive processes. In the case we examine, the steps of the process are often done under uncertainty, they are influenced by many legal regulations, and they are vital for the correct result of the process.

The paper is structured in the following manner. The next section outlines the requirements for supporting knowledge-intensive business processes, while Section 3 provides a short overview of our approach. Section 4 illustrates the developed modules of our tool, while Section 5 demonstrates the proposed Business Process Knowledge method. Section 6 pinpoints the relationship of our approach to public administration processes and describes its application to the social security business process. Section 7 examines some related approaches and compares them to our work. Finally, the last section outlines the conclusions and discusses some directions for further research.

2. Required support for knowledge-intensive processes

The starting point of our work is that an analysis of knowledge work [Buckingham (1998), Davenport et al. (1996)] shows that knowledge-intensive processes tend to be characterized by dynamic changes of goals, fluid information environment, unexpected constraints, and highly individual and ad-hoc communication and collaboration patterns. Moreover, knowledge generation and application plays an important role. Furthermore, such business processes, have to be analysed from a knowledge management perspective and knowledge management activities should be integrated into daily work. Support of this type of work seems difficult to achieve but is nevertheless desirable.

Existing systems, like project management and workflow management tools, present limitations that restrict their usability in such environment. Project management tools although flexible enough to support unique and dynamic processes, they fall short in modelling and enacting such processes. In addition, there is no possible support for context-sensitive information using such tools. On the other hand, traditional workflow management systems facilitate the modelling and execution of complex processes but they exhibit major limitations when confronting adaptivity issues and support for knowledge related tasks. The reason for this is that current workflow approaches are not flexible enough to adapt on the fly to changing processes. Moreover, the knowledge needed for executing the processes is not explicitly described in the workflow model.

However, a possible combination of the two types of systems can potentially provide adequate support for knowledge-intensive processes. More specifically, a system that combines the flexibility of a project management tool with the complexity supported by workflow tools will demonstrate the following characteristics

- **Workflow management system as an assistant:** the workflow will not follow a prescriptive, but more a descriptive philosophy to process modelling and management; the system offers to the user tasks and processes which can cooperatively be solved or changed. A continuous process improvement is aimed at. Hence the main system benefit is not so much automatic task delegation, load distribution etc, but more a “planning help”, an “advanced project management tool”, a documentation instrument, a collaboration platform.
- **Hierarchical decomposition of tasks:** processes are modelled as hierarchical task decompositions with several possible instantiations for specific subtasks. Subtask definitions maybe found in task ontologies describing the kinds of activities occurring in the organization.
- **Modelling and enactment interleaved:** starting from the idea of highly individual and ad-hoc work in a knowledge-intensive business, we expect stored task and process models to be usually incomplete or insufficient for a task at hand, to be refined, changes, or extended at runtime.
- **Expressive process logic:** since the temporal / logical interdependencies of tasks and subtasks might be more complex and difficult to articulate than it is possible in simple process definition languages we expect here an expressive language for task execution preconditions useful which might refer to the current task context, time conditions, or arbitrary domain or resource specific logical constraint.
- **Context-sensitive information management:** provision with contextually selected, task and user specific background knowledge is a main goal of the whole approach.

Another starting point is the observation that explicit knowledge relevant for a specific task or a decision is normally spread over many different kinds of documents, forms, legislative texts, etc. Project teams in knowledge-intensive business processes are used to deal with a huge amount of information. Lessons learned in previous engagements, insights from prior projects, notes for subsequent process steps are scattered among manifold "knowledge containers", from the personal memory, over paper, to different electronic systems. Even if there are mechanisms to explicitly capture and store bits and pieces of "best practice", these are seldom used in a coordinated manner, and at best take into account document content, but not so much document context, i.e. neither the creation situation nor the potential usage situation. On the other hand, business processes are a context-giving, structuring element prevalent in a company, often even formally modelled for some purpose such that it would make sense to exploit the usage of business processes to organize knowledge archives. The goal would be to enable context-sensitive storage, more purposeful access to information, and better integration with the process-oriented, day-to-day work of the employee with the knowledge system.

However, users are engaged in their daily work routines; they don't want to spend much time in searching for information or storing expertise. What they would need is an active, context-sensitive knowledge storage and delivery service, which "knows" what the user is actually doing and exploits this information for autonomous information management services at the desktop.

3. Short overview of our approach

In our approach we employ formally modelled business processes as an ontology which can be used to specify the creation, or the potential usage context, or both, for a given knowledge item. This leads to the idea of a process-oriented structured archive, a meta information system providing conceptual structures to access the underlying legacy systems.

To achieve the goal of active knowledge delivery and storage, we employ a workflow management system as the host, which is aware of the specific tasks to be performed by the user at a given point in time. Weakly-structured workflow models represent knowledge-intensive work routines which are usually not so strict and predetermined as, e.g., administrative workflows. Enriched workflow models describe information flow in the process and information needs for specific tasks. An information assistant observes the running workflow and interprets modelled information needs to offer active support from the process-oriented structured archive; further it maintains a notion of information retrieval context using the additionally modelled information flow variables which allows for more precise queries to the archive. Task context can also be used for information storage to describe the creation context of a given knowledge item.

Altogether, existing knowledge sources are used and extended in a more efficient and more consistent way throughout the company. However, the above scenario is based upon a number of non-trivial organisation analysis and modelling steps. (1) Business process maps and other domain ontologies for knowledge organisation and content description, (2) weakly-structured workflows for knowledge-intensive business processes, and (3) information flow and information needs for workflow enrichment, must be acquired and maintained over time.

The overall approach must be introduced in a company in the larger context of a comprehensive Knowledge Management or Business Process Management initiative. All required steps should be supported with appropriate methodological guidance and tools.

4. Modelling and enacting weakly-structured processes

In this section we describe the technical solution that realises the objectives mentioned in previous sections. The proposed solution consists of a tool for modelling knowledge enhanced business processes with associated information needs and for modelling domain knowledge structures and a workflow engine that enacts the modelled processes and interacts with intelligent agents that play the role of the information assistant, observing the running process, interpreting the information needs and offering context-sensitive knowledge storage and retrieval.

4.1 The Business Process Knowledge Modelling Tool

In brief, the Business Process Knowledge modelling tool is built upon the DHC CognoVision® tool [Müller and Herterich (2001)] for document and metadata handling and the MS VISIO® tool. CognoVision® is a document-based knowledge archive that creates a logical encapsulation of information objects (documents, web pages, etc), manages meta-data and the attributes of these information objects and allows for structured views and intelligent semantic links among the information objects. CognoVision® is the basis in our approach for the development of the process-oriented structured archive, while the integration of CognoVision® with MS VISIO® is used for modelling the business processes.

Conceptual framework for weak-workflow modelling

In order to model knowledge-related tasks and knowledge objects within weakly-structured business processes on a conceptual level, we construct a workflow meta-model that emphasises the coherence between them. The proposed meta-model is depicted in Figure 1.

A knowledge-intensive business process is defined in a workflow model. The workflow model consists of tasks and their interdependencies. Each of these tasks can be decomposed into (sub)tasks, which in turn can represent a whole workflow.

We distinguish two types of tasks in the workflow model: normal tasks (from now on they will be called Tasks), which describe the structured work in a business process; and knowledge management tasks (they will be called KM Tasks), which describe work associated with the generation, storage, application and distribution of knowledge in the business process.

Both Tasks and KM Tasks of the workflow model are assigned to Roles during modelling. Each of these roles has a set of permissions associated regarding the usage of the organisation's resources (tools, applications, etc.).

A detailed planning of the work to be done in knowledge-intensive business processes is quite difficult to be achieved in advance. To deal with this observation, in our approach under-specified modelling is allowed. The workflow model can include tasks not completely specified in form of a hierarchically ordered set of black boxes. The specification of such tasks can be completed during run-time with more detailed information.

During enactment time, the workflow model is instantiated. The workflow instance consists of the instances of the Tasks and KM Tasks. A Task Instance is a copy of the task model plus a reference to it and is under the responsibility of an organisational entity. The actual performer of a task can either be human (employees) or software and they are matched to the roles of the model so that the appropriate actor is selected to perform a specific task.

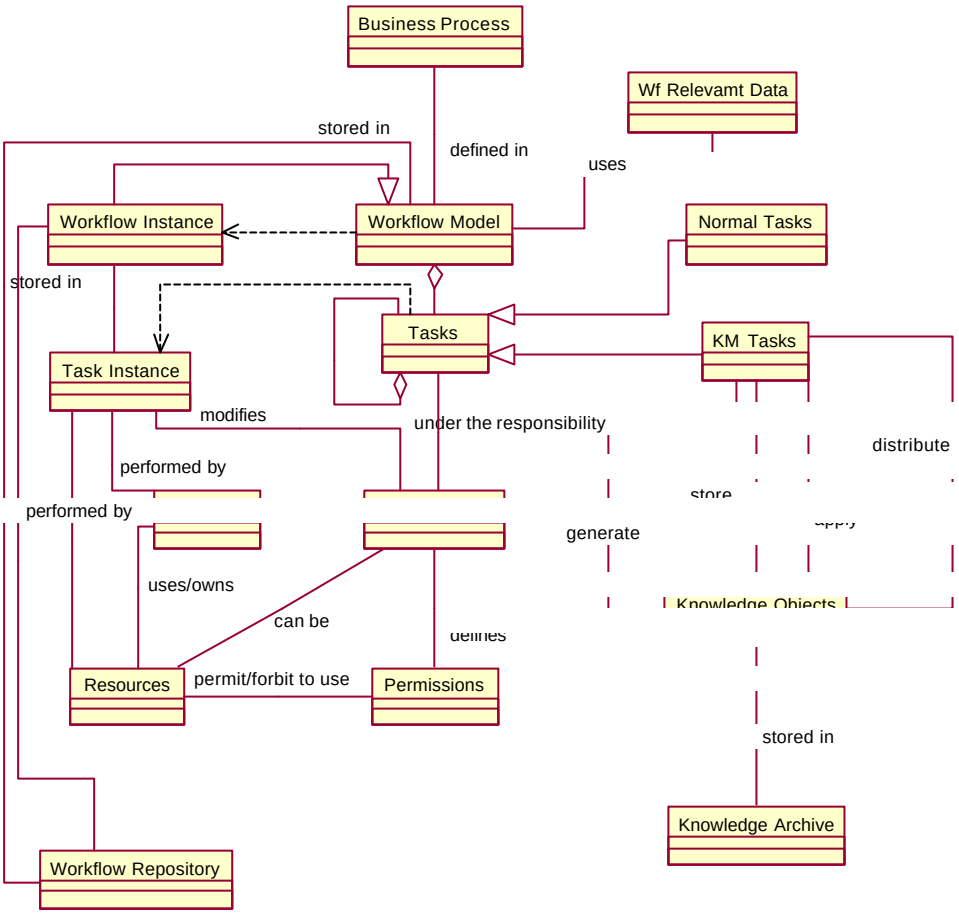

Figure 1: Workflow meta-model using UML notation

Modelling modifications can be made to a running Task-instance. Any possible modifications influences only new Task-instances, but since the changes of the model are getting logged to the workflow audit repository they can be proposed to running instances.

Knowledge enhanced business process modelling

Our modelling tool incorporates the theoretical aspects of our framework. It is realized as a set of related modelling methods for Microsoft VISIO® 2000 integrated with CognoVision®. This integration maps the MS Visio® modelling constructs to structuring elements in CognoVision®. Thus shapes in MS Visio® become information objects in CognoVision® and edges connecting shapes become links. The models developed can later be enacted using the workflow engine. For that, all the information needed is stored as attributes of these information objects and links. Information needs for specific tasks are modelled using an agent-description statement which is interpreted by the workflow engine as a call to a specific agent.

The basic modelling constructs include the following (see also Figure 2):

- *Tasks:* A task represent the structured work in the business process that have to be done to achieve some objectives

- *Knowledge Management Tasks:* KM Tasks are used to describe the work associated with the generation and application of knowledge in the business process. The execution of a KM tasks may contribute to the successful performance of a Task
- *Task Interfaces:* A Task Interface is a special kind of task used to connect two different models.
- *Automatic Tasks:* An automatic task describes work that can be done without any user interaction
- *Events:* Events are used to trigger the execution of tasks
- *Connectors:* They are used for modelling complex flows in the business process
- *Data Objects:* They describe variables used in the model to control the flow of the business process when executed by the workflow engine
- *Knowledge Objects:* Knowledge Objects represent the explicit knowledge required in a specific business process. Knowledge objects facilitate and leverage knowledge creation and sharing activities by providing to humans the information they need. They facilitate the knowledge transfer from persons to persons or from information to persons and are used to search, organise and disseminate knowledge content. Knowledge objects serve as input for Tasks and KM Tasks in the business process model and they are produced as output.
- *Roles:* Tasks and KM Tasks are assigned to roles during the modelling of the business process. They describe the entity that can and is allowed to perform the specific task.
- *Persons:* Persons describe real employees-users of the tool. If the business process model is enacted, persons are playing the roles that have been modelled.

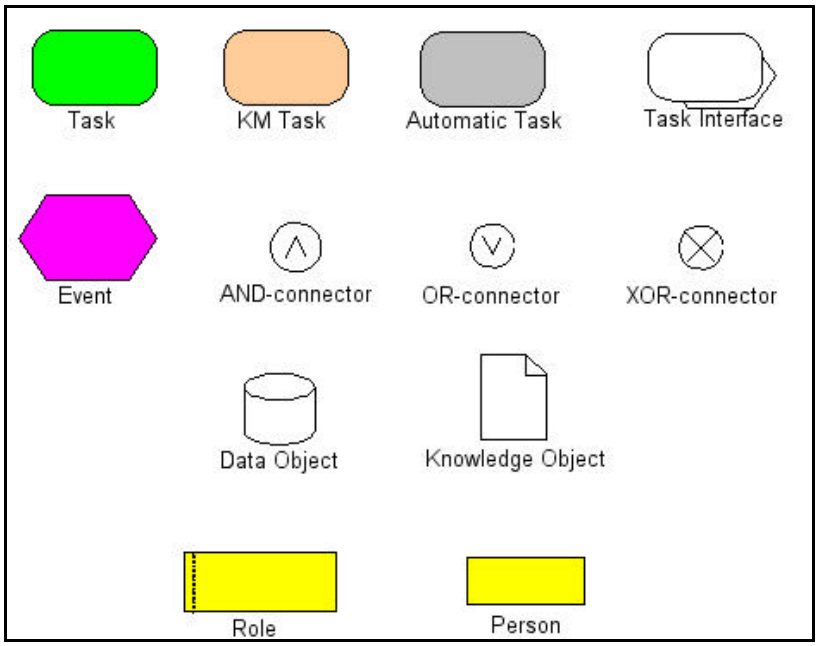

Figure 2. Business Process Modelling constructs

Tasks are connected with events using control flow elements (sequence, and, or, xor) forming Event-driven Process chains (EPCs). EPCs are extended by links to other relevant entities. In this way, tasks can be connected to input and output data to model the data flow in the process and to knowledge objects to model the information flow. The control flow of the

business process is modelled using sequences, splitters and joiners. With the sequence flow element, it is possible to link two tasks sequentially. More interesting are the split-join constructions that allow a path in the process to split into multiple parallel branches. It can be specified that such parallel branches all have to be executed at the same time (and-split), that only one (xor-split) or some (or-split) of these branches have to be executed.

In order to support in an integrated manner the modelling of those activities in the business process that are associated with the creation and application of knowledge, we extend the EPCs with additional tasks, the Knowledge Management tasks. The usage of these tasks is twofold.

First, they are used to model the automation of some knowledge-related tasks in the business process, e.g. to offer active retrieval of information necessary for the user in order to perform the tasks at hand. This is achieved by linking the modelled tasks with context-variables. These variables are the communication channel between the business process model and the intelligent agents that will perform the information retrieval when the business process is enacted by the workflow engine.

Second, they are used to extend the business process by adding KM Tasks when it is observed that knowledge is generated in the business process which can be applied in a later step of the process. An example of that is the storage and the retrieval of the lessons learned from an instance of a task.

Besides the business process model, the user of the tool has the possibility to model a responsibility diagram. This diagram associates the roles that have been assigned to the tasks of the business process with real employees and can be used as input to the workflow engine in order to assign tasks to real users.

Ontology modelling

The three central concepts that comprise the constructed ontology are *Kinds*, *Characteristics* and *Relations*. A straightforward mapping of these concepts to specific elements of the tool exists and is the following:

- *Kinds* are mapped to *structure units.*
- *Characteristics* are mapped to *definable attributes.*
- *Relations* are mapped to *links.*

Therefore, in order to implement the constructed ontology in the tool, one should take into account the previous mapping and use *structure units* to hierarchically structure the information, *definable attributes* to identify the properties of each *structure unit* and finally *links* to represent not only the relations holding between *structure units* but also to link to respective information/knowledge sources.

Consequently, one starts by the CognoVision® Administrator where the different types of *structure units*, *definable attributes* and *links* have to be defined before they can be used to implement the ontology (see Figure 3).

The next step is to implement the ontology in the CognoVision® client. Therefore, one uses the previously defined *structure units* with their assigned *definable attributes* to hierarchically structure the information, and *links* to represent the relations holding between *structure units. Links* are also used to link *structure units* to the respective information/knowledge sources (e.g. MS Word documents, adobe acrobat documents, html files etc.), provided that all such respective information sources are first imported into the

system using the import functionality of the CognoVision® client. Thus, the process–oriented knowledge archive for the selected business process is created.

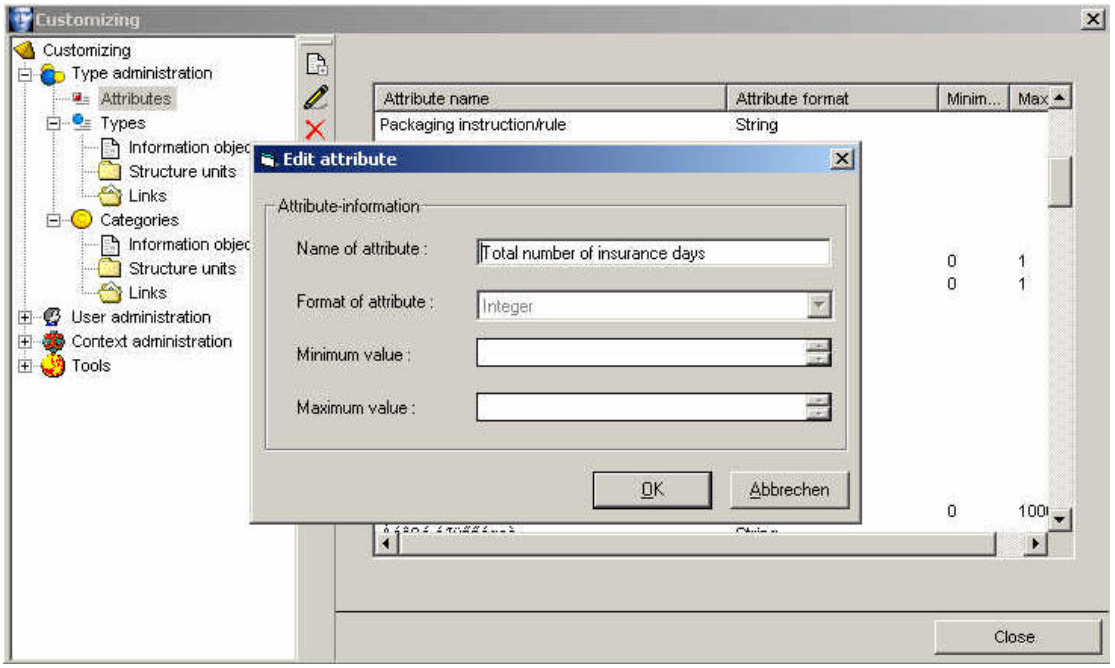

Figure 3. The CognoVision â Administrator

4.2 Enacting the weakly-structured business process

The workflow engine that will enact the modelled business process and proactively offer information from the knowledge archive is still in the development phase. Important features are the interfaces to allow for interoperability with knowledge retrieval agents and the structured archive.

The process enactment environment has been designed as an agent-based integrated weak-workflow/Organisational Memory approach [see Abecker et al.(2001)] to be implemented with an extended version of the FIPA-compliant JADE agent programming platform [see Ballifemine et al. (2001)].

The workflow engine interprets the process logic represented in the Business Process Model, goes through the modelled tasks and assigns each task to specific users according to the associations that have been modelled in the responsibility diagram. Whenever an information need is associated with a task as already described during modelling time, the workflow engine invokes an intelligent agent in the background. Given the corresponding context from the workflow task (modelled with data objects) the agent accomplishes an ontology-based information search in the process-oriented structured archive to satisfy the user's information need by presenting the relevant information.

The different functionalities of our approach are supported by various agents. Figure 4 gives a rough idea how the several agents occur together with typical communicative acts [see also Abecker et al.(2001)].

The Organisational Model Manager is responsible for the Organisational Model and its main services include the usual questions about the static organisational structure. The Model Manager handles the repository of the workflow models. The goal of that agent is to associate a task agent to every task that is not fully subsumed by its subtasks. It is responsible for managing read/write access to models, instances, concepts and embedded data, for searching

for models, instances and concepts referring to ontological criteria and for copying /instantiating a model. The competencies of that agent include queries to domain ontologies, creations and start of a task agent for a task instance and informing the audit manager about new or changed modelling decisions.

The Audit Manager handles the audit repository. It is used for performing queries about modelling history (models, modelling changes, old model versions, changes actions within a task instance model) and for storing a new model/instance. The Task Agent is responsible for the successful completion of a task. Its main actions include queries to domain ontologies, negotiations with user agents and resource agents about task execution and knowledge provision and modifications to the model of the respective task instance.

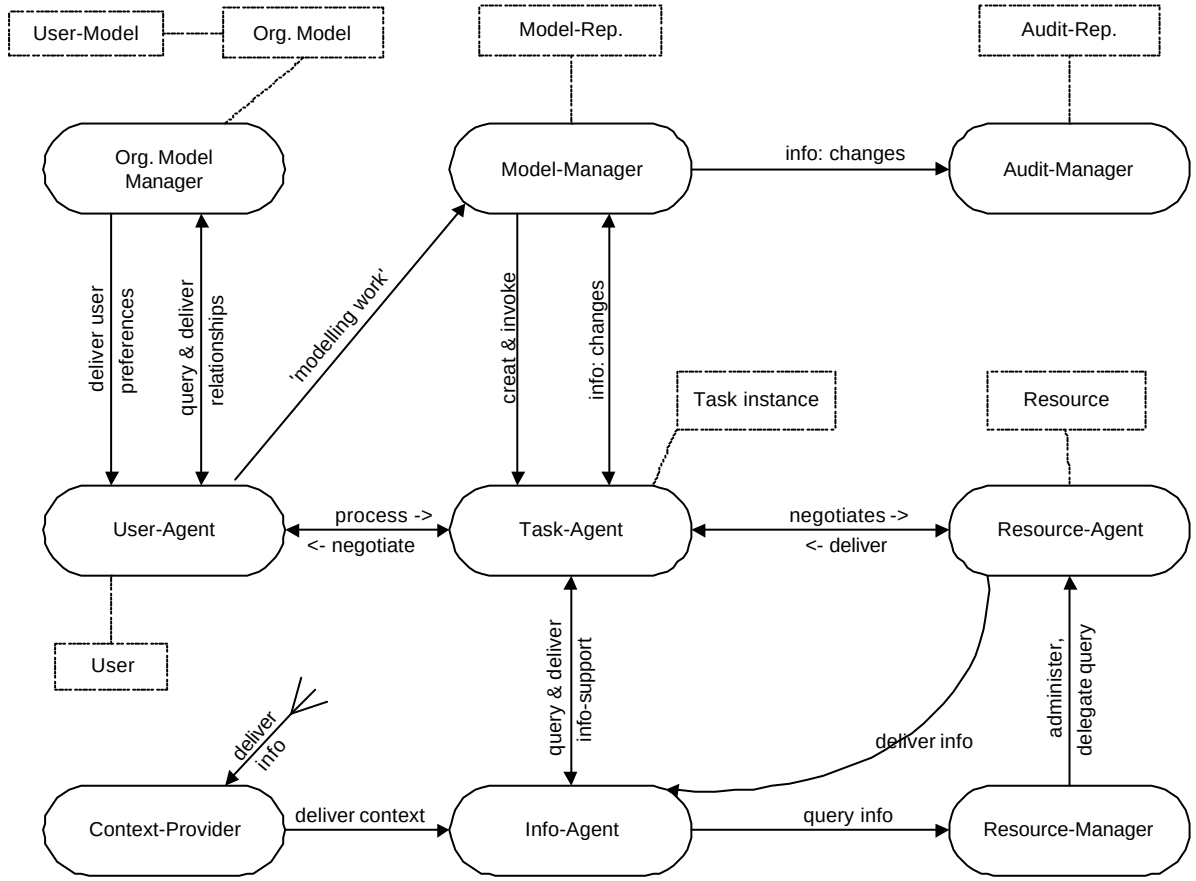

Figure 4. Communication between agents

The Context Provider uses all accessible information sources in the environment, including their information offers, heuristics for context delivery and the context model in order to offer useful and tailored context information. The Info Agent uses the context information offered by the context agent, the information/knowledge resources (managed by the resource manager) and the domain ontology in order to provide the right knowledge at the right time, contextually embedded. The Resource Manager handles the resource agents. Its main services include requests for resources with given features, direct search for a specific resource agent, requests for information with specific features and negotiation with several resource agents about information delivery.

The Resource Agent is used for information delivery for specific queries and for negotiation about this information delivery and about resource usage. Finally, the User Agent is used for handling read/write access to roles for the end users and for handling their worklist. It cooperates with the task agent for the task execution.

5. The Business Process Knowledge Method

There is an imperative need for a structured approach for performing business process oriented knowledge projects. This approach ought to support all necessary phases with appropriate methodological guidance and tools. The Business Process Knowledge Method provides the methodological guidance towards that direction amalgamating elements from the CommonKADS [Akkermans et al.(1999), Schreiber et al. (1999)] and the IDEF5 [IDEF5 (2000)] methods. Figure 5 provides an overview of the method's steps which are presented below.

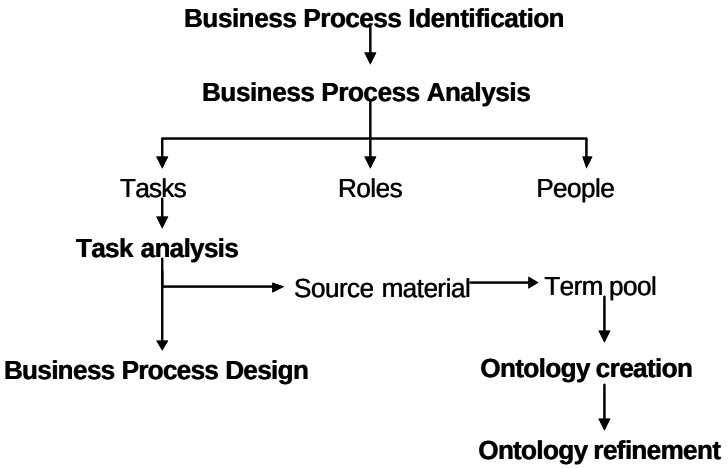

Figure 5. Overview of the Business Knowledge Method

- **Step 1: Business Process Identification.**

This activity involves the identification of the most appropriate business process/-es to be used as the central point for the development of the ontology. The selection of the most appropriate business process or processes can be based on the following two criteria: (i) *Knowledge intensity* (Scale: strong - weak), (ii) *Process complexity* (Scale: high-low). The *knowledge intensity* can be determined based on attributes such as contingency, decision scope, agent innovation, agent impact, learning time and knowledge half-time. Regarding *process complexity* the relevant attributes include process steps, involved agents, interdependency between agents and process steps, and process dynamics. Agents are persons and/or software programs which process knowledge. Business processes with high process complexity and stronger knowledge intensity are the ones of higher importance.

- **Step 2: Business Process Analysis.**

This activity involves a general description of the selected business process/-es in terms of (a) tasks consisting the business process; (b) roles involved; and (c) key people and source material. This step is necessary in order to establish a comprehensive description of the specific business process. This analysis contributes to a better understanding of the process, identifying the tasks, the roles and the people involved in it.

- **Step 3: Task Analysis.**

This activity involves a more detailed description of the individual tasks including their input and output objects, the source material handled within or delivered by the task, control relations between tasks along with constraints that govern the execution of each task as well as the roles performing the task and so on. Moreover, every task in the process is assessed

through its contribution to the core activities of Knowledge Management, i.e. generate, store, distribute and apply knowledge. This could lead to characterising some tasks as knowledge-related task.

- **Step 4: Business Process Design**

This activity involves the modelling of the business process using a graphical tool. Based on the assessment of the business process tasks from the previous step, if a gap in the sequence of knowledge-related tasks is identified, it is filled by adding the corresponding tasks. For example, if somewhere in the process the generation of knowledge has been identified but this knowledge is not stored, a Knowledge Management task for storing this knowledge can be added in the business process. The output of this step is a business process model enhanced with Knowledge Management tasks for the knowledge flow in the business process.

- **Step 5: Ontology Creation.**

This activity involves the development of a preliminary ontology taking into account the analysis made during the preceding steps. The data collection process of the ontology creation effort is both an iterative and interactive process. The data collection may occur in different modes (interviews with domain experts, direct transcription of data from source documents etc). Regardless of the data collection methods used, each piece of collected data must be traceable back to its source because it is the data that provides objective evidence for the basic ontology structures that are later isolated from this data. Therefore we use four important support documents to facilitate source data traceability: 1) Source Material Index, 2) Source Material Description Form, 3) Term Pool, and 4) Term Description Form. In the Term Pool and Term description form we record the meaningful Terms relevant to the ontology development project effort. It is from these Terms that we construct an initial ("first pass") characterization of the ontology, i.e. identify the three central concepts comprising the ontology: Kinds, Characteristics and Relations. In brief, Kinds can be considered as an objective category of objects sharing a set of properties. The properties belonging to a Kind constitute the Characteristics of the Kind and Relations are the sorts of general features that Kinds exhibit jointly rather than individually.

- **Step 6: Ontology Refinement.**

This activity involves the refinement and validation of the ontology. During this step, the ontology structures are "instantiated" (tested) with actual data, and the result of the instantiation is compared with the ontology structure. If the comparison produces any mismatch, every such mismatch must be adequately resolved. Refinements (if any) to the initial ontology are incorporated to obtain a validated ontology.

6. Public Administration as an Application Area

Our approach fits well in the area of public administration. The following four points outline the relationship of the main elements of our solution to public administration processes

The idea of **weak workflow structures** is required, since normally the legal regulations only provide a process skeleton while specific knowledge-intensive tasks [Buckingham (1998)] are below the granularity normally modelled (see [Dellen et al. (1997)] – this is what Lenk and Traunmüller see as a specific characteristic of e-government processes: "They are partly … structured by legal rules which however, often demand interpretation …" [Lenk and Traunmüller (2000)]; or because during long-living administrative process instances rules

may change [Dellen et al. (1997)]; or because specific exceptions may occur once for the first time.

The idea of **active knowledge delivery** is especially useful since not all employees dealing with a given topic have the same education and expertise, and decisions along given binding regulations must be ensured. Active hints to other's decisions are useful to guarantee equal decisions under equal conditions. Further they support the dissemination of new knowledge, for instance in the case of changed laws, etc. In the case of "normal citizens" or not deeply specialized operators interacting with a system, the active delivery fosters democracy since it allows to profit from and be part of complex processes without having all required background knowledge in advance. Moreover, it supports legal validity and transparency even in such cases as described in Lenk and Traunmüller's "innovative ways of service delivery" [Lenk and Traunmüller (2000)].

In governmental processes **ontology-based Organisational Memory systems** are especially important: many existing sources of knowledge, laws, comments to laws, specific regulations, old similar cases, available case-specific documents and information etc, are prevalent at different places and in different forms and representations, at several degrees of formality, and related by manifold links. In order to make informed, transparent, and accountable decisions, consistent with the past, compliant with the law, and coherent with similar decisions in other places, all this information should be placed into a coherent framework. Having this framework on a formal basis allows sophisticated assessment of relevance in information retrieval (cp. case-based reasoning methods).

In the area of public administration, our **Business Process Knowledge method** is definitely required because, without a deep understanding and sound approach to KM activities, the ever growing complexity of bureaucracy in a networked Europe will soon make impossible informed administrative decisions which properly take into account all relevant, actual information. Further, the increasing speed of change in administrative regulations and processes requires adequate organizational processes to keep pace with the changing world. This is even more the case since (especially in critical decisions) the citizens have access to the same information sources as the officials such that sub-optimal decisions are not longer accepted. A methodologically sound approach is also necessary because the public sector is so big that one needs clearly defined procedures in order to come to comparable (and, technically, interoperable) results.

The IKA case

Below we present an application of our approach in a specific weakly-structured knowledge-intensive business process. We tested our approach in an organisation from the social security sector: the Greek Social Security Institute (IKA), which is the largest insurance institution in Greece. Having as its primary purpose the protection of the insured persons, IKA offers an extensive range of services to them, like insurance, benefits, pensions and interstate social security. Currently, IKA provides health care to 5.500.000 insured persons including the members of their family and pays out pensions to 1.000.000 pensioners approximately. The Institute's income is derived from contributions of both workers and employers and from governmental funding.

The business process that was examined and modelled with our tool is the granting of full old age pension. The significance of the pension process lies in the large number of beneficiaries that currently amounts to 1.000.000 persons and increase at an annual rate of 10%. In addition, the pension granting process requires a deep knowledge of the relevant legislation;

first for making the decision whether the insured person is entitled to receive a pension; and second for calculating the amount of pension.

It is quite common that for one specific case more that one legal regulation may be relevant, and it is a matter of knowledge and experience to identify all these regulations and then choose the most appropriate one. If it is the case that the insured member can establish a pension right under more than one regulation, the different pension amounts are calculated and the highest one is chosen. In addition, the pension granting process -as part of a normal administrative workflow - contains some central, knowledge and document intensive steps for coming to a decision whether the insured person is entitled to receive a pension or not and to calculate the correct amount of the pension. These steps must be legally checkable, they are often done with uncertainty, based on the experience of the relevant regulations the employees have and they are vital for the correct result of the process.

The process begins with the submission of the application form by the insured person and the collection of all the supplementary documentation, which constitutes the retirement folder. The pension folder is checked at the department of pensions or the department of payments. If it is not complete, a communication between the department of pensions or the department of payments and the insured member or other departments or even other branches takes place in order to receive the documents that are required. The insured person is entitled to pension when he/she fulfils the prerequisite conditions (e.g., minimum number of working days and age) for the specific type of pension and category to which he/she belongs. The decision regarding the entitlement to a pension is made on the basis of the employment and personal data of the insured person. This decision is based also on the current legal regulations, which are differentiated according to the pension type, the category of the insured person and other factors. Having established that the minimum prerequisite conditions are met, a decision of approval is issued, which mentions all the information related to the granting and the calculation of the pension. If the insured person is not entitled to a pension, a decision of rejection is issued.

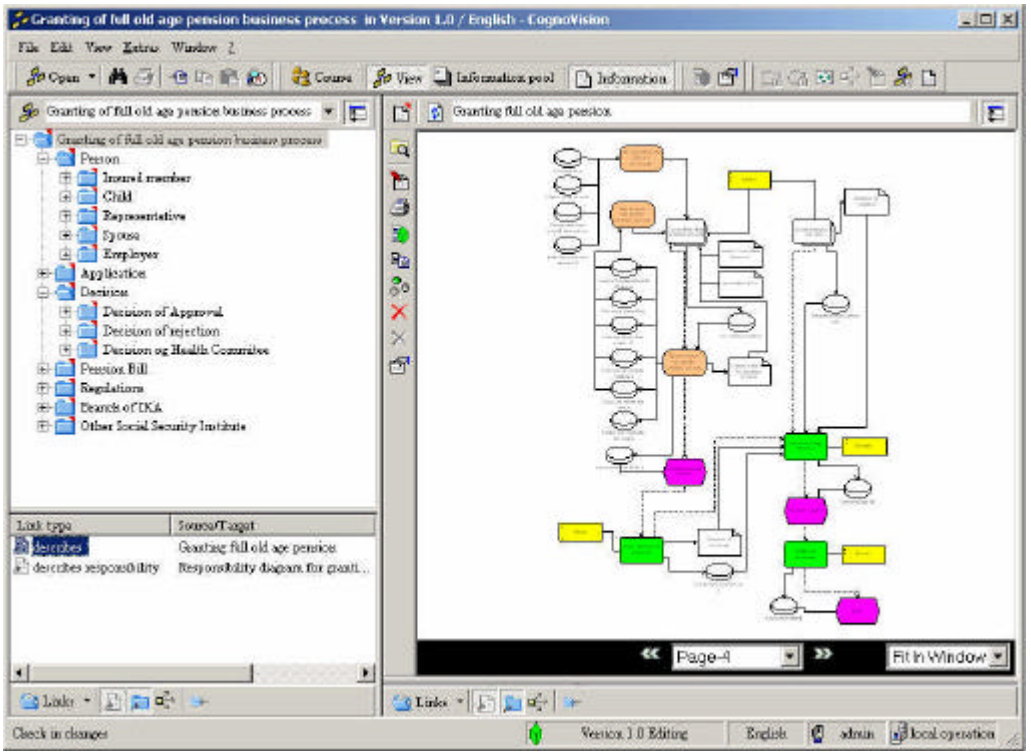

Figure 6. Part of the IKA's business process model

After application of the Business Process Knowledge Method, the model of IKA's "Granting of full old age pension" business process was developed, enhanced with Knowledge Management tasks for the knowledge flow in the business process. Figure 6 depicts part of the model as it is presented to the user.

The business process model is presented as HTML pages where the shapes are anchors for links in the knowledge archive. This means that the models can be used for navigating a knowledge network. By clicking on an object the user is given the object's attributes. The respective ontology was implemented in the DHC CognoVision® component of the Business Process Knowledge Modelling Tool (see Figure 7).

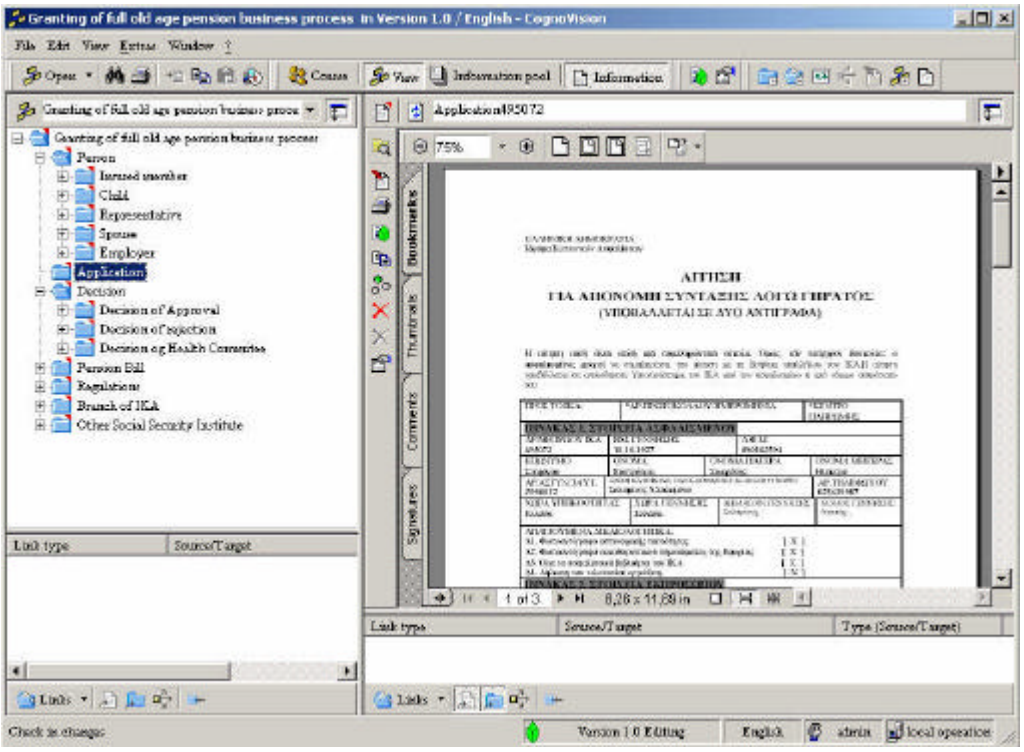

Figure 7. The process-oriented knowledge archive of IKA's "granting of full old age pension" business process

7. Related work

In many KM systems there is no explicit notion of business processes while there is some kind of knowledge-related processes support. On the other hand, in many business process management tools or workflow management systems the modelling and the enactment of business process are well supported. However, these systems lack the support for knowledge-related processes.

The importance of the combination of business processes with knowledge management tasks is also underscored by the knowledge value chain approach proposed by Weggeman (1998). His knowledge value chain is a continuously repeated process which is composed of six knowledge management tasks on the operational level: identify the required knowledge, document the available knowledge, develop, share, apply and evaluate knowledge. These tasks are linked to the strategic level (Mission, Vision, Goals, Strategy) and the business process named primary process such as order handling, for instance. Nevertheless, his approach does not provide a well developed method of how to integrate the mentioned knowledge management activities into the primary process either.

The links between the design of business processes and knowledge management are also stressed by Heisig (2000). He presents an approach to analyse the business process from a knowledge management perspective and tries to integrate knowledge management activities into daily business. Starting from the selection of the business area and business process, every task –which is considered to be a knowledge processing task- is assessed through its function and contribution to the core activities of knowledge management (i.e. generate, store, distribute, apply knowledge) resulting in a knowledge activity profile which shows the level of support provided by the operational task towards the core process of knowledge management. The business process is improved by closing identified gaps and by sequencing the core task of knowledge management.

The model-based knowledge management approach proposed by Allweyer (1998) adds a new perspective to the modelling of existing business processes, especially of knowledge-intensive processes. Knowledge management activities are considered as an integral part of existing business processes. The four level architecture of business process management is adopted for knowledge management and the method is renamed knowledge process redesign. The approach aims to the description of required and used knowledge as well as generated and documented knowledge. Knowledge is understood as information in context with value for the owner of this information which allows him to act. The approach claims to support the structuring of knowledge into categories and the construction of a knowledge map to locate who knows what inside the organization. Easy-to-understand pictograms are proposed to help users describe the use of documented and tacit knowledge within their business processes. The approach does not make explicit how to integrate the knowledge management activities into business processes and does not provide any criteria to analyse and improve the knowledge processing within the business process.

The idea of interrelating Knowledge Management Processes (KMPs) and Business Processes is also a main topic of the EU project PROMOTE [Karagiannis and Telesko (2000)] which has similar analysis goals and methods. Their method consists of five steps: Strategic Decisions-the Awareness phase, KMP Analysis, KMP and OM Modelling, Specification and Implementation, Evaluation and Continuous Optimisation. In PROMOTE, a Knowledge Builder is developed allowing users to model KMPs describing the knowledge flow in the business process. Business Process models are used to define when to access the OM and KMP processes are used to define how to access the OM. However, KM activities and BP tasks are not explicitly integrated in the modelling phase.

The usage of ontologies in order to provide task support in a business process is also a topic of the Task-Based Process Management project [Macintosh (1999). The TBPM system provides intelligent support for the management of complex, dynamic processes through the use of artificial intelligence techniques to represent, and reason with, knowledge about the domain in which a workflow system is deployed. A key component of the TBPM system is a plan library, which maintains a database of process structures, relating each structure to the types of tasks for which it is a suitable method. Each plan specifies a set of tasks, together with the ordering constraints and object flows between them. Thus, a plan represents one possible way of achieving a given type of task by breaking it down into a particular structure of sub-tasks. Central to the knowledge-based approach of TBPM is the development of a number of interrelated ontologies for structuring knowledge of the domain and processes of interest.

Ontologies have also shown to be the right answer to structuring and modelling problems by providing a formal conceptualisation of a particular domain that is shared by a group of people in an organisation [O'Leary (1998)]. A methodology for ontology-based knowledge

management can be found in [Staab et al. (2001)]. The methodology extends and improves the CommonKADS methodology by introducing specific guidelines for developing and maintaining the specific ontology. The most interesting part in contrast to other methodologies for ontology development [see Uschold et al. (1996), Guarino and Welty (2000)] is that this approach focuses on the application-driven development of ontologies.

8. Conclusions and further research

In this paper we presented an innovative approach that supports knowledge-intensive business processes by proactively offering to the users dealing with specific tasks context-sensitive knowledge from a knowledge archive. The proposed solution includes a powerful modelling tool that supports in an integrated manner the modelling of weakly-structured business process and domain knowledge structures and an engine that enacts such processes. Our solution is accompanied by a Business Process Knowledge method that offers guidance for introducing such a solution into an organisation.

Next steps in our work include the finalisation of the process enactment environment and the interfaces between the workflow engine and the intelligent agents that perform the context-sensitive knowledge retrieval and storage.

Furthermore, we work towards on providing electronic support for all the steps of our method. This means that we want to equip users with electronic forms that facilitate the gathering of all the information that are presently captured by hand, and also provide a graphical representation for drawing the domain ontology by adopting some of the symbols of the IDEF5 Schematic Language.

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