Intentional Analysis for Distributed Knowledge Management

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Abstract. Current knowledge management (KM) systems tend to presuppose a centralized approach to managing knowledge, assuming a single classification schema or ontology. In reality, organizations consist of many autonomous individuals and units cooperating and competing to pursue private as well as common goals. Knowledge needs exist from local perspectives as well as across different perspectives.

Novel approaches to knowledge management aim at taking into account these properties and at exploiting the distributed and local nature of knowledge in the organizations. A systematic approach for introducing KM technology solutions based on these approaches requires a deep analysis of the interests and intents of strategic organizational actors and of the dependency relationships among them.

This paper describes an approach based on intentional modelling techniques, aimed at capturing the strategic dependencies in the organizational setting, so that requirements for the KM system may emerge in a natural and well motivated manner. Actors, communities and their practices, as well as actors playing the role of mediators among communities, boundary objects and encounters are identified while conducting the analysis of the organizational setting, together with coordination mechanisms, such as perspective making and perspective taking processes. The analysis is pursued further, till the role of specific distributed KM technologies to be applied in the organization start emerging. Two examples from a health care administration case study are used to illustrate the approach.

1 Introduction

In knowledge management (KM) it is often remarked that technology is only a small part of the solution. Information technologies and systems in general face considerable risks and challenges during development and deployment, as

L. van Elst, V. Dignum, and A. Abecker (Eds.): AMKM 2003, LNAI 2926, pp. 351–367, 2003.

to KM. First, the agent mindset fit well with concepts that are suitable for modeling the needs of the so called "knowledge workers", i.e., individuals who need several kind of knowledge in order to execute their tasks. Adopting such a common set of concepts is crucial to allow the understanding of the influence that the social organization model has (or has to have) on the functionality and objectives of the final agent-based application.

Moreover, adopting an agent-oriented approach to requirement engineering results in a more uniform and coherent software development process, which can eventually lead to the implementation of an agent-based system.

In this paper, we argue that we need to analyze the intentional dimension of the organizational setting —the interests, intents, and strategic relationships among actors— in order to delivery effective KM solutions. Local perspectives result from differences in goals, know-how, and resources. Actors, communities and their practices, as well as actors playing the role of mediators among communities, boundary objects and encounters, are identified while conducting the analysis of an organizational setting together with coordination mechanisms such as perspective making and perspective taking processes. The analysis is pursued further till the role of specific distributed KM technology in the organization starts emerging. We use two examples from a health care administration setting to illustrate our approach. The intentional analysis is aided by a graphical modelling approach based on the ***i**** modelling framework [38]. This work complements recent work to develop technologies to support distributed knowledge management [6].

Section 2 elaborates on the theoretical background on distributed knowledge management. Section 3 describes two examples from the health care administration case study, with discussions from knowledge management perspectives. Section 4 outlines the use of intentional analysis as applied to the examples. Section 5 presents a brief overview of related work. Conclusions are given in Section 6.

2 Background

Traditional KM approaches, resting on a centralized view of knowledge, lead to the realization of KM applications based on one or a few repositories of documents, organized around a single ontology or other meta-structures. While these approaches may appeal to managerial control and appear to render intellectual capital more tangible and manageable, they often flounder in practice as users return to their normal, disparate ways of working once they fail to receive the expected benefits for their investments [7, 15, 23].

Explanations for this failure can come from organizational and cognitive sciences studies that characterize KM with respect to its social, distributed, subjective and inter-subjective nature. According to this literature, concepts like identity, knowledge and meaning are strictly connected to the idea of community as a typical social setting [36]. The idea is that complex organizations are made up of several sub-units called *communities*. A community is a group of people who share a set of elements, such as spaces, practices, artifacts or jargons, in order to reach some common goals. As an example, we can think to a company, which is made up of people belonging to different departments, each of them characterized by a physical location, meeting schedules, routines, a specific language, etc. This set of shared elements contribute to shape the community's identity, since it allows the members of the community to recognize each other. In the meantime, they contribute also to shape the community's boundaries since they allow its members to distinguish respect to people belonging to some other communities. Within its boundaries, a community develops its own internal knowledge schema (also known as mental model [26], mental space [20], or context [21]), with which its members can interpret what is internal to the community itself. Moreover, they can also develop ideas about what is external to it, such as the other organization's communities (which are the other departments or offices in the case of a company). The possibility of developing an idea about *who is outside* is at the root of any collaboration and cooperation dynamics within organizations: interaction among communities is based on different levels of context sharing. Wenger [36] discusses a set of elements which support these interactions, such as:

– *Mediators*: people who work between communities playing the role of broker between groups (for example, a project manager who has to coordinate people with different competencies);
– *Boundary Objects*: objects that are used by more than one community, even if for different goals (for example, a job contract with administrative details, content details, legal details, etc.);
– *Boundary Encounters*: events that gather together communities (for example, a convention, or a conference).

Thanks to this kind of elements, a community can get in touch with other communities, and try to understand the other's world —the other's perspective— but always resting on its own specific knowledge schema. In this sense, knowledge is always local, since each piece of knowledge is intrinsically linked to the specific context where it has been developed. Moreover, in order to open the collaboration, a community has to make explicit a part of its own perspective, even though much of the knowledge is implicit or tacit [32], since it is embedded in the community's everyday life, within processes, structures, roles, spaces, tools.

According to this conceptual framework, a basic logical architecture for KM solutions must include both means to support each community to autonomously manage its own local knowledge —that is, supporting the *perspective making* process [5]— and means to support the collaboration among communities — that is, the *perspective taking* process [7]. The latter includes:

1. *context*, that is an explicit representation of at least part of the communities knowledge system;
2. *mapping*, that are relations between a community's context and the others';
3. protocols for *meaning negotiation*, to allow individuals to interoperate by exchanging knowledge on the basis of the identified mappings.

There are several possible technological realizations of these components. For example, within EDAMOK, the development of the discussed architecture is made by a peer-to-peer communication infrastructure and agents communication protocols [6], by XML-based representation language [8] and by meaning negotiation algorithms [27].

To complement the theoretical framework and its embodiment in technology, we are investigating on the development of a requirement analysis methodology, based on the *Tropos* methodology [9]. The methodology being developed is based on agent abstractions. That is, to complement the use of agent technologies as a software paradigm, we use agent concepts to characterize and analyze the world in which the software agents will function [39].

3 A Case Study

The Health Care domain offers rich and interesting scenarios for the application of KM (see, e.g., [30]).

In the following, we present two examples derived from an analysis conducted at the Hospital Santa Maria della Misericordia in Udine (Italy), with the aim of investigating the knowledge management needs of the organization, and of analyzing requirements for possible KM solutions.

3.1 The *Cartella Integrata*

In order to have all the information about a patient accessible by the different wards involved in the care-flow, as well as to fulfill legal requirements, the hospital maintains a paper folder which contains all the documents, data and information on the patient, collected during her stay in the hospital. This folder is called the *Cartella Clinica*. In the case of a patient who has been transferred in more than one ward (for example, in the case of a patient initially hospitalized in the Emergency ward, then transferred in the Acute Care ward, then in the General and Internal Medicine ward and finally in the Surgery ward) the Cartella Clinica could became quite a thick volume, where information, which are stored simply in a chronological order, are very difficult to be accessed. The physicians and nurses of a ward, who have to get all the information about a new incoming patient, spend a lot of time reading all the data to find out only those that are relevant in their perspective.

This process is perceived as quite problematic by the involved workers, who complain about the large amount of time and efforts needed to deal with the Cartella Clinica.

The Surgery Ward is currently experimenting with an organizational solution called *Cartella Integrata*, which consists in delegating the task of filtering information collected from the Cartella Clinica to an expert nurse of the ward. The nurse extracts only the information and data that are relevant for the surgical operation, and organizes them into another clinical report, called the *Cartella Integrata*, that will be read by the surgeon before the operation.

From a KM perspective, in this scenario we can identify different individuals (the physicians and nurses involved in the patient's therapy) and communities (the hospital and the wards), which produce knowledge about the patient according to their own objectives (i.e., their own perspective on how to cure patients). This knowledge is immediately captured, while it is generated during the ongoing work, via the business process related to the maintenance of the Cartella Clinica. Such a process simply corresponds to adding new sheets to the centralized and physical archive. The only *shared* part of the *data schemata*, so to speak in terms of database concepts, is the *primary search key*, that is, the record date and time, also used, of course, for the physical sorting; for the rest, each kind of record (and possibly, even each single record) has a different structure. Obviously, such an archive becomes quite soon an inaccessible and inviable resource, and represents an unsatisfactory solution to the problem of enabling the workers of the different wards to easily access the existing knowledge on a patient. Using the terminology introduced in Section 2, the Cartella Clinica, due to its potential use from different perspectives and as a cross-communities bridge, can be seen as a *boundary object* for the different wards, which, on their own, can be seen as *communities*—with their own resources, knowledge and practices. Yet, it's evidently a too weak solution. To improve the situation, the solution of the Cartella Integrata, in some sense, adopts some of the Distributed Knowledge Management assumptions: the nurse performs a real *mapping* (done by hand) between two *contexts*: the first is represented by the individual ward that has produced knowledge on a specific patient and then recorded it within the Cartella Clinica, and the second is the Surgery Ward context (her own context), that needs relevant knowledge on the patient in order to properly plan the operation.

3.2 The Emergency Ward Nurse Teams

The Emergency Ward is made up of several units: Emergency Room, 118 Operative Center[5], Temporary Observation Unit[6] and Neonatal Pathology.

The Emergency Room and the Temporary Observation Units are directed by a chief physician and a chief nurse and are provided with two nurse teams. The chief nurse complained about the lack of collaboration that sometimes emerges among nurses of the two teams, each of them thinking she works harder than the others. She says that, in spite of the fact that she told them that: "everyone does the same work, which differs only for the different unit's needs", each nurse keep on thinking to be the *hardest worker* and the consequence is that they do not feel as part of the same team.

Referring to the elements supporting interaction dynamics that we present in Section 2, the chief nurse plays the role of *mediator*, since she works in both

[5] The telephone number 118 is the Italian correspondent of 911, but limited to medical emergencies.

[6] The Temporary Observation Unit is the area where patients are temporary kept in order to better understand the gravity of their conditions and in which specialized ward they might be eventually transferred.

the communities, but the resulting conflict demonstrates that, in this specific situation, this element is not enough to promote the perspective making mechanism.

In order to resolve this situation, the chief nurse is introducing the use of the work rotation: nurses are required to take teams to work in each unit so that they can become aware of their respective situations.

This solution is rather a case of *Boundary Encounter*. In particular it is the case called *Immersion* in [36], that consists in "visiting a practice" of another community, in order to better understand its internal configuration and its relations with the rest of the world.

The key of the solution is then in proposing a sort of perspective taking through practice. In a sense, this can be considered as a proof that the tacit knowledge about the demands and challenges of the different roles need to be experienced directly.

4 Intentional Organizational Modelling and Analysis

In both the examples presented in the previous section, one can envisage some of the problems that can arise if organizational and, possibly, technological solutions are applied without careful consideration of the intrinsically distributed nature of the organization itself, which lead to issues such as the autonomy of organizational units and actors, and the locality and distributed nature of knowledge.

In order to be able to carry on such a careful analysis, a systematic methodology for developing KM systems has to be provided with appropriate representational tools. Conventional techniques for requirements analysis (such as ER modelling [12] and Object Oriented methods) are inadequate for modelling and reasoning about organizational issues [39].

In this section, we illustrate how the organizational issues from the two examples can be brought out more clearly and systematically using an intentional modelling approach.

Intentional analysis allows us to model complex relationships among social actors in terms of their interests and intents and of the strategic relationships among them. Unlike behavior models, intentional models allow us to focus on *why* questions: What are the goals of the actors? Who share these goals? What are the divergent goals that lead to different perspectives? Why are particular behavioral or informational structures chosen? What alternatives are considered? What are the reasons for choosing one alternative over the others?

The ***i**** framework [38] supports intentional analysis through actor and goal modelling and provides an intuitive diagrammatic representation of these models. Here the concept of actor represents an abstraction of the concept of agent used in software development paradigms. The intentional elements in ***i**** are goal, softgoal, task, and resource:

- a *goal* is a condition or state of affairs in the world that the actors would like to achieve;

- a *task* specifies a particular way of doing something, a particular course of action;
- a *softgoal* represents a state of affair that should be reached but only at a qualitative level, that is, differently from goals, no clear-cut criteria can be given to decide whether a softgoal is satisfied or not, but only an approximate notion of *satisfiction* can be given.
- a *resource* is any physical or informational entity, about which the main concern is whether it is available.

Intentional links between the above entities, in ***i****, include dependency links between pairs of actors which allow to model the fact that one actor depends on another in order to attain some goal, execute some plan, or deliver a resource. The former actor is called the *depender*, while the latter is called the *dependee*. The object (goal, plan resource) around which the dependency centers is called *dependum*. By depending on other actors, an actor is able to achieve goals that it would otherwise be unable to achieve on its own, or not as easily, or not as well. At the same time, the depender becomes vulnerable. If the dependee fails to deliver the dependum the depender would be adversely affected in its ability to achieve its goals. These type of information can be graphically depicted trough *Strategic Dependency diagrams*, graphs whose nodes represent actors (circles) and whose arcs represent dependencies (a couple of arrows linked by its dependum). In ***i**** actor's goals (or tasks) can be analyzed from the actor point of view, and depicted in a sort of balloon, called *Strategic Rational diagram*. For instance, for goals, means-end analysis proceeds by refining a goal into subgoals in order to identify tasks, resources and softgoals that provide means for achieving the goal (the end). Contribution analysis allows the designer to point out goals that can contribute positively or negatively in reaching the goal being analyzed. Decomposition allows for a combination of AND and OR decompositions of a root goal into sub-goals, thereby refining a goal structure. In the remainder of this section we sketch an intentional analysis of the two examples previously introduced.

4.1 Intentional Analysis of the Emergency Ward Nurse Teams Case

We illustrate here a possible intentional analysis of the case of the emergency ward nurse teams.

In this example the key of the solution consisted in proposing a *perspective taking* by practice. It will be here interesting to see how a simple analysis of the topological properties of the ***i**** diagrams describing the two different perspectives puts into evidence the quality of the proposed solution.

As mentioned, this example requires to compare two different settings: first, we need to analyze the state of affairs that generates the nurse's conviction to be the hardest worker. Then we can analyze if this state of affairs changes after the work rotation experiment.

In other terms, we must describe the different perspectives of the nurse before and after the work rotation experiment. The ***i**** model depicted in Figure 1 includes the actors Chief Nurse, ER Nurse, Unit, ER, and Temporary Observation

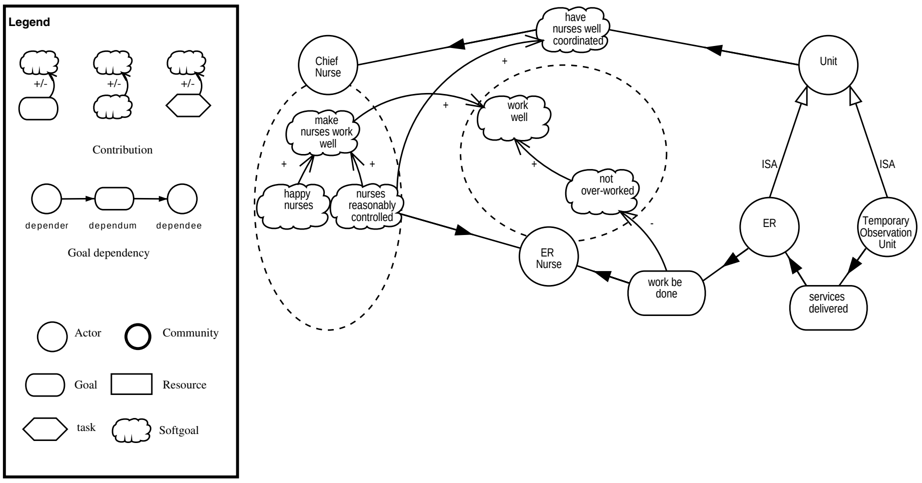

Fig. 1. ***i**** model for the Emergency Ward Nurse Teams Example.

Unit. Here, the point of view of the *unhappy* ER nurse is considered: she is willing to work well (softgoal work well) but at the same time she believes that she is probably working too much (and thus not well) because of the requests of work coming from her own unit (goal work be done) that also include requests originally coming from the Temporary Observation Unit (see the goal dependency services delivered between Temporary Observation Unit and ER, which eventually has to be delegated to the nurse). This makes her reluctant to be cooperative. In order to take into account the softgoal have nurses well coordinated, the chief nurse wants nurses controlled. This may also contribute positively to the chief nurse's own softgoal make nurses work well. The diagram puts in evidence the fact that the unit nurse is the target of different dependencies (here only work be done and nurses controlled are depicted, but other could be added), while she has no control or dependency on other actors. This configuration corresponds to an unbalanced situation with the clear identification of a weak element in the dependency chain: the nurse. Of course this is a particular *perspective* the nurse has on the real scenario. Figure 2 depicts the new nurse's perspective, that derives from the application of work rotation. Notice that now the two actors ER Nurse and Temporary Observation Nurse represent the two roles that the same nurse plays according to the work shift. In this way we modelled the *Immersion* Boundary Encounter (introduced in Section 2) of the nurse and the new points of view developed by her as a consequence of this. In the new perspective, be well coordinated is a nurse's softgoal that is not in conflict with the chief nurse's softgoal nurses controlled (we can even think it is reinforced by it), thus leading to a synergy and positive contribution to the softgoal not over-worked. The latter is no longer hurt, now, by work be done and services delivered, they being now equally distributed among the units. As a result, not over-worked is enabled

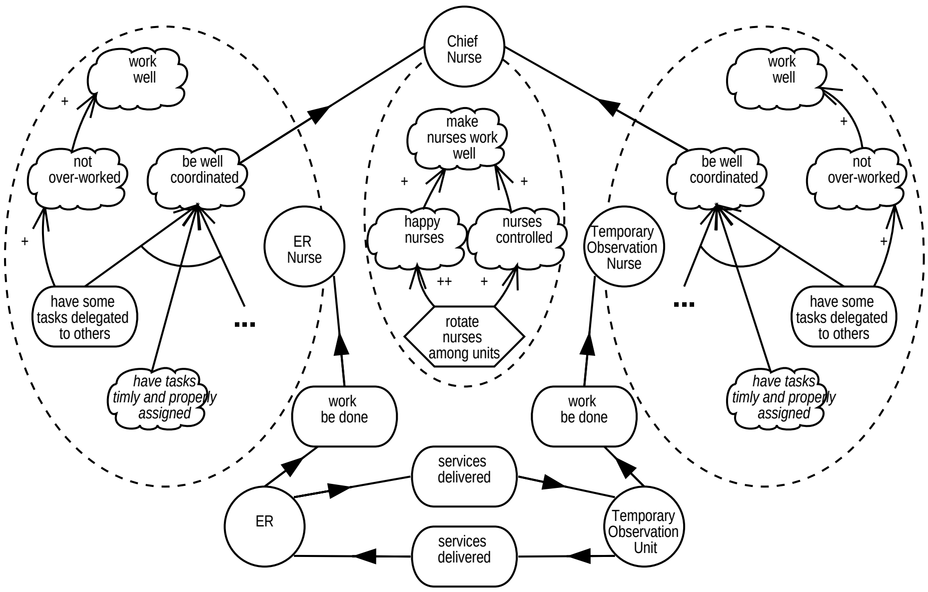

Fig. 2. ***i**** model of the nurse's perspective taking in the Emergency Ward Nurse example.

and, thus, it may positively contribute to work well. Note that the solution here has been obtained not by means of a major business redesign, but simply by introducing a simple change (the work rotation) that the analysis reveals to be a sort of perspective taking mechanism, through practice. The intentional analysis together with the ***i**** representation allows to make this observation evident also in terms of diagram topology. The first diagram places the nurse at the center of the picture, as a target of several intentional dependencies, while the second diagram is much more symmetric, introducing also dependencies the nurse may have on other actors.

4.2 Intentional Analysis of the *Cartella Integrata* Case

In the example on the Cartella Clinica and Cartella Integrata we have seen that different actors (the hospital, the wards, the surgeon and the nurse) deal (directly or indirectly) with some representation of clinical data (the Cartella Clinica and the Cartella Integrata) for different purposes. Here we propose to extend our analysis by explicitly introducing some intentional elements (the goals of the various actors) and the related intentional dependencies among the actors. The intuition is that, by doing so, we will be able to recognize possible ways to change the current setting and, eventually, propose also some kind of technological solution that can better fit the needs.

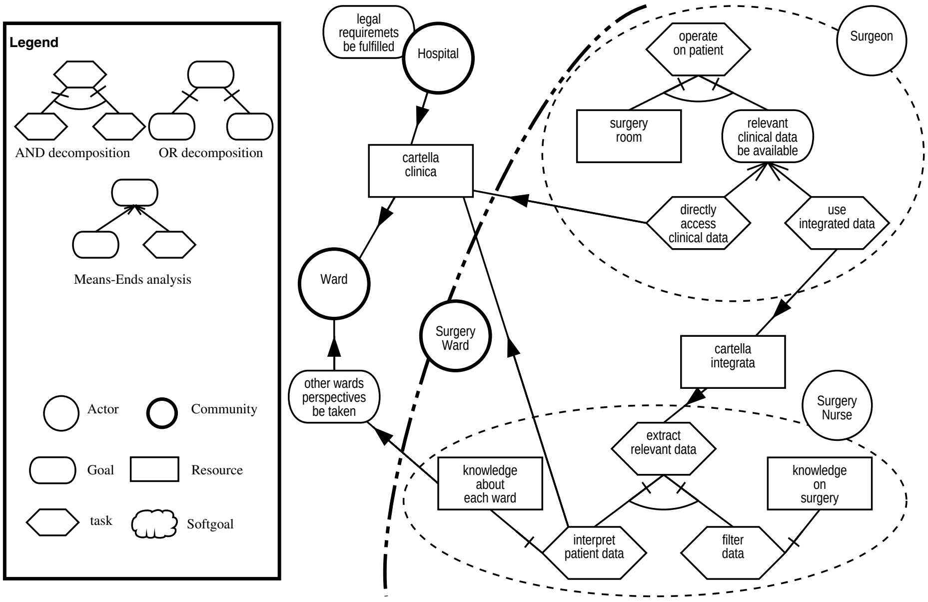

Fig. 3. Intentional model in ***i**** notation for the *Cartella Integrata* example.

The intentional analysis starts considering two of the main actors and their expectations: the Hospital (as an administrative organization), that has to fulfill several legal requirements, and the Wards. In Figure 3, they are represented with thick-line circles (corresponding to *communities*, special kind of actors). The right part of Figure 3 includes the *expansion* of the Surgery Ward model, where details of two of its relevant actors (the Surgeon —with the task operate on patient— and the Surgery Nurse) are shown.

The community Hospital has the goal legal requirements be fulfilled, that is, being able to provide patients' data on request. To this end, it depends on the wards for having them available in the Cartella Clinica. Thus ,the resource cartella clinica is part of a dependency between the Hospital and the Wards. As well, having each ward recording the patient info in the cartella clinica results in a way to satisfy the hospital goal of legal requirements be fulfilled. On the other side, in order to operate on a patient, the surgeon needs relevant clinical data that may have been produced by the wards the patient was cured by. This comes out from the analysis of the task, conducted from the point of view of the actor Surgeon, as depicted inside the upper-right dashed circle in Figure 3 (see the goal relevant clinical data be available). Two possible means to fulfill this goal are evidenced. Either, the surgeon can access the relevant data by herself and, in order to accomplish this task, she depends on the other wards to have the cartella clinica available (this is depicted in Figure 3 by the resource dependency linking the Surgeon's task directly access clinical data to the community Ward), or

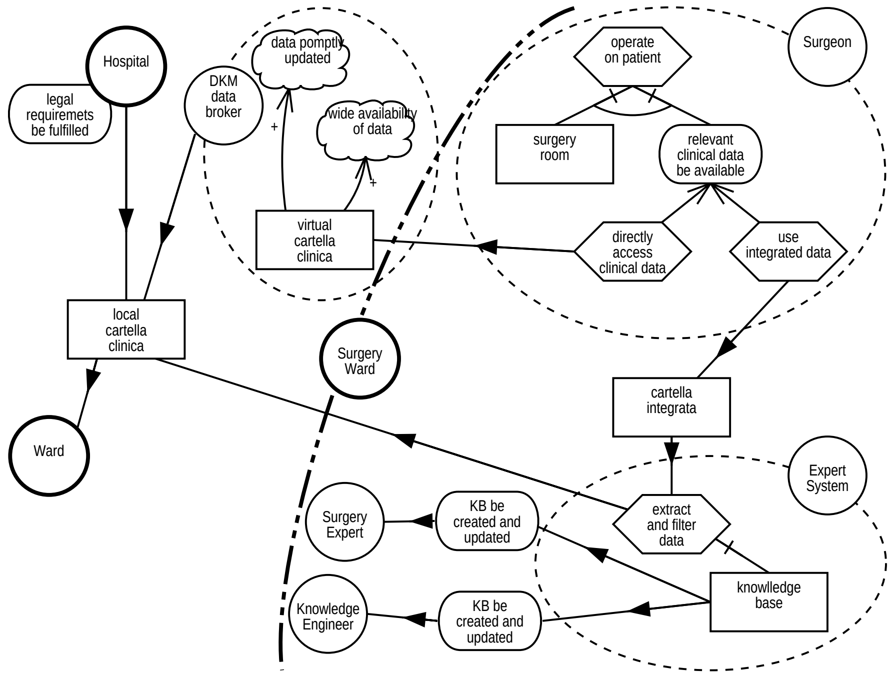

Fig. 4. Technological issues in the *Cartella Integrata* example.

she can save time and delegate the task extract relevant data to an expert nurse who then collects them in a specific report, that is the Cartella Integrata (see the resource dependency upon cartella integrata, in Figure 3). The actor Expert Surgery Nurse will satisfy the cartella integrata dependency by performing the task extract relevant data, that, upon a further analysis, can be AND-decomposed in the two sub-tasks: interpret patient data (from the original cartella clinica) and filter data (to be put into the cartella integrata). In order to perform her tasks, the nurse needs two kinds of knowledge: the knowledge on surgery and the knowledge about each ward. Notice that the first kind of knowledge pertains to the nurse's original *perspective* (she is a nurse of the surgery ward). On the other side, to have the appropriate knowledge about each ward, she depends on each Ward, specifically for the fulfillment of the goal other wards' parpectives be taken.

The analysis can be extended to consider possible technological solutions. Just to give the flavor of the idea, let's first consider the solution based on the cartella integrata. Assuming a strong commitment of all the hospital organization to transform the Cartella Clinica into an operational IT based resource, the procedure to obtain the cartella integrata could be partially, or even totally, automated, e.g., by using some information and knowledge driven pattern based classification mechanism, or any other expert system solution. Of course, at this point, other issues arise, as, for example, who (and how) should provide the explicit knowledge necessary to drive the expert system, which is the process to kept this knowledge base up to date, and how can the knowledge schema be matched with information structure underling the information system that manage the Cartella Clinica. In Figure 4, this solution is briefly sketched by introducing, aside the actor Expert System (a technological system belonging to the Surgery Ward) also the actors Surgery Expert and Knowledge Engineer, who have to provide and maintain the knowledge necessary to the Expert System. In this rough analysis is not analyzed *how* these tasks can be performed, nor it is analyzed if the roles of Surgery Expert and Knowledge Engineer may be covered by other actors, as, e.g., the nurse or the surgeon. As well, we can also observe that, in the figure, simply a replica of the same goal is assigned to each of the two new actors; further analysis may, of course, lead to a distinction of the two goals in two more specific goals for the two actors, but it is out of the scope of this paper to push further our insight.

Figure 4 also sketches some elements of the technological solution associated to the possible automation of the alternative solution already sketched in Figure 3, that is, the one in which the surgeon herself directly access the Cartella Clinica. Of course this can be considered as preferable in the case in which coding the relevant knowledge inside an expert system appears to be too complex and risky. A KM —or better DKM— tool, including context mapping algorithms, may be provided to support the surgeon in the task of accessing and filtering out the relevant knowledge. In a DKM solution a "virtual" Cartella Clinica, based on the distributed availability of the data from the different wards, can be proposed as a guarantee of robustness, reliability, and flexibility at the same time [4]. This mean that data pertaining the different wards are locally managed in local cartella clinicas, and a DKM data broker sub-system is implemented, to provide requested data to diverse clients (like, e.g., the Surgeon, or, more precisely, an appropriate computerized front-end for the Surgeon) in the most appropriate form and level of detail, according to each client needs and requests. This does not necessarily means that the DKM data broker has to maintain an integrated copy of the data from the all local cartella clinicas, but it has instead to manage appropriate *viwes* on the different local cartella clinicas, and run appropriate matching algorithms to collect, assemble, and rearrange the data for the clients.

The use a the virtual cartella clinica allow us to envisage some advantages (depicted as softgoals in the Figure), with respect to the other solution, as having data promptly updated and having wide available of data, that is, the possibility of accessing, just in case of necessity, to data that would be filtered out by the Expert System or the Expert Nurse.

It is worth noticing that this second solution can be deployed only if supported by IT, that is, only in the case in which the hospital organization decides to move from the current version of Cartella Clinica in its paper form, to an electronic version. This also explains *why* the solution of Cartella Integrata is the one currently adopted by the surgery ward: is the only one that offer some advantage to the surgeon (the most critical resource in the surgery ward comthey need to be shaped to respond to the specific needs of the organizational environment. Many system projects are abandoned or fall into disuse because of inadequate understanding of the organizational context. In the case of KM applications the challenges are amplified because the issues addressed are more complex and more varied, and the experience base is still small and spotty.

For traditional information systems there are well-established techniques and methods for system development and management. Of particular interest are methods for requirements elicitation and analysis, aimed at matching organizational needs with technical capabilities and system qualities. Modelling techniques such as ER diagrams [12], SADT [3], and more recently UML [2] are widely used. However, these are geared primarily towards systems for routinized work, with highly structured data, or reactive systems with well-specified behavior. KM focuses on the effective use of human intellectual capital and much of human knowledge is tacit and intangible. Therefore, KM calls for a much deeper understanding of the environmental context. Issues such as community, community's practices, sharing and cooperating through perspective making and perspective taking processes, go much beyond those typically considered in the conception of traditional information systems, and opens up many more ways to leverage information technologies to augment human and organizational capabilities and performance.

Yet, most KM solutions presuppose or promote a unified knowledge schema or ontology, for example, to facilitate knowledge capture, access, sharing, preservation, and/or inventory. Novel approaches, based on distributed systems technology, such as Multi-Agent Systems (MAS) [16, 10, 19] and peer-to-peer technology [29], promise to fill the gap between the intrinsic nature of KM problems and the technology component of KM solutions. This is also a basic objective of the EDAMOK[4] project, a joint effort of the Institute of Technological and Scientific Research (irst) and of the University of Trento, in which a distributed KM paradigm has been adopted and implemented in a peer-to-peer platform [6].

Given the richness and complexity of a real-life organizational setting and the availability of distributed system technologies, the practical question is about what kind of analysis must be carried on to determine the types of KM solutions that are appropriate and may be effective. How do we translate application domain concepts into system requirements and design parameters? The characterization of a system traditionally given in terms of *input-transform-output* needs to be extended to incorporate concepts from the interdisciplinary studies in knowledge management and social organizations.

This motivated the proposals of novel methodologies for requirements analysis based on an organizational perspective [17, 28] and extending approaches that were originally proposed in Agent-Oriented Software Engineering [13, 22, 37]. In [16] the suitability of the Agent paradigm for KM is discussed, both at the technological and at the methodological level. In our opinion, there are at least other two important reasons that motivate the adoption of agent oriented approaches

[4] EDAMOK stands for "Enabling Distributed and Autonomous Management of Knowledge".

munity) without requiring the use of IT. In the hypothesis of a technological improvement, the analysis briefly drawn above suggests that probably a more advantageous solution can be proposed.

5 Related Work

Different lines of research are relevant to the work presented here. In Section 2 we already mentioned research from organizational and cognitive sciences that provide us with distributed KM theoretical concepts.

Work on technological solutions for KM, such as peer-to-peer (see for instance the SWAP project [18]), MAS, (see for instance the FRODO project[7], the COMMA project and [10] and [19, 16]), and mixed approaches [4] provides a technological counterpart to some of these theoretical concepts, for instance, peer group can be used to implement virtual communities.

Interesting to our research are works that focuse on specific KM applications and develope both models and technological solution for a subset of KM processes. The problem of supporting the members of an R&D team to share their experience and to mantain a domain (project) knowledge is discussed in [34]. A characterization of KM processes taking place in a project team is proposed, namely processes such as *preserving*, *searching*, and *validating* project knowledge by team members, as well as *familiarizing* with project knowledge by a team newcomer are considered. This classification bears some relationship with what we considered processes aimed at building and mantaining a community context (the first three) and collaboration processes such as perspective taking (the last one). A software environment devoted to exploit the day-to-day operations performed by team members on desktop computers is also proposed in [34], it rests on Case-based reasoning techniques. A deep analysis of the information needs raised by the user of an information management system is described in [19], and related KM process, such as that of the management of knowledge that is valuable to a group, are considered. Moreover a conceptual model (called *Agentized, Contextualized Filters (ACFs)*) and a proptotype (called *Vividoc*) is presented.

Focusing on methodologies, the following agent-oriented software engineering approaches are worth to be mentioned:

- the methodology proposed by Dignum [17] that adopts an organizational perspective to domain analysis, analogous to that proposed in ***i****;
- the *Agent-Object-Relationship (AOR)* methodology [35] which proposes a set of concepts and relationships for modelling organizational information systems extending UML notation (via UML stereotypes). The methodology provides also a set of diagrams and guidelines to go from analysis to detailed design. In particular, it has been applied to design an agent-based peer-to-peer helpdesk system at support of extra-class interactions among students and teachers [24];

[7] http://www.dfki.uni-kl.de/frodo/

– the *Tropos* methodology [9] which proposes a requirement driven approach to software development adopting intentional modelling methods and techniques which are rooted in organizational studies.

We share a basic objective with other methodologies, such as scenarios-based analysis [11], DECOR [33] or CommonKADS [25], that is we consider all the stakeholders, and in particular the users, as central actors in the analysis of the organization where the system-to-be (either a new process or a new software system) will be deployed. A few differences are worth to be mentioned. Scenario-based design consists, basically, in analyzing a particular situation where a user exploits a specific set of facilities in order to achieve a specific outcome, under specified circumstances or time intervals. In our approach (i* dependency diagram), we do, in a sense, scenario-based analysis for eliciting the intentional model, focusing on "why" questions (i.e. why using a facility instead of another one, why giving priority to the achievement of a specific outcome, etc.). CommonKADS proposes a methodology based on six phases, each one supported by a tool, a specific model and a template, which has to be filled. Resting on the *Tropos* methodology, our approach gives a relevant role to requirement elicitation and specification, (two phases which precedes architectural design and detailed design in *Tropos*), using the same conceptual modelling language and the same analysis techniques. Methods proposed in DECOR system are rather interesting in KM context and can be usefully applied in analyzing a generic KM scenario. As pointed out in Section 2, we adopt a KM paradigm that exploits autonomy and distributedness of knowledge, so a methodology based on intentional analysis seems to be more appropriate.

Work in requirement engineering is also relevant. In particular, we refer to approaches that propose goal analysis techniques to get a deep understanding of an application domain and of system requirements [14].

6 Conclusion

In this paper, we pointed out the theoretical background we are referring to in the context of our research on a methodological framework for KM. We borrowed concepts proposed in organizational and cognitive sciences [5, 36] such as community, mediators, boundary objects and encounters, and concepts proposed to describe sharing and coordination among communities, such as perspective making and perspective taking. We showed that intentional analysis allows to identify and model these elements in an organizational setting in which a KM solution will be delivered. In fact, it offers a methodology to model the intentional dimension of an organization, as well as to perform elicitation and analysis of the solution requirements. In the paper we motivated the use of intentional analysis to complement the distributed KM theoretical framework adopted in the EDAMOK project and its embodiment in technology. Two examples from a hospital case study have been used to illustrate it. In all the examples, aspects such as local vs. distributed knowledge and needs for actors cooperation are relevant. From the analysis, the actors' local perspectives resulted, basically, from differences in their goals, know-how, and resources. The effects of distributed KM solutions —at the organizational level or at the technological level— have also been shown into the models.

Future work will be aimed at integrating intentional analysis for KM into an agent oriented software engineering framework [31], in order to offer both a methodology and a technology support to the analysis, design and development of distributed KM applications.

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